

Arab and Muslim Contributions to Modern Neuroscience

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Introduction

Medicine did not develop overnight. The civilizations of Egypt, Greece, Rome, Persia, India, China and the European Renaissance took up the responsibility of the flame of medical development. During the Dark Ages the medical flame was taken up by the Arabic-Islamic world. The period between the 7th and 13th centuries has been commonly neglected, despite the remarkable developments of biomedical science of the Arabic-Islamic world with the resultant flowering of knowledge that influenced medical practice throughout Europe (Falagas et al., 2006). We could say that the history of any nation is equal to the sum of the history of a few of its distinguished individuals. At every stage in Arabic medical history we can find outstanding people whose greatest contributions and efforts cannot be underestimated. We shall illustrate this with some examples of those whose books contributed towards the development of Medieval European neuroscience.

Terminology

The modern discipline of psychology began in the 19th century. In the pre-modern context, the term 'psychology' refers to the study of human mind and behavior, while the term 'mind' refers to human intellect and consciousness. So it must be made clear that medieval Islamic psychology does not deal with the mind only (Ashy, 1999). Early Arab and Muslim scholars wrote extensively about human psychology. They used the term *Nafs* (self or soul) to indicate individual personality and the term *fitrah* (nature) as an indication for human nature. *Nafs* is a broad term that includes the *qalb* (heart), the *ruh* (spirit), the *aql* (intellect) and *irada* (will). Early Muslim scholars had a certain philosophy in their writing that encompassed all areas of human enquiry, i.e. the knowledge of all things, both divine and human (Ashy, 1999). Therefore, Islamic psychology, or *Ilm-al Nafsiat* (psychological sciences), refers to the study of *Nafs* (self or psyche) and is related to psychology, psychiatry and neurosciences (Deuraseh and Abu Talib, 2005). *Al-ilaj al-nafsy* (psychological therapy) in Islamic medicine is simply defined as the study of mental illness and is equal to psychotherapy, as it deals with curing/treatment of ideas, soul and vegetative mind. The psychiatric physician was referred to as *al-tabib al-ruhani* or *tabib al-qalb* (spiritual physician) (Deuraseh and Abu Talib, 2005). Moreover, the Islamic and Arabic psychological era includes the establishment of the first mental hospitals, the development of the first clinical approach to mental

illness, and a unique experimental approach to the study of the mind (Khaleefa, 1999; Paladin, 1998).

Neuroscience and psychology

Islamic medicine stressed the need for the understanding of human mental health. The first psychiatric hospitals and insane asylums were built in the Islamic world in Baghdad in 705, Fes (the third largest city in Morocco) in the 8th century, Cairo in 800, Damascus and Aleppo in 1270 (Syed, 2002). The most characteristic features of medieval Muslim psychotherapy were the use of clinical observations of mentally ill patients, which resulted in the provision of ground-breaking applications of moral treatment, baths, drug medication, music therapy and occupational therapy (Syed, 2002). The concepts of mental health and mental hygiene were introduced by the Muslim physician Ahmed ibn Sahl al-Balkhi (850-934) (Table 1). His book, *Sustenance for Body and Soul* (in arabic: *Masalih al-Abdan wa al-anfus*), was the first book that discussed psychosomatic diseases with an emphasis on mind and body: "if the *nafs* (psyche) gets sick, the body may also find no joy in life with development of a physical illness" (Deuraseh and Abu Talib, 2005). Ahmed ibn Sahl al-Balkhi was a pioneer of psychotherapy, psychophysiology and psychosomatic medicine. He was the first one who recognized that the body (fever, headache) and the soul (anger, anxiety and sadness) can be healthy or sick or balanced or imbalanced. He recognized two types of depression: one caused by known causes (physiological reasons) that can be treated through physical medicine; and the other caused by unknown reasons that can be treated psychologically (Deuraseh and Abu Talib, 2005). Najab ud-din Muhamed (10th century) made careful observations of mentally ill patients with detailed descriptions of a number of mental diseases including agitated depression, neurosis, peripartum and sexual impotence (*Nafkhae Malikholia*), psychosis (*Kutrib*) and mania (*Dual-Kulb*) (Syed, 2002; Youssef and Youssef, 1996).

Al-Balkhi and Muhamed ibn Zakariya Razi (Rhazes) were the first known physicians to describe psychotherapy. Razi's books (*El-Mansuri* and *Al-Hawi*) formed landmarks for the description of mental illness in the 10th century and provided definitions, symptoms and treatments for problems related to mental health and mental illness. Razi was also the director of a unique psychiatric ward in a Baghdad hospital. Such psychiatric clinics did not exist in Europe during that time for fear of demonic possessions (Figure 1) (Syed, 2002).

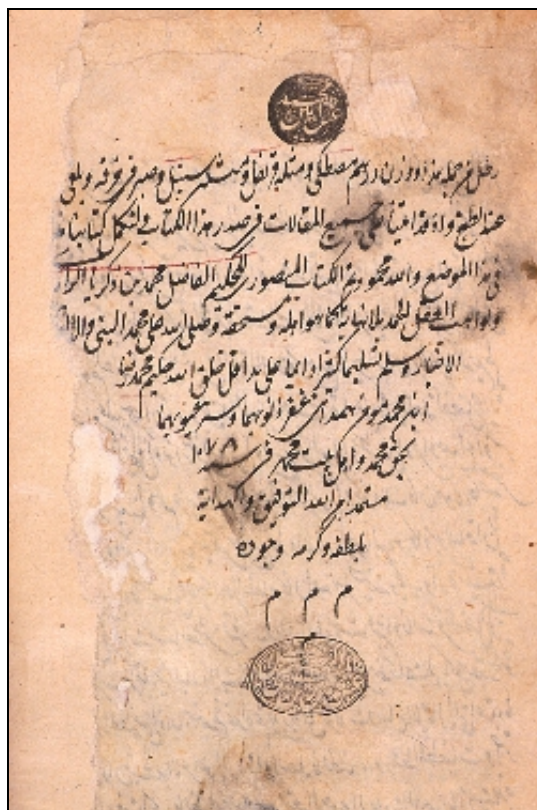


Figure 1: Razi's *Book of Medicine for Mansur*.

Ibn al-Haytham (Figure 2) is considered to be the founder of the experimental psychology and psychophysics (Khaleefa, 1999) with his distinguished book on the psychology of visual perception, *Book of Optics* (Steffens, 2006). Ibn al-Haytham was the first scientist to argue that vision occurs in the brain rather than the eyes in his *Book of Optics* (Edition III). Moreover, he pointed out that personal experience has an effect on what people see and how they see and that vision and perception are subjective feelings (Steffens, 2006).



Figure 2: Ibn al-Haytham.

Al-Biruni (Figure 3) was a pioneer in experimental psychology as he was the first person to describe empirically the concept of reaction time (Iqbal, 1999):

"Not only is every sensation attended by a corresponding change localized in the sense-organ, which demands a certain time, but also, between the stimulation of the organ and consciousness of the perception an interval of time must elapse, corresponding to the transmission of stimulus for some distance along the nerves."

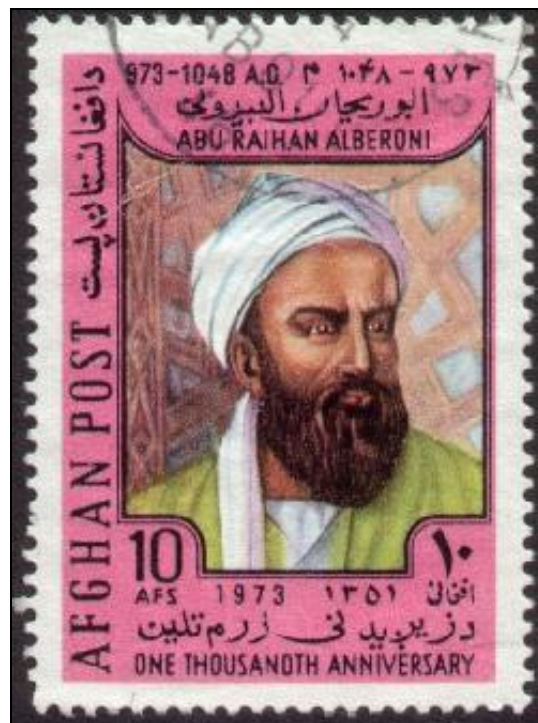


Figure 3: Abu Baihan Alberuni. Afghanistan postage stamp, 1973.

Ali ibn Abbas al-Majusi (AD 982) discussed how the physiological and psychological aspects of a patient can have an effect on one another in his famous book, *Complete Book of the Medical Art*. He found a correlation between patients who were physically and mentally healthy and those who were physically and mentally unhealthy, and concluded that "joy and contentment can bring a

better living status to many who would otherwise be sick and miserable due to unnecessary sadness, fear, worry and anxiety" (Deuraseh and Abu Talib, 2005). He is also the first person to discuss in detail such mental disorders as sleeping sickness, memory loss, coma, meningitis, vertigo, epilepsy and hemiplegia. Moreover, he emphasized the preservation of health through diet and natural healing as much as on medication or drugs (Haque, 2004).

Table 1: Principle Islamic Physicians (quoted from Ezzat Abouleish)

Name (Arabic)	Name (Latin)	Life span (AD)	Specialty & contribution	Special books	City/Country
Jurjis ibn Bakhtishu Jibril Yuhanna ibn Masawayh		700-800	Translation from Greek and Syriac into Arabic	Translation of works of Hippocrates, Galen and Aristotle	Baghdad
Hunain Ibn Ishak		826-882			
Abu Zaid Ahmed ibn Sahl al-Balkhi		850-934	Muslim psychology, medicine, neuroscience	Masalih al-Abdan wa al-anfus	Shamistiyan, Persian province of Balkh (Afghanistan)
Al-Razi	Razes	841-926	Internal medicine, epidemiology, ophthalmology, chemistry, physics, philosophy	Kitab Al-Mansuri (The Liber Al-Mansuris), Al-Murshid, Al-Hawi (Continents), Al-Gudari wa, Al-Gudari (de Peste or de Pestilentia)	Kharasan, Baghdad
Abū Nasr Muhammad ibn al-Farakh al-Fārābi	Alpharabius	872-950	Political philosophy, Epistemology, medicine	Purposes of metaphysics Translations of works of Aristotle, Focus Al-Hekam, Kitab Mabda' ara'ahl Al-Madina Al-Fadhila	Central Asia, Iran, Iraq, Syria and Egypt
Al-Zahrawi (Abu-Al-Qasim Khalaf Ibn'Abbas Al-Zahrawi)	Abulcasis (Bucasis Alzahravius)	930-1013	Neurosurgery	al-Tasrif Liman Ajiz 'an al' Ta'lif	Al-Andalus (Cordova)
Abū Rayhān Muhammad ibn Ahmad Bīrunī	Abu-Rayhan Biruni	937-1048	Anthropology, pharmacology, psychology father of anthropology, geodesy and experimental mechanics, pioneer of experimental psychology	Ta'rikh al-Hind, The Mas'udi Canon, Understanding Astrology	Persia

Ibn-Sina	Avicenna	980-1037	Medical encyclopedia, philosophy, astronomy, poetry	100 books Al-Qanun (Canon Law) (over 1 million words)	Hamazan, Jurjan
Ibn-Rushd	Averroes	1126-1198	Philosophy, medicine, law	Kitab Al-Kulliat	Al-Andalus, Granada
Ibn-Maimon	Maimonides	1135-1208	Philosophy, translations Hebrew & Latin, poisons, hygiene and public health	Al-Tadbir El-Sihhi, Moushid El-Hairan	Cairo (Saladdin's physician)
Ibn-Al-Nafis		1208-1288	Pulmonary circulation, blood supply to the heart	Sharah Tashrih al Qanun, Al-Mujaz	Damascus, Cairo

Avicenna (Ibn-Sina; 980-1037) (Figure 4; Table 1) is considered as a father of modern medicine (Haque, 2004).



Figure 4: Avicenna – Persian physician Ibn-Sina.

It was he who first recognized 'physiological psychology' for the treatment of illness involving emotions. He was a pioneer in psychophysiology and psychosomatic medicine, developing a system for associating changes in the pulse rate with inner feelings. This idea was in anticipation of the word-association test attributed to Carl Jung (Syed, 2002). Moreover, Avicenna was also a pioneer of neuropsychiatry as he first described numerous neuropsychiatric conditions, including insomnia, mania, hallucinations, nightmare, dementia, epilepsy, stroke, paralysis, vertigo, melancholia and tremors (Abbasi et al., 2007). George Sarton, father of the history of science, wrote in his famous book, *The Introduction to the History of Science*:

"One of the most famous exponents of Muslim universalism and an eminent figure in Islamic

Learning was Ibn Sina, known in the West as Avicenna (981-1037). For a thousand years he has retained his original renown as one of the greatest thinkers and medical scholars in history. His most important medical works are the *Qanun (Canon)* and a treatise on Cardiac drugs. The 'Qanun fi-l-Tibb' is an immense encyclopedia of medicine. It contains some of the most illuminating thoughts pertaining to distinction of mediastinitis from pleurisy; contagious nature of phthisis, distribution of diseases by water and soil; careful description of skin troubles; of sexual diseases and perversions, of nervous ailments" (quoted from Zahoor and Haq, 1997).

The *Canon of Medicine (Qanun: Law of Medicine)* (Figure 5) by Ibn-Sina is one of the most famous books in the history of medicine. This book is a 14-volume medical encyclopedia that was completed in 1025 (Stanley, 1994). This book was used in many medical schools, for example the University of Montpellier, France (1650). The book explains the causes of health and disease. Ibn-Sina believed that the human body can be healthy if the causes of health and disease are determined. He defined medicine (tibb) as the science by which we learn the different aspects of the human body in both health and disease.



Figure 5: Latin copy of the *Canon of Medicine* dated 1484, PI Nixon Medical Historical Library, University of Texas Health Science Center.

The Arabic text of the *Qanun* was translated into Latin as the *Canon of Medicine* by Gerard of Cremona in the 12th century and into Hebrew in 1279. Avicenna dedicated three chapters of his book to neuropsychiatric disorders. He defined madness (Junun) as a mental disorder of reason in which reality is replaced by fantasy and he located its origin in the middle part of the brain (Youssef and Youssef, 1996). In the *Canon of Medicine*, Avicenna was considered to be the father of the science of psychoanalysis through his extension of the theory of temperaments to include mentality, emotions, morality, self-awareness, movements and dreams. His four primary temperaments are summarized in Table 2 (Lutz, 2002). Later on in the 13th century, Maimonides described rabies and belladonna intoxication (Araguz et al., 2002).

Table 2: Avicenna's Four Primary Temperaments

Evidence	Hot	Cold	Moist	Dry
Morbid states	Inflammations become febrile	Fevers related to serious humour, rheumatism	Lassitude	Loss of vigour
Functional power	Deficient energy	Deficient digestive	Difficult digestion	

		power		
Subjective sensations	Bitter taste, excessive thirst, burning at cardia	Lack of desire for fluids	Mucoid salivation, sleepiness	Insomnia, wakefulness
Physical signs	High pulse rate, lassitude	Flaccid joints	Diarrhea, swollen eyelids, rough skin, acquired habit	Rough skin, acquired habit
Foods & medicines	Calefacients harmful, infrigidants beneficial	Infrigidants harmful, calefacients beneficial	Moist articles harmful	Dry regimen harmful, humectants beneficial
Relation to weather	Worse in summer	Worse in winter		Bad in autumn

Avicenna was the first person to diagnose love sickness (Ishq) when he was treating a very ill patient by "feeling the patient's pulse and reciting aloud to him the name of provinces, districts, towns, streets and people". He noticed the changes in patient's pulse and decided that the patient was in love with a girl whose home Avicenna was able to locate by the digital examination of patient's pulse (Syed, 2002). Avicenna also linked physical and psychological illnesses as he described melancholia (depression) as a type of mood disorder with characteristic associated phobias. Also, he pointed to anger as a factor in the progression of melancholia to mania. He hypothesized that happiness increases the breath, leading to uncontrolled increase in brain moisture and resulting in mental disorders (Haque, 2004). Avicenna also discovered a condition resembling schizophrenia and described it as Junun Mufrit (severe madness) with characteristic symptoms such as agitation, behavioral and sleep disturbance, giving inappropriate answers to questions and occasional inability to speak. He wrote that these patients must be restrained in order to avoid any harm they might cause to themselves or to others (Youssef and Youssef, 2002). Avicenna discovered the cerebellar vermis which he named vermis and the caudate nucleus, which he named tailed nucleus or nucleus caudatus. These terms are still used in modern neuroanatomy and neurophysiology (Aydin, 2001). Moreover, he was the first person to relate intellectual dysfunctions to deficits in the brain's middle ventricle and frontal lobe, which mediates common sense and reasoning (Theodore, 2004). Avicenna also diagnosed facial nerve paralysis, distinguishing between paralysis and hyperemia. He also diagnosed meningitis as a disease induced by the brain itself, differentiating it from infectious brain disease. Moreover, he was able to diagnose and describe other types of meningitis induced by an infection in other parts of the body (Aydin, 2001).

The earliest works on social psychology and animal psychology were written by al-Jahiz (766–868), an Afro-Arab scholar who studied the social organization of ants and animal communication and psychology (Haque, 2004). Another great scholar who was a pioneer of social psychology is Al-Farabi (Alpharabius) (Table 1; Figure 6).



Figure 6: Al-Farabi on Republic of Kazakstan currency.

Al-Farabi was the first to state that "an isolated individual could not achieve all the perfections by himself, without the aid of other individuals ... [it is the] innate disposition of every man to join another human being or other men in the labor he ought to perform." He concluded that in order to "achieve what he can of that perfection, every man needs to stay in the neighborhood of others and associate with them". Furthermore, Al-Farabi could discussed the therapeutic effects of music on the soul in his treatise "Meanings of the Intellect", where he discussed the therapeutic potential of music (Hague, 2004). Al-Farabi's *Social Psychology* and *Model City* were the first treaties dealing with social psychology. His book, *Opinions of the People of the Ideal City*, was the first book to distinguish between dream interpretation and the nature and causes of dreams (Akbar, 1984). Ibn Zuhr (Avenzoar) was the first to provide accurate descriptions of neurological disorders including intracranial thrombophlebitis and mediastinal germ cell tumors. Averroes suggested the existence of Parkinson's disease and referred to the photoreceptor properties of the retina. Maimonides wrote about neuropsychiatric disorders and described rabies and belladonna intoxication (Araguz et al., 2002).

Psychotherapy

When Al-Razi was appointed as a physician-in-chief at Baghdad Hospital, he made it the first hospital in history to have a ward devoted to mentally ill patients. Razi was considered the first person to combine psychological methods and psychological explanations and to use psychotherapy in an applicable fashion. Razi was once called to treat a famous caliph who had severe arthritis. Razi advised a hot bath and, while the caliph was bathing, Razi threatened him with a knife, proclaiming he was going to kill him. This deliberate provocation increased the natural caloric, thus creating sufficient strength to dissolve the already softened humours. As a result the caliph got up from his knees in the bath and ran after Razi. Najab ud din Muhammad, a contemporary of Razi, left many excellent descriptions of mental diseases. His carefully compiled observations of patients comprised the most complete classification of mental diseases known before then. Najab described agitated depression, obsessional types of neurosis, Nafkhae Malikholia (combined priapism, sexual impotence), Kutrib (a form of persecutory psychosis) and Dual-Kulb (a form of mania).

Avicenna often used psychological methods to treat his patients. One of his patients was a prince of Persia who had melancholia and suffered from the delusion that he was a cow, and who would low like a cow crying "Kill me so that a good stew may be made of my flesh" and would never eat anything. Avicenna was persuaded to take on the case and sent a message to the patient, asking him to be happy as the butcher was coming to slaughter him, and the sick man rejoiced. When Avicenna approached the prince with a knife in his hand, he asked "where is the cow so I may kill it?" The patient then lowed like a cow to indicate where he was. "By order of the butcher, the patient was also laid on the ground for slaughter." When Avicenna approached the patient pretending to slaughter him, he said, "the cow is too lean and not ready to be killed. He must be fed properly and I will kill it when it becomes healthy and fat." The patient was then offered food which he ate eagerly and gradually "gained strength, got rid of his delusion, and was completely cured" (Hague, 2004).

Ibn-Sina recognized 'physiological psychology' in treating illnesses involving emotions. From the clinical perspective Ibn-Sina developed a system for associating changes in the pulse rate with inner feelings, which has been viewed as a forerunner of the word-association test of Jung. He is said to have treated a very ill patient by feeling the patient's pulse and reciting aloud to him the names of provinces, districts, towns, streets and people. By noticing how the patient's pulse quickened when names were mentioned, Ibn-Sina deduced that the patient was in love with a girl whose home Ibn-Sina was able to locate by the digital examination. The man took Ibn-Sina's advice, married the girl and recovered from his illness. It is not surprising, therefore, to know that an asylum for the mentally ill had been built by the early 8th century at Fez, Morocco, and that insane asylums were also built by the Arabs in Baghdad in AD 705, in Cairo in AD 800, and in Damascus and Aleppo in AD 1270. In addition to baths, drugs, kind and benevolent treatment given to the mentally ill, music therapy and occupational therapy were also used. These therapies were highly developed. Special live music bands were brought in daily to entertain the patients by providing singing and musical performances, with comic performers as well.

Neurosurgery

Al-Zahrawi (Abulcasis) (Figure 7; Table 1) was considered the father of modern surgery as he developed material and technical designs that are still used in neurosurgery today. He was born in Al-Zahra, a suburb of Cordova. During his era, neurosurgery in the Islamic world became a respected specialty practiced by reputable physicians.

On the other hand, European surgery was belittled and practiced by barbers and butchers. This is why in AD 1163 the council of Tours declared the following resolution: "Surgery is to be abandoned by the schools of medicine and by all decent physicians." Al-Zahrawi wrote about fracture of the skull (Al-Okbi 1971):

"The types of skull fractures are numerous, their shapes are different, and their causes are many. For example, some skull fractures are due to a blow by a sword that splits the whole skull and reaches the dura, the same as the ax does to the wood, therefore it is called *axial fracture*. Sometimes the sword does not split the skull completely, it is thus called *incomplete axial fracture*. Such a fracture can be small or big. Another type is *comminuted fracture*, which can be due to a hit by a stone or a fall on a stone; and this fracture can reach the dura or only be limited to the outer part of the bone. This fracture can also be small or big. A third type is the *hairy type of skull fracture* which is so tiny and linear like a hair. A fourth type is the *depressed fracture*, which occurs due to a fall or a blow so the bone is depressed like a brass jar when hit by a blunt instrument. This usually happens when the bone is soft as children. The types of these fractures are diagnosed by examining the wound, removing the debris and contused part of the scalp, exposing the skull, and feeling it by the spatulas. The hairy fracture is difficult to discover and can be diagnosed by exposing the skull, and smearing it with ink; the linear fracture thus appears stained."



Figure 7: Al-Zahrawi - Albucasis.

Al-Zahrawi also wrote about the treatment of skull fractures using special instruments (Figure 8):

"If the patient shows serious signs such as high fever, repeated vomiting, exophthalmos, convulsions, and coma, do not touch him because he is probably going to die. Otherwise, treat him as follows: first shave the patient's head. In comminuted depressed fractures, these pieces of bone should be removed as will be explained. If in the process of the patient's examination or during surgery bleeding occurs, it can be controlled by pressure using towels soaked in alcohol and by wax. Then after control of the bleeding, the small pieces of bone are removed using special forceps. To remove the depressed fracture, first, make trephines in the healthy bone around it. These trephine instruments should not penetrate beyond the skull into the soft tissues underneath, thus they are called non penetrating trephines. They have a rounded ring in their proximal end to prevent them from penetrating beyond certain depths. You should have a number of these trephines that can stop at different depths depending on the thickness of the skull.

Connect the holes in the skull using special saws. First, use a fine small saw, then larger ones. These should be sharp and made of steel. Avoid cutting the dura by the trephine or saw. Once the depressed bone is freed, remove it gently, and then smoothen the edges of the skull by special instruments. Wash with alcohol and treat the wound with packs soaked with ointment."

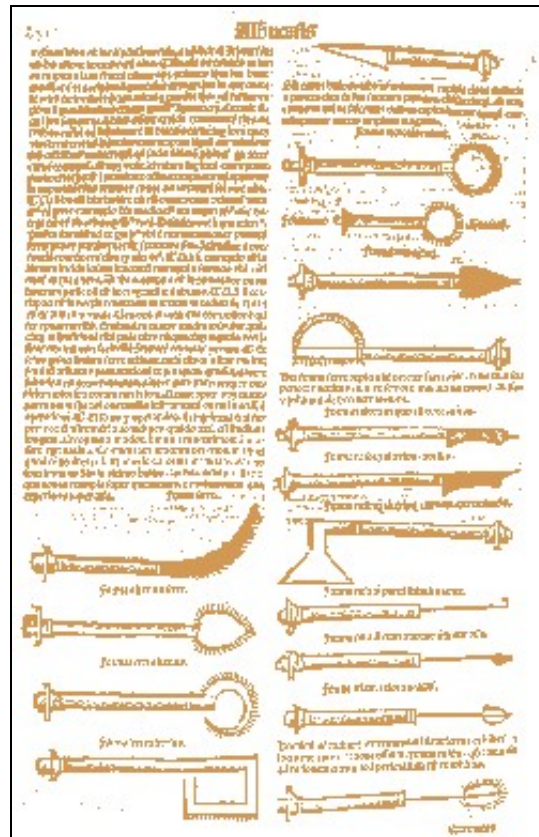


Figure 8: Page from a 1531 Latin translation by Peter Argellata of El Zahrawi's treatise on surgical and medical instruments.

The Egyptian physician Ibn al-Nafis performed the earliest-known dissections on the human brain. Moreover, he corrected some of the incorrect theories of Galen and Avicenna on brain anatomy (Oataya, 1982).

Arabs and anesthesia

The Arabic physicians gave a detailed description of the pharmacology of important narcotics such as opium, hyoscyamus and hashish (Khairallah, 1942). This is why Burton (1886) stated that "anesthetics have been used in surgery throughout the East for centuries before ether and chloroform became the fashion in the civilized West." In a Treatise on the Canon of Medicine by Avicenna (Ibn-Sina) under the article 814 Anesthetics (Skinner, 2001), a number of anesthetics are suggested:

"If it is desirable to get a person unconscious quickly, without him being harmed, add sweet smelling moss to the wine, or lignum aloes. If it is desirable to procure a deeply unconscious state, so as to enable the pain to be borne which is involved in painful applications to a member, place damel-water into the wine, or administer fumitory, opium, hyoscyamus (half dram doses of each); nutmeg, crude aloes-wood (4 grains of each). Add this to the wine, and take as much as is necessary for the purpose. Or boil black hyoscyamus in water, with mandragore bark, until it becomes red. Add this to the wine."

The soporific sponge was first introduced by the Arabs. It was commonly used for anesthesia in the Middle Ages. It was soaked with aromatics and narcotics to be sucked and then held under nostril leading to anesthesia prior to surgery (Keys and Wakim, 1971). More than 1,000 years ago

Avicenna wrote about the effect of pain on ventilation (Gruner, 1930):

"Pain dissipates the bodily strength and interferes with the normal functions of the organs. The respiratory organs are inhibited from drawing in air, and consequently the act of breathing is interfered with, and the respiration becomes intermittent, rapid, or altogether unnatural in rhythm."

Conclusion

The Arabic-Islamic world added much to earlier achievements in medicine. They fostered the flame of civilization, made it brighter and handed it over to Europe, which in turn passed it to the USA, and the cycle continues. 1,000 years ago Islamic medicine was the most advanced in the world. Even after ten centuries, the achievements of Islamic medicine appear amazingly modern. 1,000 years ago Muslims were the great torch-bearers of international scientific research. Every student and professional from each country outside the Islamic Empire aspired, yearned, and dreamed to go to the Islamic universities to learn, work and live in an affluent, advanced and civilized society.

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