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## GLIMPSES FROM THE PAST IN ANATOMY – A REVIEW

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### Abstract:

*As far as we know, anatomy is the oldest medical science. Cave paintings of the early Stone Age, about 30,000 years ago, show a simple knowledge of the anatomy of animals, and it is assumed that these cave dwellers applied some of their anatomical knowledge to their own bodies. The civilizations of the Babylonians, as Syrians, Egyptians, Chinese, and Hindus made no serious attempt to learn anatomy because they were interested in the supernatural world, not the natural one, and their cultures placed strong religious restrictions against debasing the body. Any anatomical dissections that were performed on animals were made to "study" organs in an effort to predict the future and to tell fortunes.*

*There is no doubt that medicine of a kind had its roots in prehistoric times, and that in the Neolithic Age, a technical tradition expressed in practical skills by craftsmen developed alongside a spiritual tradition perpetuated by magical and priestly cults.*

*For centuries, except on rare occasions, the practice of the craftsman remained the handmaid of theoretical dogma, it is only within the last 400 years that the conception emerged that the art of medicine and surgery can be reasonably based only on knowledge of the structure of the body.*

*This review focuses on how the study of anatomy in different parts of world has evolved through the centuries. Anatomical knowledge in ancient India was derived principally from animal sacrifice, chance observations of improperly buried human bodies, and examinations of patients made by doctors during treatment. The Vedic philosophies form the basis of the Ayurvedic tradition, which is considered to be one of the oldest known systems of medicine. Two sets of Indian texts form the foundation of Ayurvedic medicine, the Susruta Samhita and the Charaka Samhita. The Susruta Samhita provided important surgical and anatomical information of the understanding of anatomy by Indians in the 6th century BCE. Here we review the anatomical knowledge known to the mankind.*

### KEY WORDS :

Anatomy, ancient India, Charaka Samhita, Susruta Samhita.

### INTRODUCTION

The development of [anatomy](#) as a [science](#) extends from the earliest examinations of [sacrificial](#) victims to the sophisticated analyses of the body performed by modern scientists. It has been characterized, over time, by a continually developing understanding of the functions of [organs](#) and structures in the body. The field of Human Anatomy has a prestigious history, and is considered to be the most prominent of the biological sciences of the 19th and early 20th centuries. Methods have also improved dramatically,

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advancing from examination of [animals](#) through dissection of cadavers to technologically complex techniques developed in the 20th century.

Anatomy is one of the cornerstones of a doctor's medical education. Despite being a persistent portion of teaching from at least the renaissance, the format and the amount of information being taught has evolved and changed along with the demands of the profession. What is being taught today may differ in content significantly from the past but the methods used to teach this have not really changed that much.

### The Ancient River Cultures

City cultures arose during the Bronze Age in the rich alluvial valleys of rivers at first, the Jordan, the Euphrates Tigris, the Nile and the Indus. We know that the Sumerians of Mesopotamian developed a literature and a numerical system, the earliest, records of which date from 3000 B.C. and that they practised mathematics, astronomy and mythology as well as medicine. After the Sumerians had been submerged by the Semitic dynasty of Babylon before 2000 B.C. our knowledge of the priestly medical lore practiced at the time becomes a little more precise and a reasonably complete anatomical nomenclature was employed. Thus a legal code promulgated by King Hammurabi (1800 B.C.) in Babylon systematized the order Sumerian laws dating back to about 3000 B.C.

In the civilization of the valley of the Nile, the earliest know Egyptian medical papyri date from about 2000 B.C. and refer to the teachings of Imphotep, a many sided personage Grand Vizier, physician, magician and architect of the first pyramid who probably flourished about 1,000 years earlier and was subsequently deified as the God of Medicine. Mummifiers whose knowledge of anatomy must have been considerable.

It is true that many of the scientific achievements of the Greeks were initially derived from the cultures of Mesopotamia. Egypt and perhaps the valley of the Indus, established a tradition of science and medicine that forms a thread of knowledge which, although it has occasionally been lost for a time, stretches from the 6<sup>th</sup> century B.C. to the present days.

### The Greek Period

Greek medicine started in the Ionian cities of Asia Minor and throughout the Mediterranean littoral where it flourished during the 6<sup>th</sup> century B.C. until the former were subjected by Persia in 530 B.C. (the Ionian Period). Alexander the great created an empire in which Alexandria became the scientific, centre of the world wherein the exact sciences and anatomy flourished (the Alexandrian Period 330-30 B.C.)

The most outstanding figure of this early period was Pythagoras (582-500 B.C.) world of medicine as we know it had little place and anatomy had none. Initially medicine remained an affair of the temple, the province of the priesthood, particularly those engaged in the worship of the God of Medicine, Asclepios.

Certain priest of Asclepios, claiming direct descent from the God and calling themselves the Asclepiadae, dissociated themselves from the worship of the temple and began to apply objective methods to their practice. The greatest of this school was Hippocrates of cos (460-375 B.C.) who flourished in that extraordinary period of Athens.

Hippocrates undoubtedly deserves the title of "the Father of Medicine." For under his influence medical practice cast aside magic, and the ritual of the priesthood had become a science of reason based on observation for the first time acknowledging the unknown, it was based on science of diagnosis, prognosis and relatively rational treatment merged wherein the physician was the servant rather than the master of nature.

Therein diseases were certainly discussed on an observational basis but without localization to any particular organ, the brain however seems to have been recorded as the seat of nervous activity. In such a philosophy anatomy was of little importance, indeed its practice was impossible because of the reverence among the Greeks for the dead body and their insistence on its proper burial, a ritual accorded to friend or foe alike since only thus would the dead find rest and leave the living unmolested. It was only when the conception of a soul as an entity separate from the body arose with Plato (427-347 B.C.) and became disseminated in scientific thought through the writings of his pupil Aristotle, that the dissection of a dead body became morally possible. It was thus not until the great medical school of Alexandria was founded about 300 B.C. that descriptive anatomy was born as a science and the Greek physicians gathered there were able to dissect the human body.

If Hippocrates is regarded as the Father of Medicine, Aristotle (384-322 B.C.) is equally to be considered the creator of natural history and the founder of comparative anatomy. He undoubtedly

dissected the animals and a vague conception of the form of the organ emerged.

For three hundred years (330-30 B.C.) the Hellenistic school flourished in Alexandria, and for the first time, under the beneficent patronage of the Ptolemies, a deliberate attempt was made to organize and subsidize science.

#### **Historia animalium**

The earliest medical teacher in the museum, Herophilus of Chalcedon (344-280 B.C.) was, however, the first to dissect the human body in public and apparently wrote a treatise on the anatomy. But the enthusiasm of the early Alexandrian period during which according to Celsus, hundreds of condemned criminals were dissected alive so that the movements of their organs could be watched, was not to last, and when on the death Cleopatra, in 30 B.C., Rome took over the control of Egypt, the curtain was drawn on further progress. Among the Romans, the most superstitious of civilized people, the human body again became inaccessible for dissection and anatomy languished, but they absorbed and preserved much of the learning of Alexandria, indeed a fortunate thing since nothing of the great Library with its three quarters of a million papyri survived the destruction of the museum and we are entirely indebted to Roman and Arabic writers for any knowledge we have of them.

The earliest of the former was Aurelius Cornelius Celsus (25 B.C. A.D. 50), the author of *De Medicina*, the oldest systematic medical treatise that has survived to our day, dating from the reign of the Emperor Tiberius. The Elder Pliny (A.D. 23-79), a diffuse and uncritical writer with no qualifications for science except industry and enthusiasm, added little to ophthalmology. *Historia Naturalis* (A.D. 78-9), although his notes on comparative anatomy are of interest, Bufos of Ephesus (A.D. 98-117), however, who lived in the reign of Trajan, the author of the earliest work on anatomy that has come down to us, gave a more coherent description. Moreover his writings contain the first known systematized description of the central nervous system.

The most brilliant and authoritative exponent of his period however, was Cladius Galenus (Galen) of Pergamos (A.D. 130-200) who left Asia minor to study in Alexandria and ultimately practiced in Rome, becoming physician to the Emperors Marcus Aurelius and Commodus.

Whereas Hippocrates had freed medicine from religious superstition, Galen, solving all problems and answering all questions, left it fettered to dogma and just as he himself idolized Hippocrates, so also was his system, accepted throughout the medical world without question for over ten centuries partly because its theistic implications suited both Islamic and Christendom.

After the synthesis of knowledge and speculation achieved by Galen at the end of the 2<sup>nd</sup> century, the spirit of investigation ceased in the Western world with remarkable abruptness, for the forms of oriental paganism and the intolerance characteristics of the Christianity which permeated the Roman Empire were antipathetic to scientific enquiry, finally with the moral, economic and physical decay of Rome and its eventual fall to the Teutonic barbarians in 455, the "Dark Ages" engulfed the Western world from the 5<sup>th</sup> to the 10<sup>th</sup> centuries.

#### **Anatomy in ancient India**

Healing traditions and medical practices are inextricably tied to human history. The oldest known civilizations have healing traditions associated with them and have added to our current knowledge of the medical sciences, particularly anatomy. Areas such as Greece, Mesopotamia, Egypt and China have shaped the study of medicine and human anatomy. As one of the oldest civilizations, India was rich in such history and tradition, which includes significant contributions to our understanding of human morphology. The foundation for modern Indian Ayurvedic medicine can be found in ancient texts, some of which predate the Christian era by 4000 years (Persaud, 1997). The developmental history of ancient India can be divided into three periods: the Vedic (c. 1500–500 BCE), Brahmanic (600 BCE– 1000 CE) and finally the Mughal (1000 CE until the 18<sup>th</sup> century) (Persaud, 1997). The ancient Indian name of the 'science' of medicine was 'Ayurveda,' the Veda for (lengthening of) the span of life, which was considered an upanga (subsidiary) to the Atharvaveda.

The science of medicine was also called 'Vaidyasastra' and the physician was called vaidya, 'possessing knowledge' (vidya) Winternitz & Jha, (1986). The Vedic philosophies form the basis of the Ayurvedic tradition, which was considered to be one of the oldest known systems of medicine and was compiled during the Vedic period Bhagvat Sing Jee (1978). The four Vedas are considered the oldest Sanskrit literature and are the main religious texts that form the basis of the Hindu religion. The Vedas contain rituals, hymns and incantations. The Ayurveda scripture focuses on health and medicinal practices Micozzi (2006). According to tradition, the Ayurveda originally consisted of eight parts (astranga), in

which major surgery (salya), minor surgery (salakya), treatment of diseases of the body (kayaacikitsa), demonology (teachings on the diseases caused by demons) (bhutavidya), healing of diseases of children (Kaumarabhrtya), toxicology (agadatantra), elixir (rasayana) and aphrodisiacs (vajikarana) were included Winternitz & Jha (1986). Two main sets of texts form the foundation of Ayurvedic medicine, the Susruta Samhita and the Charaka Samhita.

The Susruta Samhita was written by the famous physician and surgeon Susruta in the 6th century BCE who taught at the University of Benares (alternatively Kasi or Varanasi) on the Ganges River (Figure-1). He was best known for his tome of surgical wisdom, practices and tools (Figure-2). In Susruta's work, it was evident that considerable thought was given to anatomical structure and function, as Susruta was a proponent of human dissection Persaud (1984); his texts include a systematic method for the dissection of the human cadaver. Charaka lived in the mid 2nd century and was associated with the north-western part of India and the ancient university of Taksasila. Charaka Samhita contains 120 chapters arranged in five books. The Sarira-sthaka discusses mainly anatomy, embryology and technique of dissection. The original date of the Charaka Samhita is not known but some estimate its composition to have occurred early in the 4th century BCE Porter (1998). The Charaka Samhita is often philosophical and ethical in its considerations and includes an Oath of Initiation that is akin to the Hippocratic Oath. The teaching of medicine in ancient India followed a hereditary model, with the knowledge being passed from 'Guru' to 'Sisya'. These ancient Indian texts were written solely in Sanskrit and were inaccessible to anyone who was not a direct disciple of that Guru or that particular school Nagaratnam (1989). Anatomical knowledge in ancient India was derived principally from the sacrifice of animals, by chance observations of improperly buried bodies, and examinations of patients by physicians Zysk (1985).

### China

Civilized society arose in China as it did in Mesopotamia, Egypt and India as a bronze-age culture in a river valley, the earliest known phase of which flourished under the Shang Dynasty on the Yellow River, about 1500 B.C.

A period of the Wars followed in which the Han period (202 B.C. to A.D. 220) was notable for its technical innovations, a time from which the standard Chinese medical work, the Canon of Medicine dates. In it, anatomy and physiology are based on the analogy between Man on the one hand, and the State and the Universe on the other, the heavens are round and the earth flat, hence the head is round and the feet flat. The heart is the prince of the body, the lungs his ministers, the liver the military commander, the spleen and stomach the granaries, and so on. The greatest Chinese medical work, Pen Tsao (the herbal), compiled from ancient sources by Li Shih Chen who completed his tasks in 1578 after 28 years labour, lists 1892 of them animal, vegetable and mineral.

### The Renaissance In Europe

During the brilliant period of the Arabian civilization when moslem learning flourished in Asia, Africa and Spain, the only institution which could have maintained the tradition of scholarship in an otherwise illiterate Europe was the church, called for the abolition of free thought and the rigid acceptance of dogma, that the body was a thing to be scorned, not worth knowing or saving, disease an expression of God's wrath to be eased by an appeal to Heaven rather to an earthly physician.

Europe was at last beginning to awake from an intellectual sleep that had lasted for a thousand years and men were becoming sufficiently receptive to absorb the knowledge, then available.

The school of Salerno, situated on the Tyrrhenian Sea, some 30 miles from Naples, was of extreme importance in the revival of learning in the West. It was the first medical school to be founded in Christian Europe. Eventually it was given a charter by the excommunicated Emperor Frederic II (1231) the most versatile and enlightened ruler of the middle Ages.

During this period, however, partly owing to ecclesiastical opposition and partly from popular prejudice, little new or original emerged.

The writings of Galen and Avicenna were accepted as established law to question which was sacrilege, to find out the number of the teeth no one dreamed of opening the mouth and looking when as ancient authority was available for consultation. It is true that Mundinus of Bologna (c. 1276-1326) is said to have risked the displeasure of the church by dissecting the bodies of two females before his students, the first anatomical demonstrations since the Alexandrian school of Herophilus and wrote a handbook of anatomy (Anathomia) wherein the head and orbits are described although it contains little of original

observation and the anatomy is that of the Alexandrian Greeks, this book was the first anatomical book worthy of the name and was classical anatomical text in general use until the end of the 16<sup>th</sup> century.

While for 200 years in the Western world anatomy, it remained a futile exercise in commentaries or disputations. On classical knowledge original observation may be said to begin with Leonardo Da Vinci (1452-1519). This Florentine artist scientist and engineer, with the enthusiasm for accurate observation and original experiment and with his genius in re-inventing the art of drawing in perspective in which even today he has never been surpassed, was symbol of the renaissance in Western thought. His beautifully executed drawings, however, made from actual specimens remained largely unknown because of the absence of the technical means of reproduction and exercised little influence on contemporary anatomy. The invention of printing served as potent catalyst in the development of European scholarship since it made possible the wide dissemination of knowledge. In 1467 the first medical work was printed in Strasbourg and towards the end of the 15<sup>th</sup> century the old classical teaching of anatomy was becoming generally available to the newly-founded universities of Europe in printed Latin translations from the original Arabic and Greek texts, creating an interest so that practical anatomy began to be studied seriously anew, particularly in Italy. This movement set the stage for the appearance of Andrea Vesalius (1514-64), a native of Brussels who became professor of medicine at the University of Padua, a genius learned in the old Greek texts and at the same time equipped with wide practical experience of Human dissection. With the appearance of his book, *De humani corporis fabrica* (1543), in the beautiful drawings of which he was able to use Leonardian perspective and to disseminate his knowledge by the newly developed art of wood cuts, modern anatomy as a systematic and exact science may be said to have begun for the first time since Herophilus of Chalcedon, a real step forward had been made, and Galen was at last dethroned.

In the meantime however, minor although significant anatomical discoveries had been made, such indeed, could hardly fail to occur in the Varolio (1543-75) made an anatomical study of the optic nerve and central nervous system.

#### **The Early Modern Period (1600-1900)**

The first of these was the introduction of chemical fixative for anatomical study by the Jesuit, Christophorus Scheiner (1575-1650). A second method of investigation which bore fruit was introduced by Frederick Ruysch (1638-1731). A Dutch physician, professor of legal medicine and botany at the Athenaeum, who injected specimens and thus was able to describe the vascular system Marcello Malpighi (1628-94), professor of medicine at several Italian universities and physician to Pope Innocent XII, who employed a simple magnifying lens in his investigations and laid the foundations of the science of histology. About the same time, another famous Dutchman, a haberdasher from Delft, Antony Van Leeuwenhoek (1632-1723), perfected the magnifying glass into a very useful simple microscope, making a multitude of discoveries (Figure-3).

Meantime, the use of chemical fixatives was elaborated by the great French ophthalmologist, Antoine Maitre-jan (1650-1730). DU (1664-1741) of Paris introduction of frozen sections, a technique which allowed an accurate assessment of the relationships.

The introduction of these methods led to a rapidly increasing fund of anatomical knowledge typified in the treatises of Johann Gottfried Zinn (1727-59), professor of anatomy at Gottingen, Sir William Bowman (1816-92). In a few years of brilliant and intensive work rarely equaled in any aspect of knowledge this young investigator, after revolutionizing current knowledge of the minute structure of muscle and the kidney, since Bowman's day histological anatomy has gone on apace, aided the development of improved technical facilities, Outstanding among these were the multitude of ideas introduced by the brilliant Czech physiologist, Johannes Evangelista Purkinje (1787-1869) of Breslau and Prague, such as the preparation of thin sections of tissues, their fixation by sublimate, their clearing with turpentine and olive oil, and their staining with indigo, while an ever increasing degree of accuracy. Rotary microtome as well as the introduction of fundamental improvements in the compound microscope, such as the oil-immersion lens and the sub-stage condenser by Ernst Abbe (1840-1905).

#### **Modern Anatomy**

Susruta's seminal work, the *Susruta Samhita*, forms the basis for the Ayurvedic tradition, which is still widely practiced today. The contributions of ancient civilizations to our modern understanding are well appreciated, with ancient India being no exception. An appreciation of the evolution of anatomical knowledge can be gleaned from reviewing such ancient texts.

To many, gross human anatomy is associated with Gray's Anatomy, originally published by the English surgeon Sir Henry Gray in 1858. Since then the book has had several authors and has evolved into the current thirty-seventh edition in Great Britain and the thirtieth edition in the United States, each with its own character.

Radiological advances in the twentieth century have allowed scientists to make remarkable connections between anatomy and physiology, and researchers are integrating the study of anatomy with other disciplines, including biochemistry, genetics, and biophysics. Physicians now have access to advanced technology such as CAT and PET scanners, and magnetic resonance imaging (MRI), all of which go far beyond microscopy and x-rays. These techniques permit physicians to look inside the body without performing surgery, yet another major breakthrough in the history of anatomy.

### CONCLUSION

Anatomy teaching has changed considerably over the last 1000 years though it is still very much at the heart of the philosophy of western medicine. Western medicine seeks to find a cause to all disease and attempt to cure it; very much cause and effect. Without a good understanding of the arrangement of the human body then this becomes somewhat challenging. Western medicine is in fact taking a more holistic approach today, with the psychosocial biomedical model of disease. However, most practicing doctors would readily adapt their thoughts and treatments if it was proven that there was a biological cause to disease previously thought to be idiopathic. Anatomy is often regarded as being a complete science, in that we know what and where most of the body is and does with little left to discover. The recent controversies with [Gunther von Hagens](#)(2002) and public displays of dissection may divide opinions on what is ethical (even the legality of a public dissection). The future of dissection may be uncertain and indeed, if pressure to obtain cadavers continues, even the few medical schools that continue to do dissection may have to halt. This hopefully however will not reduce the number of people able to benefit from a single cadaver if current prosection methods become the prevalent method of demonstrating gross anatomy.

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### LEGENDS TO FIGURES

Figure-1. A statue dedicated to Sushruta at the [Patanjali Yogpeeth](#) institute in [Haridwar](#). In the sign next to the statue, Patanjali Yogpeeth attributes the title of [Maharishi](#) to Sushruta, claims a floruit of 1500 BC for him, and dubs him the "founding father of surgery", and identifies the Sushrut Samhita as "the best and outstanding commentary on Medical Science of Surgery".

Figure-2. A picture of Susruta examining a patient. Note the palpation of the radial pulse.

Figure-3. Replica of microscope by Van Leeuwenhoek.



Figure -1.



Figure-2.



Figure-3

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