March 11, 2016

The Medical Renaissance

As we have seen, the rediscovery and translations of ancient Greeks and Romans scientific texts started around 12-13th century. This led to the Renaissance – renewal of knowledge by re-discovering the wisdom of the ancients.

In matters of medicine and biology, the renaissance was led by the re-discovery and publication of the works of Galen – first through Islamic sources and then through translations of Galen’s own writings directly into Latin. Galen will first be re-discovered, celebrated – and then challenged. Three names are associated with the challenge to Galen’s authority:

Leonardo da Vinci 1452-1519

Andreas Vesalius 1514-1564

Paracelsus 1493-1541

DaVinci and Vesalius end up producing a new understanding of human anatomy, while Paracelsus challenges the idea of humors and opens the door to the use of inorganic chemicals in medicine.

The Medical Renaissance: the Great Galen revival in the 16th century

In our lecture on Islam, we already noted that Hunayan ibn Ishaq (808-73), at the House of Wisdom in Baghdad had translated 95 of Galen’s works and 15 Hippocratic works. Just like they had assimilated and extended the work of Ptolemy in astronomy, Muslim doctors and philosophers had also written many critical commentaries on Galen’s work.

* Abu Bakr al-Razi (854-925): philosopher, social critic, and a critic of Galen and Aristotle, a defender of atomism (theologically unacceptable in Islam) and a physician. His general text book became popular in Europe. He also a wrote a treatise called “Doubts about Galen” .
* Abu Ali al-Husayn ibn Sina, Avicenna (980-1037): a polymath and a doctor. Author of more than a 100 treatises. His *Canon of Medicine* borrowed freely from al-Razi and organized it under five headings: generalities, herbal remedies, diseases from head to toe, diseases not specific to organs, and compound drugs. His medical encyclopedia was translated into Latin in 12 c and printed five times in the first 50 years of the printing press.

Arabic translations of Galen and the commentaries by Islamic doctors had been translated into Latin. In fact, the 16th century Europe got to read Galen only through translations of Arabic text books: al-Razi and Avicenna were being taught in medical schools in Europe.

But there was dissatisfaction regarding the Arabic terminology and worries about the quality of translation from original Greek into Arabic. This was the period of Renaissance in Europe when there was a great interest in recovering the lost wisdom of the ancients. So in 1506, one of the most renowned printing presses in Europe, the Aldine Press of Venice, published the complete works of Galen in the original Greek. The Aldine edition was later translated into Latin and went through close to 600 editions through the 16th century. This was followed by a Hippocrates revival involving Aldine Press again.

But all this time, books of Avicenna and al-Razi continued to be taught.

# A brief history of human dissections

Galen’s views on human anatomy were challenged by a new generation of anatomists who were able to dissect human bodies.

Human dissections do not seem to have been practiced with any regularity before the end of the 13th c. in either pagan, Jewish, Christian, Muslim cultures. In other words, all cultures have shown cultural-religoius scruples against cutting open dead human bodies.

The only exception was a brief period in the 4th to 3rd bce in Alexandria where Herophilus and Erasistrats, two Greek medical scholars made a series of studies of human bodies based upon dissections.

HUMAN DISSECITONS BEGIN in ALEXANDRIA THIRD CENTURY BCE: for a brief period, in the early Roman empire, human dissections were permitted. There are at least two major medical treatises dating back to that time that involved human dissections:

Heorphilus(approximately 255 bce), studied med on the island of Cos famous for Hippocratic tradition, moved to Alexandria and worked for the Ptolemaic kings.

* Investigated the anatomy of the brain, identifying two of the brain’s membranes, i.e. the dura matter and the pia matter.
* He traced the connections between the brain and the spinal cord.
* Dissected the human eye and identified the connection between the optic nerve and the brain
* Explored the organs of the abdominal cavity
* Distinguished veins from arteries by thickness of the walls.

ErasiSTRATUS (b. 304 bce): If Herophillus was more interested in structure; E was more interested in function. He studied

* The bicuspid and tricuspid valves of the heart. Explained it as a bellows, expanding to fill up with pneuma or air, inhaled from the atmosphere.
* Human physiology:
  + Food – turned into juice
  + Seeps through pores in the stomach to the liver
  + Where it is converted into blood
  + Blood carried by veins to all parts of the body
  + Arteries contain only *pneuma*, or air, which is supplied to the left side of the heart and then circulated to the entire body through arteries, supplying the body with vitality
  + Nerves contain a finer form of pneuma, a *psychic pneuma*, purified from arterial pneuma in the brain.
* Theory of disease: disease caused by flooding of veins with surplus blood caused, for e.g. by excessive eating. This opens up the channels between veins and arteries, pushing blood into them.
* The soulution: reduce the blood, by cutting food or by blood letting.

After this brief period, there were no more dissections of human bodies.

Greeks and Romans (Hinduism and Buddhism as well) avoidance of human dissections have their roots in the belief that dead bodies are polluting, or ritually unclean.

The Greek-Roman culture was Christianized and Christianity has its own attitude toward dead bodies: It does NOT consider dead bodies as polluting: On the contrary, bodies of dead people (Jesus Christ himself) became an object of veneration and potential sources of healing and magical powers. In fact, Christianity has religious reasons for opening up dead bodies: for embalming (preserving) the bodies of saints and other people considered holy; the inspection of internal organs of holy men and women for signs of sanctity; the operation to remove the fetus from the bodies of women who died giving birth so that the fetus can be baptized (this procedure is known today as Caesarean birth.) All these practices show that the Church as an institution did not in principle prohibit opening up a dead body.

But things began to change in early modern Europe when the Church and civil authorities began to allow dissections for medical purposes. Europe had been hit by its worst pandemic ever: it was called the Black Death which wiped out at least one-third of the population. Autopsies were permitted in order to understand what could be causing the deaths.

The first recorded public human dissection was conducted in Bolonga arond 1315 by Mondino de Luzzi (1270-1326). But Mondino saw what Galen and the Arab texts taught: errors like five-lobed liver and three ventricle heart were repeated by him. The importance lies in trying to include anatomy in medical education. He produced the first known anatomy textbook based upon dissections, which became a standard text in medical education and continued to be taught until the 16th c.

So from around 1250 or so, public displays of human dissections had become quite common in Italian, French and German towns, with surgeons called in to investigate homicide and establish the cause of death. From Bologna, human dissections spread to Padua and later to Spain (first dissection in 1391), to Vienna (in 1404), and only later to England and Germany.

Public dissections were quite a spectacle: a physician used to sit in academic robes high on a throne, intoning from a Galenic text, while a surgeon slit the cadaver with the knife and a teaching assistant pointing out the notable features that the professor was intoning. No new knowledge was gained, but rather these dissections merely demonstrated what was already known – often time wrongly in the works of Galen and other ancients.

Andreas Vesalius came from this new tradition of anatomy based upon human dissection.

Whose bodies were being dissected?

Demand for dead bodies that could be dissected went up. The state gave out licenses for dissections: Where were these bodies coming from?:

Bodies of executed criminals

Bodies of foreigners (anyone more than 30 miles away!) who had no families to claim them.

The destitute and the old dying in hospitals, whose bodies were not claimed by anyone.

Sometimes, there would be a shortage, and that led to some reported cases of grave robbing, even hijacking bodies from funeral processions!

Most dissections would be carried out in the winter months.

Anatomical contributions of artists

Excerpt from Kate Kelly, The Scientific Revolution and Medicine, 1450-1700 (Facts on File, 2010)

**Leonardo da Vinci (1452–1519):**

**Contributions to Medical Knowledge**

Leonardo da Vinci is best remembered today for his paintings.

Though there are only 17 known works—not all of them completed—

some of his paintings, the *Mona Lisa* and *The Last Supper*

among them, are the most famous in the world. His drawing of

*Vitruvian Man,* described later in this chapter, is *iconic.*

Contemporaries knew that he was a highly gifted individual

who contributed to many fields, including architecture, technology,

military weaponry and fortifications, human aviation, and

botany, and he developed a basic explanation of plate tectonics.

All of these ideas were well ahead of their time. Less well

understood—and basically unknown during his lifetime—were

his contributions to the field of medicine. Unbelievably beautiful

and anatomically accurate drawings of various parts of the

human body filled many of Leonardo’s notebooks, but this work

was not discovered by others until after his death. As a result,

his incredible step forward in the field of anatomy remained

unknown until at least the 1650s

**Leonardo’s L ife**

Leonardo was the illegitimate son of a Florentine notary, Piero da

Vinci. He was born in the Vinci region of Florence, so he would

have been known as Leonardo di ser Piero da Vinci. When he was

14, Leonardo was apprenticed to one of the most successful artists

of the day, Andrea di Cione, known as Verrocchio. Verrocchio

believed strongly that his apprentices needed to master a wide

range of technical skills as well as to undertake serious study of

drawing, painting, and sculpting. Verrocchio emphasized that his

pupils study anatomy, and Leonardo showed an immediate gift for

topographic anatomy, drawing many studies of muscles, *tendons,*

and other visible features.

Though his only formal education was in art, Leonardo was

fascinated by a wide range of subjects and taught himself in fields

as diverse as mathematics and Latin. The Renaissance was a time

when science and art were not considered polar opposites. The

notebooks that contained his work were filled with thousands

of pages of notes and sketches on many subjects, ranging from

studies of the inventions that he was conceptualizing (including a

helicopter and various forms of hydraulic lifts), and his anatomical

studies, which were significant to the world of medicine. His

drawings of the human anatomy are unrivaled.

**His Interest in Anatomy**

…a Veronese anatomist, Marcantonio della

Torre, gained special permission to perform dissections, he asked

Leonardo to work alongside him to prepare illustrations for a

text on anatomy. When Della Torre died unexpectedly, Leonardo

assumed both tasks, performing the dissections and then working

on the illustrations. Because he was not the one who had gained

permission, he worked in secrecy in the cathedral cellar of the

mortuary of Santo Sprito in Florence, dissecting and drawing as

many as 30 human bodies.

Leonardo drew many studies of the human skeleton and its

parts, as well as muscles and *sinews,* the heart and vascular network,

the reproductive system, and other internal organs. He made one of the first scientific drawings of a fetus *in utero.* While the topographical studies were notable, Leonardo’s dedication to

observing and recording individual parts of the body as they performed

mechanical activity was the feature that made his work

so exceptional. He probed the brain, the heart, and the lungs, and

he found ways to draw transparent layers to depict the internal

organs and how they functioned. He also observed and recorded

the effects of age, emotion, and disease on *physiology.*

His anatomical studies of animals permitted additional study,

and he worked out ways to expand his knowledge. He injected hot

wax into the brain of an ox, which provided him with a model of

the ventricles. This represented the first known use of a solidifying

medium to define the shape and size of an internal body

structure. He developed an original mechanistic model of sensory

physiology and worked at researching how the brain processed

visual and other sensory input.

He seemed to read widely, and his interest in dissection may

have been inspired by reading Galen. He differed from Galen, however,

in understanding that human dissection was vital to understanding

human anatomy. (Galen felt other living creatures could

be studied instead.) Though Leonardo differed from Galen on many

issues, he maintained the description of the circulatory system that

Galen provided, indicating that “pores” between the ventricles permitted

the blood to travel between the two sections of the heart.

Leonardo’s illustrations do not reflect these pores between the ventricles,

but Galen was so revered that even when the anatomy did

not fit with the theory, Galen was held to be correct.

Many of Leonardo’s drawings were done on various-sized

loose pieces of paper, and it is thought that they were collected

into notebooks by one of his students. Though the material

appeared to be intended for publication, it is not clear why that

never occurred. Leonardo was known to be a procrastinator so

it may have been that he never got around to it, or it could have

been that his lack of a formal education in anything but art—and

hence his lack of formal education in mathematics and Latin—left

him feeling that he did not have the right credentials to publish

in a more scientific field.

His inventions and anatomical drawings were usually accompanied

by Leonardo’s explanations of what he was drawing. These

notations were written in mirror-image cursive. It was originally

thought that Leonardo intended the notations to be somewhat

secretively written, but later it was noted that Leonardo wrote

with his left hand, and so it was probably simply a practical solution

to prevent smearing. It would have been far easier to write

from right to left with a nib pen if he were using his left hand.

In 1651 (almost 150 years after his death), many of his anatomical

drawings were published for the first time as part of a treatise on

painting. The wealth of Leonardo’s anatomical studies that have survived

forged the basic principles of modern scientific illustration.

**An Understanding of Proportions**

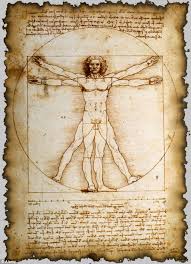
Though Leonardo’s anatomical studies were kept private, he published

some of his observations of human proportions, most notably

*Vitruvian Man.* This work was quite fascinating because it so

perfectly captured the proportions

of the human body.



Leonardo took the proportional

theoris of Vitruvius, the first century b.c.e. Roman

architect, and imposed the

principles of geometry on the

configuration of the human

body. Leonardo demonstrated

that the ideal proportion of

the human figure corresponds

with the forms of the circle and

the square. Leonardo’s illustration

of this theory shows

that when a man places his

feet firmly on the ground and

stretches out his arms, he can

be contained within the four lines of a square,

but when the body was in a spread-eagle position,

it could be inscribed in a circle.

Andreas Vesalius

# Who was Andreas Vesalius?

Born in Brussels, Belgium to family of physicians. Learned Latin and Greek and enrolled in paris faculty of medicine, studying under a staunch Galenist teacher by the name of Jacob Sylvius who would later opposed Vesalius. He was forced to return to Belgium due to wars and he taught at the University of Louvain where he completed his studies and wrote a dissertation on the works on al-Razi.

In 1537, he moved to University of Padua, where he did his most of his path-breaking work on human anatomy.

# New style

At Padua University, dissections were allowed. In fact, the civil authorities and the judges used to delay executions so as to provide fresh bodies to suit Vesalius’s schedule.

What is remarkable about Vesalius is that he took on the job of actually cutting up himself. At that time, professors (and doctors) did not dirty their hands: the actual job of dissecting was left to surgeons-barbers who were considered low in status and were often not trained as doctors. The usual practice was that the professors used to only read the text of Galen from the podium, while surgeons-barbers dissected and a research assistant (usually an intern) demonstrated what the professor was reading.

Vesalius was the first one to get down from the podium, and take the scalpel and the knife in his own hands. He ridiculed the old procedures as “detestable” and called the professors “jackdaws aloft in a high chairs .” He took the knife in his own hands and performed dissections while lecturing…

(Recall the Zlisel thesis: with Vesalius we find a flattening of hierarchy, with the learned professor taking on the task of supposedly lowly barbers and surgeons. )

# Vesalius challenges Galen:

By this time, Galen’s works on anatomy had been published and there was a move among the medical faculty to include dissections as a part of medical training. V. published his first book, Six Anatomical Pictures (1538) in which he gave accurate pictures of liver, male and female reproductive organs, venous and arterial system. . But such was the spell of Galen that he was still seeing through Galen’s eyes and repeated all his mistakes.

Gradually begins to challenge Galen: begins to realize that Galen had dissected animals and not humans.

Out of a large number of dissections, he gathered material for his *Fabrica*. It is considered one of the gems of Renaissance.. high degree of accuracy , thanks to the perfection of the printing press.

Artist : Jan Stephan van Calcar (or Kalkar) of the Netherlands drew the pictures of the dissections. Kalkar was a highly respected student of the artist Titian and quite well-known for his art. The drawings were carefully etched on blocks – the name of the craftsman who did the engraving remains unknown. The woodcuts were transported to Basel, Switzerland, as Vesalius wished that the work be published by one of the foremost printers of the time, Joannis Oporini. The illustrations were also created using engraved copper plates (called intaglio), which allowed for very fine detail. This is an example of coming together of science, art and technology.

# Overturning Galen’s anatomy

Based on his observations, Vesalius challenged some of the key teachings of Galen:

1. Questions the septum: denied Galen’s notion of pores through which blood was supposed to ooze form the right to the left side of the heart.
2. Brain: denied Rete mairabile in humans
3. Human sternum has 3 not seven bones.
4. By displaying the skeletons of apes and humans side by side, showed the difference and demonstrated that Galen had extrapolated from apes to humans.

Even though he started out rather timidly, by the end of his career he openly repudiated Galen: “how much has been attributed to Galen by those physicians and anatomists who have followed hi and often against reason! I myself cannot wonder enough at my own stupidity and too grate trust in the writings of Galen …”

Yet, while the contested Galen’s anatomy; he did not question the physiology and medicine of galen. So he is seen by historians as a reformer, but not a revolutionary.

Other important anatomists/surgeons:

Gabriel Fallopius (1523-52), a student of Vesalius, described the structure of the inner ear, discovered the Fallopian tubes and also invented the condom

Hieronymus Fabricius (1537-1619), a student of Fallopius, discovered the valves in the veins of legs and arms. Fabricius will be the teacher of William Harvey (whose work we examine in the next lecture.)

SIGNIFICNANCE of Vesalius and his fellow anatomists/surgeons

* They did not bring about any remarkable conceptual shifts as much as new facts about the human body.
* Methodological shift: the anatomist must perform the dissection himself, the EYE WAS PREFERABLE TO AUTHORITY
* Laying the foundations of an observation based anatomy.

Paracelsus:

**Paracelsus** 1493-1541: **Challenges to the Humoral medicine of Galen/Hippocrates**

Came from Paracelsus – an original, although eccentric figure who challenged the presence of humors from the point of view of magic and occult.

His full name was Theophrastus Phillipus Aureolus Bombastus von Hohenheim, born in Swistzerland and educated by his physician father in botany, medicine and natural philosophy. Around the age of 20, he briefly learned medicine in Italy but after that, he simply let the life of a wandering student. He claimed to have learned his medicine from “tramps, butchers and barbers.” He worked as a physician at the silver and copper mines owned by the famous Fugger family, one of the wealthiest family of bankers and venture capitalists at the time.

His rather unorthodox education brought him in touch with esoteric or occult traditions which taught the doctrine of signatures: the plant eyebright resembled blue eyes, so it was good for eyes, the orchid looked like testicles, so it could cure venereal diseases; a walnut looks like the brain, so it is good for the brain etc.

He scorned the Hippocratic tradition as developed by Galen primarily because he believed in the value of experience and observation over learning from ancient texts. He was an outspoken and rather querulous critic of humoral medicine: as town doctor of Basel and a professor in the University of Basel, the refused to take the Hippocratic oath, and publicly burned Galen’s books.

He rejected the notion of humours as having no basis in physiology: Paracelsus supplemented and challenged this view with his beliefs that illness was the result of the body being attacked by *outside* agents. While working at the Fugger Mines, the saw the occupational diseases of miners. This probably led him to believe that the causes of diseases are not some imbalances of imaginary humors, an idea that he ridiculed as silly. Instead he thought that disease is caused by something breathed in from the air, or absorbed through the skin. He believed that diseases are the result of causes external to the body and that each disease had a specific location (v. a general humoral imbalance). The aim of Parcelusian medicine was to find specific substances to cure specific diseases. This was an important insight which was to become the nucleus of later developments in chemical and germ theories of disease.

The search for curative chemicals was linked to P’s views of chemistry (or rather alchemy). He believed there were three chemical “principles” which had spiritual connotations:

Salt, related to solid state, corresponds with the earth and the body