PADUA AND THE BIRTH OF MODERN MEDICINE

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The story of Western Medicine is the story of Greek ideas, their partial loss and recovery and their transformation into the medicine of today. Instrumental in recovery and transformation were the Universities of Europe and foremost of these was the University of Padua. Greek anatomy was partly right, partly wrong and incomplete: Greek physiology and pathology were utterly wrong. In Padua Vesalius corrected and expanded the anatomy, Morgagni transformed the pathology into a modern science and Harvey with Paduan inspiration did the same for physiology.

Origin of Universities

The institutions now called Universities arose differently north and south of the Alps. Such an institution was known in the twelfth century as a *studium generale* and later as a gymnasium, academy or archi-lyceum. *Universitas* meant a body of people, in this context a guild of teachers in a cathedral or monastery school in France or a guild of students in one of the old secular schools of Roman law and rhetoric in Italy. Bologna is the earliest surviving Italian university and the archetype. It was a centre of learning in 1000 AD though the formation of a *universitas* of students dates from the later part of the following century. From the beginning such guilds were organised in national groups with their own elected officers. They offered corporate strength, employed and paid the professors (an arrangement which survived partly in Padua until 1560) and attended to the discipline of the students in university and civic matters. They thus had control of all the affairs of the school apart from the granting of degrees. The Italian university was, in fact, a consumers' co-operative developed in a secular institution whereas north of the Alps, the University was a providers' cartel based on church institutions.

Students often amounted to one quarter of a town's population and their presence brought considerable prosperity. In any conflict with the town authorities, their principal weapon was to transfer themselves elsewhere. At the beginning of the thirteenth century there were such waves of secession from Bologna and in 1220 a massive migration, possibly of the

whole school, to Padua. Further waves of immigration from Bologna continued for about a hundred years during which time in Padua new statutes of 1260 introduced regular salaries for the teachers and in 1262 the chairs of medicine were increased from two to three. In 1346 Clement VI confirmed the status of the school as a *studium generale* (originally conferred by Frederick II) and in 1363 Urban V sanctioned the institution of a *studium generale* in theology in addition to those in Law and in Medicine and Arts.

In 1405 Padua passed under Venetian rule which continued almost uninterrupted until the arrival of Napoleon in 1797. Venetian rule brought the University honours, favours and wealth. The present buildings date from this time. Most important of all however was the free and tolerant outlook of the Venetian Republic. By 1409 the university had conferred its doctorate on a Jew and during the Counter Reformation the Venetians maintained a very detached attitude, refusing for a time even to burn a notable Calvinist. As a result, Padua attracted many of the best brains of northern Europe who were excluded from their own universities by the effects of the Reformation. Degrees however were still conferred in the way laid down in 1264 by Urban IV, namely in church in the presence of the ecclesiastical authorities, the graduate taking an oath on the Bible. When Pius IV issued the bull *In Sacrosancta* during the Counter Reformation (which prohibited non-Catholics from obtaining the degree in medicine) the Republic countered by instituting conferment on the authority of the college of masters by a Palatine Count of Imperial Title, observing that 'it was not thought necessary that an excellent physician should be profound in theology'. It was by the application of this provision that William Harvey received his degree in 1602 from Count Sigismondo Capodilista.

What did they learn: what did they discover?

Until the end of the eleventh century Western scholars had access to only a small fraction of the learned writings of the ancient world in Latin versions. Knowledge of Greek was exceptional and the full range of surviving texts of Hippocrates, Aristotle, Galen and others was available only in Byzantium and the Islamic East. Familiarity with these texts was not gained until the fall of Constantinople in 1453 and until the almost simultaneous invention of printing (including printing in Greek) had accelerated the spread of Greek studies. However, Arabic translations (often through the intermediary of Syriac) were carried to Spain with the spread of Islam during the tenth to twelfth centuries and a wave of Arab and Jewish

scholars in Cordoba and elsewhere edited, collated and summarised them, adding commentaries and new Arab material. These works began to reach the West in Latin translation. Some of the most famous and influential are shown in Table I:

TABLE I

THE ARAB COMMENTATORS

Author	Title	Content
Rhazes d. 925	Almansor	Clinical, empirical
Haly Abbas fl. CX	Pantegni or Liberregius	Synopsis of Galen
Avicenna d. 1037	Canon	Synopsis of Galen attempt to harmonise with Aristotle
Albucasis d. after 1009	Surgical compendium	
Averroes d. 1198	Colliget	Often Aristotelian

They contained much of Aristotle and Galen previously unknown in the West but in versions that were often corrupt, incomplete or even spurious. Nevertheless they were the basis of university teaching until near the end of the sixteenth century. Much of medicine was closely intertwined with philosophy and in mathematics, astronomy and chemistry the Arab contribution often combined genuine science with superstitious errors such as astrology, alchemy and magic.

In this context emerged the first great figure of the University of Padua, Peter of Abano (1250-1316). He had travelled to Constantinople and studied Greek, reading Aristotle and Galen in the original (still an unusual accomplishment). Later he taught at Paris for ten years. When he took up the chair of medicine at Padua in 1306 he was already famous throughout Italy. He introduced the rational and Aristotelian ideas of Averroes in contrast to the closed scholasticism of Paris and Bologna and favoured settling doubtful points by observation and logic rather than by appealing to authority. It was this so-called Averroist style which led to Padua's later achievements. His wide scientific knowledge included astronomy and astrology and he believed in the need for a horoscope in determining

diagnosis, treatment and prognosis.

By 1310 he had completed three great works; the *Lucidator Astronomiae* (the most important astronomical treatise to appear in Italy in the first half of the fourteenth century), a *Commentary on the Problems of Aristotle* and his most famous work, the *Conciliator Controversiarum quae inter Philosophos et Medicos versantur*. This sought to resolve by syllogistic logic two hundred conflicting opinions of Greek philosophy and Arab medicine, that is of Aristotle and Galen-via-Averroes.

Abano's lectures were packed; Dante is believed to have been among his hearers; as a practitioner he treated Popes and nobles; his pupil and successor Iacopo Dondi, besides being a professor of medicine, designed the astronomical clock which is still to be seen functioning in Padua today; and he met Marco Polo. His therapeutics included spa treatment which had been practised in Abano his birthplace since Roman times. His books retained their importance for more than two centuries and were still being published in printed form in the sixteenth century. In 1315 he was denounced to the Inquisition as a heretic by the Dominican friars. In the following year he died of natural causes but the trial was still carried out and he was sentenced to be burned at the stake posthumously. There is evidence that this was carried out.

Peter's enquiring, critical and independent approach to scientific questions illustrates a phenomenon even more strikingly seen in the sixteenth century. As men became more familiar with the Greek texts, they became less submissive to their authority and more "Greek" i.e. critical in their attitude.

The Physician described by Chaucer could well have been a student of Peter's with his astrological skill, Galenic pathology and grounding in the Arab texts.

Infectious Disease

During the fourteenth century a number of epidemics swept across Europe culminating in the bubonic plagues of 1346-49, 1361-62 and 1369. Although the nature of infectious diseases was not fundamentally understood, the principles of prevention were known to the author of Leviticus and Venice soon introduced rational anti-plague measures. In 1374 the entry of infected or suspected goods or persons was forbidden and three inspectors were appointed. In 1377 a by-law was introduced at Ragusa (Dubrovnic) detaining ships arriving from Egypt and the Levant for thirty days; this was later extended to forty, whence the term

quarantine. By 1403 cases and suspected cases of plague were being detained and in 1422 a hospital was opened for ailing pilgrims returning from the Holy Land. Gentile da Foligno and Pietro da Tossignano in Padua (both famous in their time) wrote works on the plague during the fourteenth century.

The most outstanding figure in the whole history of infectious disease however was Girolamo Fracastoro (1478-1553). He was a pupil of Achillini the anatomist, a fellow student in Padua of Copernicus and a friend of Cardinal Pietro Bembo who restored good style to Latin and Italian writing. It was to him that Fracastoro dedicated the poem 'Syphilis sive Morbus Gallicus' which was considered to be the most beautiful Latin verse since the Golden Age. The name of the disease has been taken from its title which in turn comes from Ovid's story of Syphilus, the son of Niobe. It describes how the shepherd Syphilus was afflicted by Apollo and gives an exact description of the course and manifestations of the disease, prescribing the use of mercury and guiacum. It went through many Latin editions and was still saleable two hundred years later when the first Italian vernacular edition appeared in 1739.

Even more important was Fracastoro's second work *De Contagione et Contagiosis Morbis* (Venice, 1546). It was the first truly scientific study of epidemic diseases and distinguished three routes of infection and contagion; direct contact, indirect through fomites (a word which he was the first to use in this sense)[1] and transmission at a distance. He imagined that infectious diseases were propagated by germs (*seminaria*) which were living, had the power of rapid multiplication, and could be absorbed through the breath. He also asserted that tuberculosis was contagious and could be spread by fomites, particularly bedlinen.

Anatomy

It is in the field of anatomy that Padua's contribution to medical knowledge is most widely known.

Permission to dissect the human body was given by Sixtus IV (Pope 1471-84)[2] and in 1493, after three years in the chair of anatomy in Padua, Alessandro Beneditti[1] published *Anatomice sive Historia Corporis Humani*. He urged the need to free dissection from dependence on the bodies of executed persons. He also built an anatomy theatre, probably the first of its kind, which could be erected and dismantled as required like a circus ring.

Von Haller called him the first restorer of anatomy.

In spite of Sixtus's permission, dissection was still carried out infrequently and with difficulty in most universities up to the time of Andreas Vesalius (1514-64) who became Professor of surgery and anatomy in Padua in 1537. Its main purpose was to illustrate the works of Galen. Nowadays it is popularly supposed that Galen's anatomy was almost entirely wrong and that Vesalius discovered the truth about everything. In fact, Galen was the greatest medical scientist of antiquity in every field but his anatomy was not based on human dissection. It contained errors which happened to be important and which had been canonised in the Middle Ages. Vesalius's essential contribution was not simply to correct the errors but to take anatomy out of the realm of authority into that of observation. In other words, to make it scientific. His other contribution was the realisation that the accurate pictorial representation of topographical detail required new standards of anatomical drawing. His great work *De Humani Corporis Fabrica* (Basel, 1543) (which was in every respect a luxury volume) marks a level never before attempted and never since surpassed, combining the achievements of renaissance figure drawing with the new printing technique of wood block engraving. The authorship of the illustrations has been much debated but they are probably the combined work of Vesalius himself, his fellow countryman Jan Stephan Kalkar and Titian in whose studio Kalkar worked.

The discovery of the true facts of anatomy and the disposal of Galen's errors (and some of Vesalius's) were continued by his successors. Realdo Colombo (1510-99) and his pupil Andrea Cesalpino (1519-63) were both important precursors of Harvey in the study of the circulation and Cesalpino was an early worker on medical botany. Colombo expressly denied the existence of Galen's pores in the ventricular septum and his successor Gabriele Falloppio, Falloppia or Fallopius (1523-62), besides correcting some Galenical and Vesalian errors, described the tubes and aqueduct which bear his name as well as the *chorda tympani* nerve, semicircular canals, oculomotor muscles and cerebral nerves (*Observationes Anatomicae* (Venice, 1561)).

Girolamo Fabrizio d'Acquapendente (1537-1619) was a pupil of Falloppio and the teacher of Harvey. He was the first serious student of embryology and his work *De Formato Foetu* was published in Venice in 1600. Harvey, who was in Padua in 1600, also wrote a major work on this subject and his *De Motu Cordis* makes use of an illustration from another work of Fabricius, *De Venarum Ostiolis*. Materially Fabricius's most enduring monument is

the beautiful Anatomy Theatre built in 1595. Consisting of a series of six rising concentric oval tiers it affords a perfect view of the dissection to every by-stander. An illustration fails to convey how tiny it is, the top tier being only about fifteen feet above the lowest. Harvey must often have attended Fabricius's lectures here and it remained continuously in use until the close of the nineteenth century. The title page of Veslingius's *Syntagma Anatomicum* (Padua, 1647) shows it in use. It is still perfectly preserved and may be visited.

By the end of the sixteenth century the sway of authority in science was long past and topographical anatomy was a science whose main facts had been established almost entirely by the school of Padua. Further gleanings still lay in the field for later teachers and students of the school, including such names as Wirsung, Santorini, Bartholin, Spighelius, Rudbeck and Worm (Table II):

TABLE II

THE ANATOMISTS OF PADUA

Alessandro Beneditti 1450-1502	Prof. 1490	Linacre a pupil
Andreas Vesalius 1514-64	Prof. 1537-43	Caius a pupil
Realdo Colombo 1510-99	Successor to V. ?1543-51	lectured with Caius
		?Circulation suggested
[Andrea Cesalpino 1519-1603]	Pisa and Rome	?Circulation suggested
Gabriele Falloppio 1523-62	Prof 1551	Followed Colombo *Observationes anatomicae* 1561
Fabrizio d'Acquapendente 1537-1618	Prof. certainly 1595-1602	Pupil of Fallopio Teacher of Harvey Anatomy theatre 1595 Foetus & veins

Also, Veslingius, Wirsung, Santorini

Bedside Teaching

University medical teaching in the Middle Ages was purely academic and the study of patients hardly entered into it. It is not surprising therefore that the introduction of bedside teaching revolutionised medicine and surgery in the same way that dissection of the human body revolutionised anatomy. This too was a Paduan innovation, introduced by Giovanni

Battista da Monte (Montanus) (1489-1551), who in 1543 commenced the practice of conducting his students around the Ospedale San Francesco. One of these was John Caius who was at the time lodging with Vesalius. Caius later published an *Essay* on medical treatment based on the methods of Galen and Montanus.[4] His famous *Boke or Counseill against the Disease called the Sweate* considered by Copeman as 'the prototype of clinical description' is undoubtedly the fruit of Montanus's discipline of clinical observation. The clinical ward-round had a chequered history. After Montanus's death it lapsed and was revived a few times before being transported to Leyden by a Dutch student. Here it underwent the same fate until it was gloriously revived by Boerhaave and then spread to Vienna and Edinburgh.

Other important events of the mid-sixteenth century were the laying out of the first physic gardens in 1546 by Francesco Buonafede. In Padua it is claimed to be the first of its kind anywhere and it is still in existence. It was encouraged by Montanus and aimed to revive the plants (simples) mentioned by Pliny, Galen and Dioscorides. Within 1000 days, between 1543 and 46, Padua saw the publication of Vesalius's *Fabrica* and Fracastoro's *De Contagione*, the introduction of bedside teaching and the laying out of the garden of simples. Further afield Nicholas Copernicus, who graduated in medicine at Padua in 1504, published *De Revolutionibus Orbium Coelestium*, also in 1543.

Measurement, Calculation and Planned Experiment

The introduction of measurement and calculation into medical research in Padua at the end of the sixteenth century marked the beginning of a new era and it was undoubtedly the result of the presence of Galileo (also medically qualified) who was Professor of Mathematics between 1592 and 1610.

In 1611, Sanctorio Sanctorius (1561-1636) became Professor of Theory of Medicine. He was the first to use a thermometer or count the pulse but it is as the originator of the metabolic balance study that he is mainly remembered. His studies were balance studies in fact as well as name and the well-known illustration shows him suspended from a balance, sitting in a chair as he eats and drinks. By this means he discovered the insensible losses of the body for which he invented the term perspiration as distinct from visible sweating. He published his results in 1614 as *De Statica Medicina*. The following year, writing to Galileo he remarked that the insensible losses exceeded all the sensible ones added together.

The other epoch-making Padua-inspired discovery which depended on planned experiment and measurement as well as observation, was Harvey's proof of the circulation of the blood. Colombo and Cesalpino had made pertinent observations but it required experiment and measurement to prove the concept. With that proof not only was Galen's idea of the heart and blood disproved but his physiology of humours and spirits lost its basis.

Organ Pathology

The final blow to Galen however was in the field of pathology. Traces of the humoral concept of disease lingered on until the modern concept of morbid changes in individual organs was introduced by Morgagni (1682-1771) in 1761. Professor of medicine in Padua from the age of 30, he spent his time tirelessly performing post-mortems and recording the findings collated with the ante-mortem symptoms. Then at the age of 79 he published *De Sedibus et Causis Morborum per Anatomen Indagatis*. The science of special pathology was created, the book swept Europe, three editions were sold out in three years and the ideas of three millenia were wiped away.

Besides the giants we have been considering, Padua had many lesser but still honourable champions. Three deserving mention are Gabriele Zerbi (1468-1505) who wrote the first book on Geriatrics (*Gerontocomia*), Girolamo Mercuriale (1530-1606) the first on dermatology and Bernardo Ramazzini (1633-1714) on occupational medicine.

Influence in Britain

Among the students from all over Europe who flocked to Padua and carried its influence back home were many English. It is known for example that between 1518 and 1671 the Royal College of Physicians numbered 57 Paduan graduates among its members. Four of these deserve special mention, Thomas Linacre, John Chambre, John Caius and William Harvey. Caius and Harvey we have met already and it only remains to add of Harvey that in addition to his studies he was also rector of the English student *universitas* or *natio* in 1601 and 1602 and his coat of arms was therefore painted on the courtyard cloister ceiling where it may still be seen. Linacre and Chambre were both royal physicians and members of the group who persuaded Henry VIII to grant the charter founding the Royal College of Physicians. Linacre played an important rôle in the introduction of Greek studies into England and was a friend of Erasmus and Thomas More while Chambre was also one

of the physicians present when Henry VII granted the Barber-surgeons their charter, appearing in Holbein's famous picture of this event.

In conclusion, how then may one characterise the story of the University of Padua? We learn, I think, that there have been only two epochs in medicine, the ancient which was based on philosophical inventions and concepts and the modern which relies on observation, measurement, experiment and analysis. The transition took place in a comparatively brief period of time around the sixteenth century. Padua was ready because of its history and able because of the atmosphere of tolerance of free enquiry encouraged by the Venetian Republic. The work has been accomplished and no comparable revolution in human understanding seems in prospect. Medicine continues to progress, ever indebted to Padua's contribution.

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Notes

1. *Fomes, fomitis* (masc.)-tinder, kindling. (cf. fomentation).
2. Builder of the Sistine chapel.
3. A teacher of Thomas Linacre.
4. *De Medendi Methodo, Libri duo ex Cl. Galeni Pergameni et Jo. Baptistae Montani Veronensis Principium medicorum Sententia* (Basel, 1544).

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