Roman knowledge about the body and disease

The Romans did not allow dissection of human bodies, so they were limited in what they could find out about human anatomy. They also rejected many Greek ideas about medicine. These factors slowed down their progress, but they continued to explore new ideas about the causes and prevention of disease.

Overview

Roman doctors learned a lot about the human body as they tended gladiators wounded in the amphitheatres. However, dissection of humans was forbidden in the Roman empire, so Roman anatomists such as Galen had to rely mainly on dissections of animals to further their knowledge. Galen recommended dissecting monkeys that walked on two legs, like men.

He did manage to work a little with the human body, and described how he had human corpses to dissect when he found a hanged criminal, and when a flood washed some bodies out of a cemetery. Despite this, he made various errors in his analysis of how bodies work.

Galen's books show a good knowledge of bone structure. He also studied the lungs, the muscles, the heart and blood and the nervous system. He conducted experiments on pigs, and when he cut the spinal cord in different places he realised how the nervous system takes messages from the brain to the muscles.

Galen accepted the Greek theory of the four humours as the cause of disease. However, the Romans did not continue the Greeks' investigations into disease and rejected Greek ideas, so Roman knowledge of disease did not progress.

Roman ideas about disease were muddled. For example:

- Crinas of Massilia thought illness was caused by the stars (astrology).
- Varro blamed creatures too tiny to be seen.
- Columella blamed poisonous vapours in the swamps.

All these ideas survived until the 19th century.
Anatomical errors in Galen

Galen based most of his information about anatomy on what he saw when he dissected the bodies of animals. This led him to make mistakes. Some of his errors were:

1. He thought that muscles attach to the bone in the same way in humans and in dogs.
2. He thought that blood was created in the liver. He realised that it flowed round the body, but said it was burned up as fuel for the muscles.
3. He thought he saw holes through the septum, which allowed the blood to flow from one side of the heart to the other.
4. He made mistakes about the blood vessels in the brain.
5. He thought the human jaw-bone was made up of two bones, like a dog’s.
6. He was mistaken about the shape of the human liver.
Roman knowledge about the body and disease - Test

1. Which of the following properties of the human body did Galen understand?
   ○ the way that muscles attach to the bone
   ○ the way that the nervous system uses the spinal cord
   ○ the way that blood flows through the heart

2. Where, according to Galen, was blood created?
   ○ in the liver
   ○ in the heart
   ○ in the septum

3. Who thought that poisonous vapours were the cause of disease?
   ○ Galen
   ○ Varro
   ○ Columella

4. Who thought that invisible creatures were the cause of disease?
   ○ Crinas of Massilia
   ○ Galen
   ○ Varro

5. Who thought the 'four humours' were the cause of disease?
   ○ Columella
   ○ Crinas of Massilia
   ○ Galen
Medieval medical knowledge

Knowledge was hard to come by in Medieval times, especially during the Dark Ages when barbarian tribes roamed western Europe. The knowledge gained by the ancient Greeks and Romans was largely lost to Europeans, and superstition reigned - although learning was more advanced in the Muslim Middle East.

Summary

Knowledge went into reverse in the west in Medieval times - many of the books of the Greeks and Romans were lost, and the knowledge they contained was replaced by mere speculation and superstition.

Even when universities developed, after 1100 (Montpellier, Bologna and Salerno had famous medical schools), lectures on anatomy were rudimentary. They consisted simply of a butcher pointing to the different parts of a body, while the lecturer read a text by an authority such as Galen.

Although students did debate the ideas of Galen, any new ideas were judged on the debating skills of the student, not on scientific proof. The Church said that Galen's ideas were so correct that there was no need to investigate any further.

Generally, the Church forbade the dissection of human bodies, so knowledge was hard to come by - and ignorance led to numerous errors and misunderstandings on the part of Medieval doctors. For example, the Italian doctor Alderotti claimed that combing the hair 'comforts the brain'.

Medieval superstitions and Muslim knowledge

Although many Medieval doctors continued to believe in the theory of the four humours, they also said disease was caused by demons, sin, bad smells, astrology and the stars, stagnant water, the Jewish people etc.

 Ultimately, they believed that life was controlled by God and his saints, and a plague such as the Black Death was seen as a punishment from God. Guy de Chauliac, the Pope's doctor, blamed the Black Death on a conjunction of Saturn, Jupiter and Mars.

Things were different only in the Muslim Middle East where, during the reign of Harun al-Rashid (786-809), the books of Hippocrates were translated into Arabic. At first, Muslim doctors like al-Razi ('Rhazes known as the Galen of Islam') conserved the ideas of the Greeks and Romans.

Later, Muslim doctors such as Avenzoar and Ibn an Nafis actually began to challenge errors and to develop new ideas. However because the Christian Church was at war with Islam, Muslim ideas spread only slowly to western Europe. The exception was a book by Ibn Sina (often known as Avicenna) - the 'Canon of Medicine'.
Source analysis and questions

A medieval doctor

“
A Doctor too emerged as we proceeded.
No one alive could talk as well as he did
On points of medicine and of surgery
For, being grounded in astronomy
He watched his patient's favourable star
And, by his Natural Magic, knew what are
The lucky hours and planetary degrees
For making charms and effigies.
The cause of every malady you'd got
He knew, and whether dry, cold, moist or hot;
He knew their seat, their humour and condition.
He was a perfect practicing physician.
All his apothecaries in a tribe
Were ready with the drugs he would prescribe
And each made money from the other's guile
(They had been friendly for a goodish while)
He was well-versed in Aesculapius too
And what Hippocrates and Rufus knew
And Disocorides now dead and gone,
Galen and Rhazes, Hali, Serapion.
In blood-red garments, slashed with buish-grey
And lined with taffeta, he rode his way;
Yet he was rather close as to expenses
And kept the gold he won in pestilences.

Chaucer, 'Canterbury Tales' (c.1387)

Question

1. What can Chaucer tell historians about medicine in Medieval times?
2. Were doctors in Medieval times hated or fêted?

Answer

Question 1 - what can Chaucer tell historians about medicine in Medieval times?

Chaucer tells historians that there was a huge range of different ideas and superstitions - astronomy, magic, charms, the four humours, drugs, acceptance of the authority of the ancients.

Question 2 - were doctors in Medieval times hated or fêted?

Chaucer clearly disliked the doctor he described: - 'No one alive could talk as well as he did' - 'Each made money from the other's guile' - '[He] kept the gold he won in pestilences'

Patients, however, continued to flock to the doctor, and must have thought he had something to offer, otherwise he would not have been so rich.
Medieval knowledge about the body and disease - Test

1. Whose ideas had the Church's seal of approval?
   ○ Alderotti’s
   ○ Galen’s
   ○ Guy de Chauliac’s

2. Which of the following were not bases of Medieval medicine?
   ○ speculation and superstition
   ○ research and science
   ○ errors and misunderstandings

3. Which Muslim doctor significantly affected the ideas of Medieval doctors in western Europe?
   ○ Avenzoar
   ○ Avicenna
   ○ Rhazes

4. Which of the following was not blamed by Medieval doctors for causing the Black Death?
   ○ conjunctions
   ○ terrorists
   ○ rats

5. What colour are the garments the doctor wears in Chaucer’s 'Canterbury Tales'?
   ○ gold
   ○ red
   ○ taffeta
Renaissance medical knowledge

The Early Modern Age was an exciting time for medicine, with knowledge of the human body progressing in fundamental ways - although the causes of disease remained a mystery.

Knowledge about the body

Two key practitioners moved knowledge forwards in the Early Modern Age:

Vesalius

The first was Vesalius, whose patron was Charles V of Spain. He trained at Louvain, Paris and Padua universities, and ransacked cemeteries and gibbets for bones and for bodies to dissect.

1536
He discovered the spermatic vessels. He also realised that the famous doctor Galen could be wrong, when he discovered that the great man was mistaken about there being two bones in the jaw, and about how muscles were attached to the bone.

1537
He became professor of medicine at Padua University. He said that medical students should perform dissections for themselves, stating that:"... our true book of the human body is man himself."

1543
He published 'Fabric of the Human Body' (with high-quality annotated illustrations).

William Harvey

The second important practitioner was William Harvey - who discovered the principle of the circulation of the blood through the body. He trained at Cambridge and Padua universities, and became doctor to James I and Charles I of England.

1616
He calculated that it was impossible for the blood to be burned up in the muscles (as Galen had claimed).

1628
He published 'Anatomical Account of the Motion of the Heart and Blood', which scientifically proved the principle of the circulation of the blood. This book marked the end of Galen's influence on anatomy.
Knowledge about disease

Despite progress in some areas of medicine, Early Modern doctors did not advance understanding of the causes of disease.

- **Paracelsus** declared "Galen is a liar and a fake" but still believed in the *four humours*. He believed in *alchemy*, and believed it was possible to find the elixir of everlasting life.

- **Thomas Sydenham** insisted that doctors should visit the sick, rather than the other way round, which showed some progress in his thinking - but he taught that disease was caused by 'atmospheres'.

- **Nicholas Culpeper** believed that illness was caused by the stars.

- **Anton van Leeuwenhoek** discovered bacteria in 1683, using a single-lens microscope, but no one realised their significance, or that they caused disease.

**Syphilis** - a terrible sexually transmitted disease which became prevalent at the time - was thought variously to be a punishment from heaven, or caused by small worms that floated through the air, the planet Saturn at certain times, sexual contact between a man and a sick woman, or contact with the New World.

Despite the lack of progress in some areas, doctors did come to realise that the plague was a *contagious* disease.
Development through time and question
The discovery of the circulation of the blood is an excellent example of how
knowledge can accumulate over time.

Discovering the circulation of blood through time

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Who</th>
<th>Contribution to debate</th>
<th>Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start point - Galen</td>
<td>c.200</td>
<td>Doctor in Rome</td>
<td>Said blood <strong>passes through the septum</strong>, and the heart pumps it to the muscles, where it is burned up.</td>
<td>Main authority for 1,500 years</td>
</tr>
<tr>
<td>Ibn an Nafis</td>
<td>c.1250</td>
<td>Persian doctor</td>
<td>Said blood does <strong>not</strong> go through the septum, and is pumped past the lungs.</td>
<td>Muslim doctor, not known in Europe</td>
</tr>
<tr>
<td>Leonardo da Vinci</td>
<td>d.1519</td>
<td>Artist</td>
<td>Made detailed drawings of the anatomy of the heart.</td>
<td>Drawings not discovered until 1850</td>
</tr>
<tr>
<td>Vesalius</td>
<td>1543</td>
<td>Professor at Padua</td>
<td>Said blood does <strong>not</strong> pass through the septum.</td>
<td>Well-know anatomical textbook</td>
</tr>
<tr>
<td>Servetus</td>
<td>d.1553</td>
<td>Italian preacher</td>
<td>Said blood <strong>does</strong> go through the septum, and is pumped past the lungs.</td>
<td>No effect - burned as a heretic</td>
</tr>
<tr>
<td>Columbo</td>
<td>1559</td>
<td>Professor at Padua</td>
<td>Said blood does <strong>not</strong> go through the septum, and is pumped past the lungs.</td>
<td>William Harvey read his book</td>
</tr>
<tr>
<td>Caesalpino</td>
<td>1571</td>
<td>Professor at Pisa</td>
<td>First used the word 'circulation' in relation to blood, but could not explain the process.</td>
<td>William Harvey did not know of his book</td>
</tr>
<tr>
<td>Fabricius</td>
<td>1603</td>
<td>Professor at Padua</td>
<td>Discovered valves in the veins only allow the blood to go one way.</td>
<td>William Harvey's teacher at university</td>
</tr>
<tr>
<td>William Harvey - End point</td>
<td>1628</td>
<td>London doctor</td>
<td>Proved that blood circulates round the body, and described how it happened.</td>
<td></td>
</tr>
</tbody>
</table>
**Question**

Use the table to study development through time by identifying:

1. an example of an error that lasted many years
2. discoveries that had no effect on the development of knowledge
3. examples of ideas that had an effect because they were disseminated
4. the effect of education and training
5. the 'pathway of knowledge' that led to Harvey's discovery, excluding all the false starts and people who had no effect

**Answer**

1. **an example of an error that lasted many years**
   - Galen's idea that the heart pumped out blood to be burned up in the muscles

2. **discoveries that had no effect on the development of knowledge about medicine**
   - Nafis (Muslim; not known) / da Vinci (lost) / Servetus (burned) / Caesalpino (not known)

3. **examples of ideas that had an effect because they were disseminated**
   - Vesalius and Columbo - wrote books read by Harvey

4. **the effect of education and training**
   - Fabricius was Harvey's tutor - his discovery of valves was vital for Harvey's discovery

5. **the 'pathway of knowledge' that led to Harvey's discovery**
   (excluding all the false starts and people who had no effect)
   - start point: Galen - blood passes through the septum and is pumped out to be burned up in the muscles
   - Vesalius - blood does not pass through the septum
   - Columbo - blood is pumped past the lungs
   - Fabricius - valves mean blood can only go one way through the veins
   - Harvey - blood cannot be produced fast enough to burn it up - leads to understanding of circulation of blood
Renaissance knowledge about the body and disease - Test

1. Where did both Vesalius and Harvey do their medical training?
   - Cambridge
   - Padua
   - Paris

2. What made 'Fabric of the Human Body' (1543) such a world-changing book?
   - annotated illustrations
   - personal dissection
   - scientific method

3. What made 'Anatomical Account of the Motion of the Heart and Blood' (1628) such a world-changing book?
   - annotated illustrations
   - personal dissection
   - scientific method

4. Who declared: 'Galen is a liar and a fake'?
   - William Harvey
   - Paracelsus
   - Vesalius

5. Who made the medical breakthrough that would eventually lead to the Germ Theory of disease?
   - Nicholas Culpeper
   - Anton van Leeuwenhoek
   - Thomas Sydenham
19th-century knowledge about the body and disease

There was a general atmosphere of scientific research and advance throughout the 19th century, and this was reflected in the fast build-up of medical knowledge. Pasteur's discovery that germs cause disease was a crucial turning point.

Knowledge about the body

Knowledge about the body increased greatly in the 19th century:

1. **William Beaumont** (America: 1822) studied the digestive system of Alexis St Martin, a Canadian who had an open hole into his stomach.
2. **Theodor Schwann** (Germany: 1839) realised that animal matter was made up of cells, not 'humours'. This was the vital breakthrough of knowledge that at last destroyed belief in the old 'humoral' pathology of the Greeks.
3. **Henry Gray** (Scotland: 1858) wrote 'Gray's Anatomy', which had over 1,000 illustrations. Many people bought a copy to own at home. After the 1870s, pupils started studying anatomy in schools.
4. **Starling and Bayliss** (England: 1902) discovered the first hormone.
5. **Casimir Funk** (Poland: 1912) discovered the first vitamins, and realised that some diseases were caused simply by poor diet.
Knowledge about disease

Knowledge about disease also increased greatly in the 19th century.

Louis Pasteur (France: 1860s) discovered (by using a swan-necked flask) that germs cause disease. Before he made this discovery, doctors had noticed bacteria, but they believed it was the disease that caused the bacteria (the so-called theory of 'spontaneous generation') rather than the other way round.

One of the spin-offs of Pasteur's discovery was the pasteurisation of milk, which prevented it from going sour by killing the germs and sealing it from the air.

Other scientists also made crucial discoveries, among them:

1. Robert Koch (Germany: 1878), who discovered how to stain and grow bacteria in a Petri dish (named after his assistant Julius Petri). He was thus able to find which bacteria caused which diseases:
   - septicaemia (1878)
   - TB (1882)
   - cholera (1883).

2. In the same period other bacteria were discovered, including those that caused:
   - typhoid (1880s)
   - pneumonia (1880s)
   - plague (1894)

3. Patrick Manson (Britain: 1876) discovered that elephantiasis was caused by a nematode worm, and that mosquitoes were the vector (carrier). This was a breakthrough discovery, because researchers soon found out that other tropical diseases were transmitted by vectors such as mosquitoes (malaria and yellow fever) or tsetse flies (sleeping sickness).

4. Charles Chamberland (France: 1884) found that there are organisms even smaller than bacteria that also cause disease - he had discovered viruses.
Causes of improvements in physiology and pathology

1. **The Industrial Revolution / inventions**
   - There was a general atmosphere of scientific research and advance.
   - Louis Pasteur's first commission was to find a **cure for sour wine**, which set him off on his revolutionary course.
   - Joseph Jackson Lister (Britain: 1826) invented the **multi-lens microscope**, which allowed doctors to see very tiny things accurately.
   - Carl Ludwig (Germany: 1847) invented the kymograph, which allowed more accurate measurement of the **pulse**.
   - Wilhelm Roentgen (Germany: 1895) discovered **x-rays**.
   - Willem Einthoven (Holland: 1900) invented the **electrocardiograph** (measured heart activity).

2. **Scientific knowledge**
   - Jan Purkinje (Czechoslovakia: 1836) set up the first university department of physiology (science of how the body works).
   - Louis Pasteur started as a research chemist. He set up a team of researchers at the Pasteur Institute (1888).
   - Robert Koch developed his **Postulates** of how researchers should find a disease. These led to four basic procedures - make sure the germ in question is present in the sick specimen - grow a culture of that germ - inject it into a healthy specimen - see if the disease develops.

3. **Social factors**
   - Nationalism - eg the rivalry of Pasteur and Koch. Shibasaburo Kitasato (Japan) and Alexandre Yersin (France) raced to discover the plague bacterium in 1894.
   - The deaths of his two daughters motivated Louis Pasteur to redouble his efforts in the fight against disease.

3. **Social factors**
   - Nationalism - eg the rivalry of Pasteur and Koch. Shibasaburo Kitasato (Japan) and Alexandre Yersin (France) raced to discover the plague bacterium in 1894.
   - The deaths of his two daughters motivated Louis Pasteur to redouble his efforts in the fight against disease.
19th-century knowledge about the body and disease - Test

1. Who exploited a bullet-hole to learn about the digestive system?
   ◯ William Beaumont
   ◯ Alexis St Martin
   ◯ Robert McVitie

2. Who destroyed the old 'humoral pathology' of the Greeks?
   ◯ Jan Purkinje (1836) when he developed the discipline of 'Pathology'
   ◯ Theodor Schwann (1839) when he discovered animal cells
   ◯ Louis Pasteur (1860s) when he discovered germs

3. What did Starling and Bayliss discover in 1902?
   ◯ LPG (Liquefied Petroleum Gas)
   ◯ B1 (the first vitamin)
   ◯ Secretin (the first hormone)

4. What was 'spontaneous generation'?
   ◯ the theory that disease causes bacteria to grow
   ◯ the theory that bacteria cause disease
   ◯ the theory that germs cause disease

5. What utensil or instrument did Pasteur use to prove his 'germ theory'?
   ◯ a Petri dish
   ◯ a swan-necked flask
   ◯ a multi-lens microscope

6. Who thought up the idea for a Petri dish?
   ◯ Louis Pasteur
   ◯ Robert Koch
   ◯ Julius Petri

7. Robert Koch developed the discipline of...
   ◯ bacteriology
   ◯ pathology
   ◯ histology

8. What is the name for the set of rules Koch developed to confirm how researchers could discover a disease?
   ◯ Koch's Positives
   ◯ Koch's Postulates
   ◯ Koch's Principles

9. Who discovered that elephantiasis was caused by the nematode worm, and why was it a 'breakthrough discovery'?
   ◯ Patrick Manson (1876) - because it introduced the concept of 'vectors'
   ◯ Charles Chamberland (1884) - because it introduced the concept of 'Viruses'
   ◯ Casimir Funk (1912) - because it introduced the idea of 'vitamins'

10. Who invented the first machine to measure the pulse?
    ◯ Carl Ludwig - the kymograph (1847)
    ◯ Wilhelm Roentgen - x-rays (1895)
    ◯ Willem Einthoven - the electrocardiograph (1900)
20th-century knowledge about the body and disease

Knowledge about the body and disease increased greatly in the 20th century. Developments ranged from the discovery of the cause of diabetes to the creation of 'test-tube' babies for previously infertile couples.

Significant developments

There were many scientific and medical discoveries and developments during the 20th century. The following are among the most significant:

A positronic emission tomograph (PET) scanner

**1896:** Walter Cannon (America) used a **barium meal with x-rays** to track the passage of food through the digestive system.

**1910:** Henry Dale (Britain) discovered the chemical **histamine**, which is produced by the body during an allergic reaction. This allowed him to understand allergic response and surgical shock.

**1921:** Frederick Banting and Charles Best discovered **insulin**, which breaks down sugar in the bloodstream. Thus he found the cause of diabetes.
1923: Edgar Allen (America) discovered oestrogen (the hormone that powers femaleness). In 1935 Ernst Laqueur isolated testosterone, the hormone that creates maleness.

1931: The invention of the electron microscope allowed doctors to see bacteria and viruses for the first time.

1951: The Mexican company Syntex developed norethisterone, which prevents ovulation - leading to production of the first contraceptive pills.

1953: Francis Crick and James Watson (Britain) discovered DNA.

1953: Leroy Stevens (America) discovered stem cells.

1970s: Patrick Steptoe (Britain) developed IVF fertility treatment; in 1978 Louise Brown became the first 'test-tube' baby.

1970s: Endoscopes - fibre optic cables with a light source - enabled doctors to 'see' inside the body.

1972: Geoffrey Hounsfield (Britain) invented the CAT scanner, which uses x-ray images from a number of angles to build up a 3D image of the inside of the body.

1980s: MRI scans were developed to monitor the electrical activity of the brain.

1986: In the Visible Human project undertaken in the US, the bodies of two criminals (a male and a female) were frozen, cut into 1mm slices, stained, photographed and stored as 3-d images on the internet.

1990s: The Human Genome project undertaken in the US mapped all the genes in the human body - 40,000 of them. Humans share their gene make-up with much of the natural world, leading scientists to joke that because of the genes we share, human beings are 60 per cent banana! In 1997 Scottish researchers bred Dolly, the first cloned sheep.

2002: Gunther von Hagens (Germany) performed live dissections on TV.
20th-century knowledge about the body and disease - Test

1. Who invented the 'barium meal' in 1897?
   ○ Theda Bara
   ○ Walter Cannon
   ○ Marie Curie

2. Who in 1921 discovered insulin, the miracle substance that alleviates diabetes?
   ○ Banting and Best
   ○ Henry Dale
   ○ Starling and Bayliss

3. When was norethisterone developed by Syntex, and why was this important?
   ○ 1923 - creates 'femaleness'
   ○ 1935 - creates 'maleness'
   ○ 1951 - led to invention of first contraceptive pill

4. What did Crick and Watson discover in 1953?
   ○ BCG
   ○ DNA
   ○ IVF

5. Who became the first 'test-tube' baby in 1978?
   ○ Louise Brown
   ○ Patrick Steptoe
   ○ Leroy Stevens

6. What allowed doctors (in 1931) to see bacteria and viruses for the first time?
   ○ CAT scanner
   ○ electron microscope
   ○ fibre-optic cables

7. What allowed doctors for the first time to monitor the electrical activity of the brain?
   ○ CAT scanner
   ○ MRI scanner
   ○ ultra-sound scanner

8. What person or project was behind the cutting of the dead bodies of two criminals into 1mm slices, and showing the pictures on the internet?
   ○ Jeffrey Dahmer
   ○ The Human Genome Project
   ○ The Visible Human Project

9. How did Gunther von Hagens disseminate knowledge about the body in 2002?
   ○ He published pictures of a foetus in the womb live on the internet.
   ○ He performed dissections of dead bodies live on TV.
   ○ He pushed an endoscope up an artery and into his heart, live during a lecture.

10. Scientists have found that there are only 40,000 genes in the human body and that you are...
    ○ 40 per cent banana
    ○ 60 per cent banana
    ○ 100 per cent thick