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Medicine for Managers

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1628

1628 was an interesting year. The Anglo-French war had started the year before. King Charles I's second parliament was established and Oliver Cromwell was the MP for Huntingdon. In March of that year the King issued a writ demanding a ship tax from every County in England, irrespective of whether they had sea ports. Witch trials were in full swing in Europe, especially in Germany.

In England's green and pleasant land, the English Civil War was still sixteen years away and King Charles would keep his head until 1649. Apparently it was a poor summer with a lot of rain.

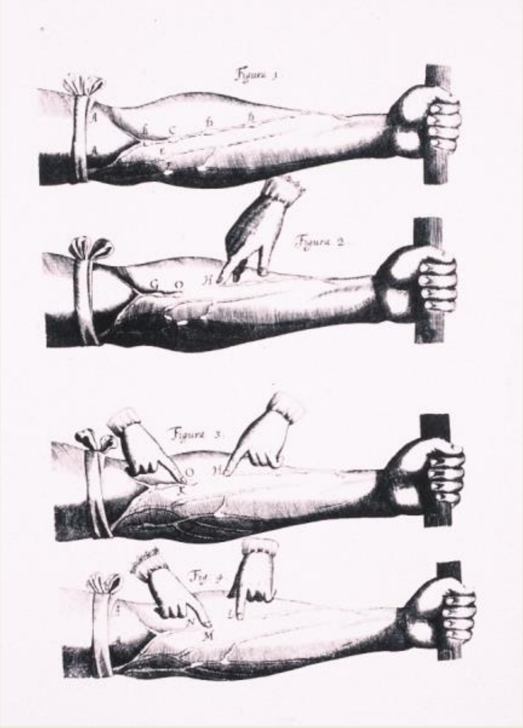
It was, however a momentous year for Medicine because of a physician called **William Harvey.** Born in Folkestone in 1578, the son of a merchant, he had been educated at King's College Canterbury and Cambridge University. He subsequently travelled to Italy where he studied medicine at the University of Padua. He returned to England in 1602 and married Elizabeth Browne, the daughter of Queen Elizabeth I's physician. He was appointed Physician to St. Bartholomew's Hospital in 1609. He recognised the importance of dissection in understanding human anatomy and physiology and concentrated on the heart and blood vessels. In 1616 he delivered preliminary results to the College of Physicians and , in **1628**, he published his book ***Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus***. Latin was the universal language for the dissemination of medical information and it established the key principles of the operation of the cardio-vascular system.

EXERCITATIO
ANATOMICA DE
MOTV CORDIS ET SAN-
GVINIS IN ANIMALI-
BVS,
GVILIELMI HARVEI ANGLI,
Medici Regii, & Professoris Anatomiæ in Col-
legio Medicorum Londinensi.

FRANCOFVRTI,
Sumptibus GVILIELMI FITZERI.
ANNO M. DC. XXVIII.

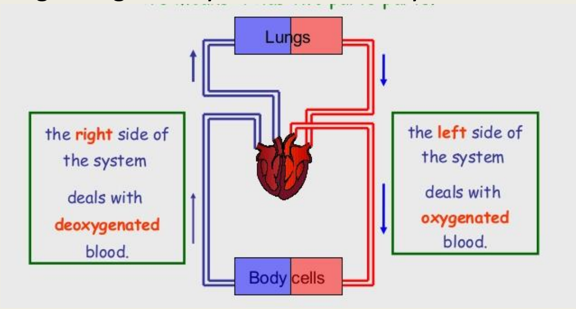
"An Anatomical Exercise on the motion of the Heart and Blood in Animals" was a landmark.

He combined the results of his dissections with observations, rudimentary physiological experiments, and hypotheses to reach his conclusions. Before that time there were a jumble of theories many of which were far-fetched and which linked the heart with the soul and emotion. However, there were some basic findings which did set the scene for Harvey's work. The transfer of gases through the lungs had been proposed in the thirteenth century. In 1553, Servetus had stated that blood from the heart travelled to the lungs where it mixed with air and returned to the heart. In 1590 Cesalpino postulated some sort of circulation of blood and the venous valves, which prevent backflow of blood were recognised by Acquapendente in 1603.



For Harvey and the other physicians achieving an understanding of the true operation of the heart and lungs existed because of Galen, the philosopher and physician who had lived in the second century. He was regarded by many as the acknowledged authority and his treatise had cast a long shadow over the understanding of the function of the cardiovascular system which was to last for 1500 years. He said that blood was created in the liver from food. Some flowed to the right side of the heart, some to the lungs where it gave off 'sooty vapors', and some through invisible pores into the left side of the heart where it gained vital spirits with *pneuma* which reached the heart through the trachea. Some arteries flowed into what he described as a '*rete mirabile'* at the base of the brain where vital spirits changed into animal spirits before being distributed to the rest of the body in hollow tubes called nerves. The blood was then consumed by the tissues.

In his book, Harvey produced a medical earthquake by providing an explanation for the complete circulation of the blood. He dismissed the concept of the heart as having mystical properties and invisible connections and recognised and described the heart as a pump and the blood system as a circulation. He documented that each beat of the heart pumps out two ounces of blood and so, assuming an average heart rate of seventy-two beats a minute, that equated to five hundred and forty pounds of blood an hour. He recognised that such volumes could only be achieved if the same blood was pumped and and returned again and again. He also recognised the one-way valves in the heart directing blood into the arteries and causing it to return by way of the veins. Unfortunately in 1628, it was not possible to visualise capillaries and it was Malpighi who discovered them by seeing blood move in a frog's lung a few years after Harvey's death.

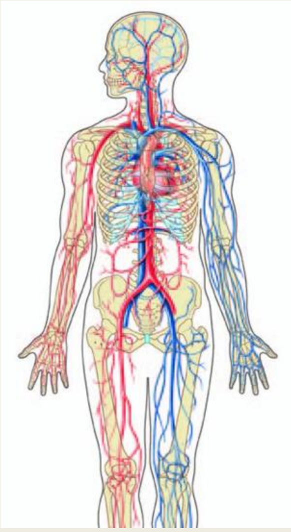


So, and by way of revision for all of you for whom 'O' level or GCSE is a distant memory, the above diagram shows the circulation.

- Deoxygenated blood enters the right side of the heart and is pumped to the lungs.
- In the lungs it is oxygenated
- It travels from the lungs to the left side of the heart from where it is pumped into the general circulation.
- The oxygenated blood travels to the body capillaries where oxygen passes into the body tissues
- The resulting deoxygenated blood is returned to the heart
- The cycle starts again.

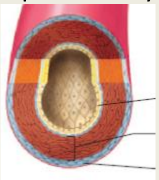
For a resting individual the blood takes about **one minute** to complete a circulation of the body but, if exercising, it is quicker.

The body's circulation is very complex because oxygen and nutrients must be carried to every cell in the body.



The principal transport blood vessels are the arteries and veins.

Arteries carry blood away from the heart and they have thick muscular walls. They lie deeply in the body wherever possible and they display a pulse. They have no valves.



The design of the arteries is crucial to the operation of the circulation because they smooth out variations in pressure. Imagine that an artery was like a copper tube. With each beat of the heart a bolus of blood would shoot down the artery at great pressure. In between beats no blood would come from the heart and the blood vessel would be empty. The pressure would fall to approaching zero. The system would not be able to cope with swings of such huge magnitude and it would not be long before the tube developed a leak. In fact, when the heart beats the arteries expand to increase their capacity to hold some of the blood and they absorb most of the pressure rise. After the beat the artery recoils to push the stored blood onwards so ensuring the the blood flow is continuous and the pressure does not fall too low. That is why two figures are recorded when the blood pressure is taken. The upper figure is the maximum pressure in the system when the heart beats and the lower figure is the residual pressure in the system as the artery recoils in the heart's rest phase. For a healthy young individual, the blood pressure might be

120

80

Measured in millimetres of mercury pressure, the 120 mm is the highest pressure and the 80 mm is the lowest pressure experienced within the system respectively during the beat and the rest phase of the heart.

In a patient with hardening of the arteries (atherosclerosis) the elasticity of the arteries is reduced. They are therefore unable to absorb much pressure during the beat phase and therefore more blood passes down the vessel and there is less recoil during the rest phase to stabilise the pressure. In an older person with severe arterial hardening the blood pressure might be something like:

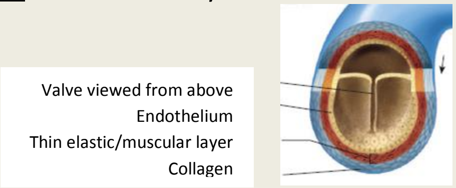
200

50

Such patients are vulnerable to stroke and heart attack.

Towards the periphery of the body the arteries divide into smaller arteries and then into smaller arteries called arterioles. Untimately they divide finally into **capillaries.** Each capillary consists of a tube which is only one cell thick. Through them can diffuse oxygen and nutrients carried from the blood. Waste products manufactured by the cell as it produces energy (carbon dioxide and waste products such as urea) diffuse into the capillary. The capillaries then join to form venules which join to form small veins which then join together to form:

Veins. The veins carry blood to the heart.



Their walls are thin with very little muscle or elastic tissue and, because all the pumping pressure of the heart is dissipated as the vessels break down into capillaries, the blood collected into the veins is at no pressure. It is possible to distinguish between a bleeding artery and a bleeding vein because an artery spurts with the pulse and elevating the bleeding part makes no difference, whereas elevating a part with a bleeding vein will stop the bleeding because it is under no pressure. The different treatments therefore are pressure on an artery, elevation of a vein. The lack of pressure would mean that blood would not circulate if it was not for two factors, (a) the presence of valves which prevents the blood in the veins from flowing backwards and (b) the fact that blood is pushed towards the heart because more blood is being pumped into the arteries making the system a circulation. Veins have no pulse and are located much closer to the skin.

It is truly amazing that nearly four hundred

years ago William Harvey worked almost all of the system out in the face of opposition from traditionalists and with little more than observation, dissection, some experiments on animals (usually invertebrates) and common sense. He died at the age of 79. He spoke profoundly and left behind many quotes. Though simple in today's world to understand, how remarkable was he to be able to shed the guidance of those who had gone before and to discover anatomy from what he could feel and what he could see. He said "I profess both to learn and to teach anatomy, not from books but from dissections; not from positions of philosophers but from the fabric of nature". A truly great man.

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