Six Great Scientists

Rosemary Border

Range 6 Fact

Series Editor: Carol Christian

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The great doctor and scientist ***William Harvey***

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Until the great doctor and scientist William Harvey began his work in the early seventeenth century, knowledge about the way the heart works had remained unchanged since the days of the Greeks, 1400 years earlier. Harvey's careful scientific approach showed later scientists the way. Harvey's advice, 'Look for yourself,' seems ordinary now. But, when he began his work, doctors and scientists accepted the words of the great scientists of the past, and did very little research for themselves.

The Greeks believed that the blood moved backwards and forwards through the body, like the waves of the sea. They believed that it was the arteries, with their strong, thick walls, that sent the blood through the body, not the beating of the heart. They believed that the blood in the veins was made in the liver. It then passed into the heart, where it met blood from the arteries, which was mixed with air from the lungs.

It was not until the sixteenth century that anyone thought there might be a circular movement of blood between the heart and the lungs. Then, just before Harvey started his studies, the doctor who later taught him noticed that there were valves in the veins. This was an important step forward but the doctor did not discover what the valves did. If he had, he might have discovered the secret of the circulation of the

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approach lungs

Where the ships came in, in Folkestone

blood before Harvey did. But his discovery stopped there.

As it was, the movement of the blood was a great mystery. As in all good mystery stories, there were plenty of signs that pointed to the truth, but it took a clever man to work out the relationship between them and find the answer. That man was William Harvey.

He was born on 4 April, 1578, at Folkestone, Kent, on the south-east coast of England. It was a small town in those days, but it was already important because of its trade with Europe. Harvey, who travelled much in later years, must often have watched the tall sailing ships loading and unloading, and wondered where they came from, and where they were going next.

William Harvey was the oldest of nine children by the second marriage of Thomas Harvey. Thomas had made a lot of money in trade with Europe and he was able to provide a good, comfortable home for his family.

His first wife, Juliana, had died giving birth to their first child, a baby daughter also called Juliana. His second wife, Joan, gave him nine children. As well as bringing up her own family, she made a happy home for Juliana until she married. Thomas Harvey stayed friendly with both his fathers-in-law. He worked with William Jenkin, Juliana's father, in running a passenger boat service to Europe, and traded with Thomas Hawke, Joan's father, who had business interests in Canterbury.

At the time William Harvey was born, Elizabeth I was Queen of England. It was a time of great discoveries. Sir Walter Raleigh brought potatoes back from the New World. Sir Francis Drake sailed right round the world and returned with his ships full of treasure. Britain won victories on land and sea.

Young Harvey knew all about his country's wars. His

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relationship wonder (v)

father, Thomas, was Mayor – the most responsible and important position in Folkestone – in 1586, when the lad was eight. His father had to make sure that Folkestone was ready to defend herself against enemy ships. His job included arranging for the money to be collected from the people of the town, to pay for seamen, ships and gun-powder. This was a very responsible job for, when – only two years later – King Philip of Spain sent his ships to attack Britain, local towns had to be ready to defend themselves day and night. The result of Philip's attack is well-known. Sir Francis Drake and Britain's little wooden ships defeated the larger ships of Spain before they got anywhere near Folkestone, or could do any damage to British towns.

In the summer of 1588, while Folkestone was expecting King Philip's ships at any moment, William Harvey passed his examination in reading, writing, English and Latin, which allowed him to become a pupil at the King's School, Canterbury. He lived with his uncle, Thomas Hawke, while he was a pupil there. His father often came up to Canterbury on business, with gifts for the lad from the rest of the family, so he was not lonely. He was a happy boy. From his mother, who brought him up in the Church of England, he learnt his great kindness and gentleness. From his father came his love for hard work and his attention to detail. He had a happy and united family, and a comfortable home.

Canterbury was a very old and beautiful city which was surrounded by lovely country. So there was William, at the age of ten, going to school in the morning and returning to his uncle's home at night. By this time he could speak Latin well – all educated men at that time wrote their important books in Latin – and he knew some Greek. Before he was sixteen he had done well enough to apply for a special free place at the University of Cambridge. This offered him six

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-en (wooden) defeat attention detail surround educate apply

years of study without cost at Gonville and Caius College. (The English, for some reason no one can understand, say 'keys' for Caius.) To apply, boys had to be 'able and learned youths of good character, born in Kent and educated in Canterbury.' William took the examination, and won his free place. He was the first winner of such a place to apply to study medicine.

The students' day at Gonville and Caius sounds very hard to us. The students got up at half past four in the morning, winter and summer. They went to church at five, then they had lectures from six until ten, with only a short pause for a breakfast of bread and weak beer. At ten they had 'dinner poor food and not much of it,' Harvey remembered later. Then there was more teaching and learning until five in the evening, when the students were allowed to stop for supper ('more or less like dinner, with a cup of poor, thin beer'). From six until half past nine in the evening, came 'reasoning, or other study'. Then, at half past nine, the students got together in the great hall for half an hour's running 'to get some heat on the feet before bed'. They must have needed that 'heat on the feet', as there was no heating at all in any of the college buildings.

Altogether, it sounds an uncomfortable way of life for young Harvey, who had come from such a happy, pleasant home. It is not really surprising that, after the summer of 1598, he was often ill, although it did not stop him from finishing his course at the college.

But Harvey felt that he was not learning much at Cambridge. There were too many lectures, and not enough actual dissections to allow students to observe how the human body worked for themselves. A dissection was a rare event; indeed, many Cambridge students became doctors without ever seeing the inside of a human body.

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college

This, Harvey felt, was not good enough. At Padua, in Italy, there was a very famous school of medicine. There, experiments were encouraged. Students were encouraged, too, to watch dissections, and to express their ideas freely to their teachers. This was very different from the situation in Rome where, in 1600, a scientist was burnt alive for expressing his ideas. Students came to Padua from Britain and all over Europe encouraged – like Harvey – by the freedom of thought they found there.

At Padua there was a hospital where students could examine sick people and discuss their diseases with experienced doctors. And, best of all, there was a theatre where students could watch dissections. This theatre still exists today.

Think, if you can, of a circular room with a very high roof. Then imagine six circles, one inside the other, with the first, smallest circle at the same level as the floor and the last, largest, circle almost touching the ceiling. Fill those circles with students, all looking at the dissection table in the centre. Now you have some idea of what the theatre was like. The students in the outside circle were still only twenty-five feet from the body on the table. And the theatre could hold three hundred people. There were no windows. The light came from candles hanging from the ceiling, and from eight lamps which were held close to the body on the table by students.

The greatest teacher at the school of medicine at that time was Fabricius. We have already mentioned his discovery of the valves in the veins. He was the man who started serious study of the blood at the University of Padua. He was interested, too, in embryos – a subject that Harvey later took up, and made great progress in, later in his life.

Fabricius himself taught in the lecture theatres . . . about the valves in the veins (he called them 'flood-gates', which is a

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experiment express situation exist level

very exciting description; you can just imagine little gates holding back the blood, allowing it to flow one way only, as a flood-gate holds back water). He also taught about the diseases of the human body, and about the way an embryo grows before birth. He used to say to his students, 'Careful observation is needed in everything; you must use your own eyes and ears as well as the observations of others. Remember that your own experience is more to be trusted than that of someone else, for all true knowledge depends on experiment. And you must take special care that you know things, not only through your reading and lectures, but through dissections of animals and men.' He went on, 'Forget cleverness, and likely guesses, and keep to what you can see for yourselves. Then you may discover many things which are still unknown to others.'

This is the sort of advice of which there was so little at Cambridge. Harvey took that advice and, as Fabricius promised, 'discovered many things'.

In 1602, at the age of twenty-four, Harvey had learnt all that two great universities could teach him, and was ready to put his knowledge into practice. At this time he was, according to a writer of the day, 'Rather small with black hair, dark eyes that seemed to see everything, a rather dark skin, and an eager, restless manner and quick speech'.

Padua had done a lot for Harvey. Some people even think that the first idea of the circulation of the blood came to him in the theatre there, while he was watching a dissection. Certainly the subject was in his thoughts from about that time until he made his discovery public many years later.

When he came home, he got himself into the Royal College, the doctors' union, or learned society, of the time. He also found time to marry Elizabeth Browne. Her father was another doctor, Lancelot Browne, who had been doctor

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description flood -ion (observation) likely manner

to Queen Elizabeth I. Elizabeth was, according to a writer at that time, 'tall, with a dark skin and a rather serious manner.' She and Harvey were married in 1605. It was a long, happy marriage, but they had no children. However, since he was one of ten children, Harvey had plenty of nephews and nieces, so there is no reason to believe that he and Elizabeth were lonely. And Harvey was such a busy man that it is unlikely that he had time to worry much about this lack of children.

Soon he had an important job – as doctor to the great Saint Bartholomew's Hospital in London. This was one of several hospitals set up hundreds of years before to look after sick people who were too poor to pay for a doctor. Before he was allowed to work at 'Bart's', as it is called for short, Harvey had to sign a long sheet of paper. In it he promised that, as 'Doctor to the Poor of this Hospital,' he would, 'one day a week at least, all through the year, or more often if needed, come to the Hospital, and see as many of the Poor there as need the advice of the Doctor . . . And, in God's name, try to the best of (your) knowledge of Medicine, to order such Medicines as are needed by the Poor, every one according to his Disease. You must not, for favour, money or any other reason, do anything for the Poor except such things as will do them good. And you shall take no gift or reward from any of the Poor for your advice or help. This you must promise before God . . . And if any poor person is unable to come to the Hall to be seen, you shall then visit him in bed and give advice on his disease.'

Quite a promise for a young man to make! But Harvey must have learnt a lot there, observing all the diseases that seventeenth century London could produce. There were plenty of them. He was doctor to Bart's, at a wage of twenty-five pounds – later thirty-three pounds – a year until he was

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sheet God reward

thrown out by Oliver Cromwell's men in the 1640s.

Meanwhile he was doing well with his private patients. In 1618 he became doctor to King James I, and looked after him in his last illness. Rich patients like this brought in rather more than twenty-five pounds a year, or even thirty-three pounds a year, but everyone spoke very highly of Harvey's kindness to his poor patients at Bart's.

To us, it may seem odd at first that Harvey did not make public his discoveries about the circulation of the blood until 1628, when he was fifty. He had made the discovery many years before. Why, then, was there such a long delay in telling the world?

We have to remember that it needed a lot of courage to publish any new ideas at that time. After all, Harvey was saying that opinions held for thousands of years were wrong. People had been burnt alive for less. Perhaps he remembered that scientist in Rome whom he had heard about in his youth.

But, at last, he wrote his book, one of the most important works ever written, according to many. He began by saying, 'I wish to learn and teach the workings of the body not from books but from dissections, not from the ideas of men but from Nature . . . I follow only the truth, and I give all my time and efforts to being able to give to the world something pleasing to good men, and useful to learned ones, and of service to Man.'

His book has only seventy-two pages, all in Latin, as almost all important scientific books were in those times. This seems very short, but that is because not one word is wasted.

First, Harvey points out the weaknesses of all the other arguments before his own. This he does in a very kind, modest and generous way. Instead of suggesting how stupid earlier scientists were, he says how difficult he himself found

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effort modest

it to work out, from his own observations, how the blood circulated. 'At one time I almost thought it was understood only by God himself.'

He described the movement of the heart, starting with the auricles forcing the blood out into the ventricles. Then the ventricles beat, and so send the blood into what Harvey calls the 'artery-like vein' – the *vena cava* – and the aorta, which is the big artery that feeds the whole body with blood.

'It is clear,' wrote Harvey, 'that one ventricle of the heart, the left one, would be enough to send the blood through the body, and to take it out again from the vena cava (which indeed is the way it happens in all creatures without lungs). When, however, Nature wished the blood to pass through the lungs, she provided a right ventricle to drive the blood through the lungs from the artery-like vein to the left ventricle. So one must look upon this ventricle as having been made for the lungs and for the movement of blood from there, and not only to send blood to the lungs. It is most unlikely that the lungs themselves need so large a supply of blood, delivered in such a way, and so pure. Why should the lungs need this more than the brain, or the heart itself?'

He had it! The blood went through the lungs to be filled with pure, oxygen-filled blood. Then the arteries forced this blood, with its life-giving oxygen, through the whole body. The blood flowed back through the veins, with their thin walls and the valves – Fabricius's 'flood gates' – back to the heart. In other words, its movement was in a circle, not a backward-and-forward movement like the waves of the sea.

Harvey goes on in his book to describe an experiment he did on a living snake. He tied off the vena cava a little way below the heart, and watched how the piece of vein between the string and the heart 'became slowly smaller and weaker'. Once the vena cava was untied, the vein returned to normal.

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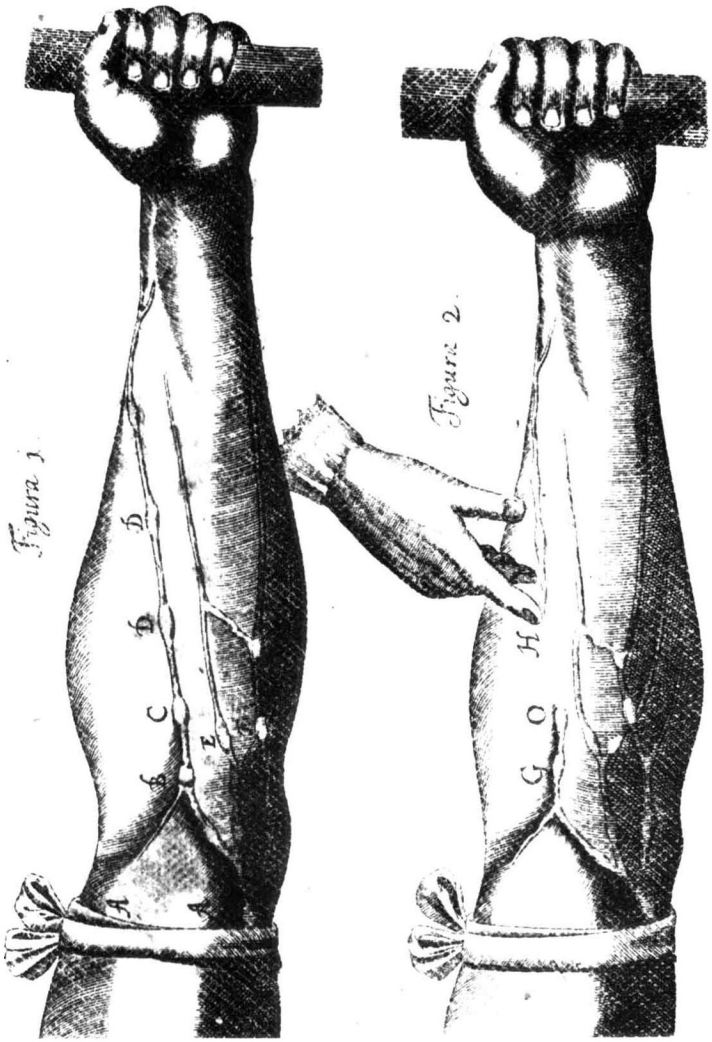
brain snake string



A drawing in Harvey's book on the circulation of the blood **1628**

He went on to explain how the heart is the pump that supplies blood to the whole body: a pump that never stops except between heart-beats. If, for some reason, the heart stops, even for a short time, the whole body dies because it is not getting its supplies of fresh, clean, oxygen-filled blood.

Harvey offers further proof of his argument. He points out the differences between the arteries and the veins. The arteries are thick-walled, because they must be able to contract, or pull together; the veins are thin-walled, with valves to stop the blood from flowing the other way.

So there it was proof of the circulation of the blood. There were, however, things which Harvey did not discover, such as the tiny capillaries which join the veins to the arteries, and supply the whole body. If the veins and arteries are the main branches of a tree, these little capillaries are the smallest ones, on which the leaves grow. In fact, if you draw the body's blood vessels it looks very like a tree, with the aorta in the middle and the other, smaller arteries and veins like branches. But it was not until fifty years later that the capillaries were discovered. Then proof of the circulation of the blood was complete.

Of course, there were many people who disagreed with Harvey's ideas. In Britain, Doctor James Primrose said, 'Patients were healed in the old days, without any knowledge of the circulation of the blood. So this knowledge even if it is true will be useless.'

Many of the greatest doctors in Europe spoke against the 'dangerous and harmful' idea of the circulation of the blood. Harvey very quietly stuck to his argument, and patiently explained why it must be true.

In 1630 Harvey travelled to Europe with a member of the royal family. There he dissected a body in a lecture theatre to show the truth of the ideas he had outlined. Most people

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pump heal outline

believed him, but the more-old-fashioned doctors did not. 'What was good enough for Aristotle and Galen and the other Greek teachers is good enough for us,' said one, although Galen and Aristotle had lived well over a thousand years earlier.

The next year Harvey was made doctor to the King. King Charles I was interested in science himself. He gave Harvey permission to use the animals in the Royal Parks for his research into embryos, for at this time Harvey was trying to find out how life began. The King persuaded Harvey to show him, Charles, how the blood circulated. Harvey was a great favourite with the royal family. He went along to Scotland to look after the King when he was drowned there in 1633. Charles seems to have found Harvey good company as well as a good and wise doctor.

While he was in Scotland, Harvey visited the Bass Rock, where thousands of sea-birds lived (and still do). He was surprised by their number and variety. Some notes that he made, in Latin, about them still exist. It was perhaps this visit which encouraged Harvey to study the development of the embryo inside a bird's egg. This became one of his greatest pieces of research. It is sad that his papers describing it were lost. But that comes later.

As the King's own doctor, Harvey had some interesting cases, not all of them to do with medicine. Perhaps the oddest was the case of the Lancashire witches. The story began, simply enough, with a small boy who went out to play instead of going to school. The lad had a very powerful imagination. When he was asked what he had done instead of going to school, he told the strangest story that the local people had ever heard.

'Old Mother Dickenson seized me in her arms,' said the boy – Old Mother Dickenson was an old lady who lived

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old-fashioned permission