DR EDWARD JENNER 1749-1823

Edward Jenner is remembered today as the pioneer of the smallpox vaccination and the father of the science of Immunology. Smallpox was the most feared and greatest killer of Jenner's time. In today's terms it was as deadly as cancer or heart disease. It killed 10% of the population, rising to 20% in towns and cities where infection spread easily. Among children, it accounted for one in three of all deaths. Jenner called it the Speckled Monster.

From the early days of his career, Edward Jenner had been intrigued by country-lore which said that people who caught cowpox from their cows could not catch smallpox. Jenner observed this in his local area. These observations led him to investigate and experiment using cowpox as a means to prevent catching smallpox.

Jenner published many case studies to ensure the whole world knew what he had discovered. The research finally led to the naming of this groundbreaking process as 'vaccination'. The name of the process was fittingly taken from Jenner's research as the word vacca means 'cow' in Latin.

EARLY LIFE

Edward Jenner was born in Berkeley, Gloucestershire, on 17th May 1749. He was the eighth of the nine children born to the vicar of Berkeley, the Reverend Stephen Jenner, and his wife Sarah. The family lived in the old Vicarage of Berkeley (pictured right) that sadly no longer stands.

Unfortunately, by the time Edward was five years old both his parents had died and he was left in the care of his older sister,

Mary, who was soon to marry the incoming vicar, the Reverend G.C. Black.

Edward grew up with a great knowledge of, and interest in, country matters. He collected birds' eggs. He visited the shores of the River Severn, only a mile to the west of Berkeley, to collect fossils and anything of interest that might have been washed ashore.

SCHOOLING

Edward Jenner attended schools in Wotton-under-Edge and Cirencester. While at Wotton he had his first brush with smallpox. He underwent variolation, which is inoculation with the smallpox virus against natural infection.

APPRENTICE

At the age of 14 Jenner was apprenticed for seven years to Mr Daniel Ludlow, a surgeon of Chipping Sodbury. Here Jenner gained most of the experience needed to become a country doctor.

TRAINING IN LONDON WITH HUNTER

In 1770 he went to St. George's Hospital in London to complete his medical training under the great surgeon and experimentalist, John Hunter. Hunter quickly recognised Edward's abilities at dissection and investigation, as well as his understanding of plant and animal anatomy. The two men were to remain lifelong friends and correspondents.

RETURN TO BERKELEY

In 1772 at the age of 23 Edward Jenner returned to Berkeley and established himself as the local doctor. Although in later years he also established medical practices in London and Cheltenham, Berkeley was always his main home.

GENERAL PRACTITIONER

Jenner faced a vast array of medical cases on a daily basis. Patients would often come to consult at The Chantry, Jenner's home, or he would make home visits on horseback, sometimes riding great distances in bad weather.

On one occasion he almost lost his own life when visiting a patient at Kingscote, ten miles from home, during a blizzard. Amazingly, he visited patients over an area of about 400 square miles, from Gloucester in the north to Bristol in the south. His medical practice did not abandon those too poor to pay for treatment.

Between 1796 and 1804 Reverend Robert Ferryman, built for him a small thatched hut in the corner of the Chantry garden. In this building on certain days the poor of the district would be given vaccinations, free of charge.

SURGEON

Jenner was also a practising surgeon. Bloodletting, either by cutting veins or by applying leeches, was a common treatment. He would have been proficient at the rapid amputation - without anaesthetics - of limbs that were gangrenous with infection after injury.

Although Jenner's friend Humphry Davy had suggested in 1800 that the gas nitrous oxide could be used to relieve pain, the use of anaesthetics did not enter routine medical practice until the 1840s.

The operation that Jenner performed most frequently was 'cutting for the stone' - the removal of kidney stones. Tracheotomy (the insertion of an artificial windpipe to relieve obstruction in the throat) had been introduced into surgery in 1730. It was a vital development in the relief of the effects of diphtheria. Appendicitis could be diagnosed and corrected surgically after 1736.

In routine medicine the value of measuring body temperature was not demonstrated until 1815, although Jenner himself was aware of temperature changes in animals and owned a precious thermometer. His close friend, the great London surgeon John Hunter, had given this to him. The stethoscope was introduced in 1816, opening the way to a better understanding of the mechanics of the heart and lungs.

THE BALLOONIST

The story of flight started at the end of 1782 near Lyons in France when two brothers, Joseph and Etienne Montgolfier, began experimenting with balloons. They harnessed the power of wood smoke to lift objects from the ground.

Jacques Charles launched the first balloon to use hydrogen as a lifting agent in Paris in August 1783. It was twelve feet in diameter, rose to a height of 3,000 feet, and travelled 15 miles.

Intense enthusiasm for anything concerned with balloons or ballooning followed the first manned flight in a Montgolfier balloon which took place from Paris in November 1783. In Britain, the first unmanned balloon flight was probably one that took place in London in November 1783. The first flight of an unmanned ballon in the West Country was probably carried out by physician Caleb Hillier Parry, lifelong friend of Edward Jenner. Parry launched a hydrogen balloon from the Crescent in

Bath on 10th January 1784. Made of varnished silk, it was 17ft in diameter and 8.5ft high. It flew 19 miles, landing just west of Wells.

JENNER'S HYDROGEN BALLOON

Determined to try the experiment for himself, Edward Jenner wrote to Parry requesting a length of silk and urging him to join him in Berkeley. Jenner launched his hydrogen balloon from the courtyard of Berkeley Castle at 2pm on 2nd September 1784. It flew 10 miles north eastwards, landing in a field at Kingscote, where, the Gloucester Journal reported, it terrified the reapers so much that for some time they could not be persuaded to approach it!

The balloon was re-launched and drifted north along the line of the hills for a further 14 miles. Its journey ended a few miles east of Gloucester at the beauty spot known as Birdlip. The local inn, known since the 1820s as the Balloon Inn and now called the Air Balloon Inn, may well commemorate this exciting event.

POET

Jenner had a love of words and wrote several poems in his lifetime. He used the world around him as inspiration for his medical research.

We know that Jenner enjoyed spending time in his garden, which may have provided inspiration for his poems 'Address to a Robin' and 'Signs of Rain'.

No doubt an accomplished wordsmith, Jenner also wrote ditties and limericks about his colleagues and his medical experiences.

'AND WHEN RUDE WINTER COMES AND SHOWS'

His icicles and shivering snows,
Hop o'er my cheering hearth and be
One of my peaceful family:
Then Soothe me with thy plaintive song,
Thou sweetest of the feather'd throng!'
(excerpt from 'Address to a Robin')

MUSICIAN

It is thought that Jenner not only played the flute but was also a promising violinist and played in a local music society. No doubt Jenner would also have played at his many dinner parties and soirees to entertain his friends and guests.

LIFE AFTER THE PUBLICATION OF THE INQUIRY

Edward Jenner became world famous following the publication in 1798 of his 'Inquiry' in which he demonstrated that vaccination with cowpox prevented the deadly smallpox.

As use of his treatment spread, he found that he had to spend more and more of his time answering correspondence about it. He called himself 'Vaccine Clerk to the World'. He continued to advise and research on the safest ways to produce and transport his cowpox vaccine.

Sadly, Edward Jenner's family life was marred by illnesses. He had married Catherine Kingscote in 1788, when he was 39 and she 27. She had borne him three children: Edward (1789), Catherine (1794) and Robert Fitzhardinge (1797).

His daughter married but did not produce a grandson for him until after his death. His son Robert remained unmarried. His other son, Edward, died of tuberculosis in 1810, aged 21.

Catherine, had never been strong and her health was a constant worry to her family and friends. Back in 1790, the great John Hunter had written from London enquiring about her condition. On 13 September 1815 she, too, succumbed to tuberculosis.

FINAL YEARS

To ease his depression he returned to his past interests of fossil-collecting and developing his home and his garden, the latter which received much attention. He had both a kitchen garden and an ornamental area. The latest varieties always attracted him. He imported vegetable seeds from Italy and Spain. He became expert at propagating fruit bushes such as gooseberries, raspberries and figs. In 1818 he introduced young grapevines from the famous stock at Hampton Court. The previous year he had built an extension for them onto his hothouse which stood at the rear of The Chantry. The vine is still in full production and nearly two centuries on those same Black Hamburg vines produce fruit for sale to visitors every summer.

Through his later years Edward Jenner was an active Freemason and magistrate. The plight of the poor and the rising level of crime troubled him. He blamed some of the latter problem on the influx of navvies who dug the Berkeley to Gloucester Canal in 1815.

EDWARD JENNER'S DEATH

On a cold January day in 1823 Jenner did not appear for breakfast. He was found unconscious. Jenner's nephew Henry

bled him several times, without effect. He never regained consciousness and had suffered a stroke.

He passed away quietly just after two o'clock on the following morning, 26 January 1823. He was 73.

Edward Jenner was buried in the family tomb beside the altar in St. Mary's Church in Berkeley (picture left) next to his parents, eldest son and wife Catherine. The funeral was a very local affair, with no one attending from London. Fittingly, James Phipps, who as a child had been the recipient of the first vaccination in 1796, was a pall-bearer.

HIS WORK

Most famous for his development of vaccination against smallpox, Jenner is considered to be the pioneer of vaccination as a medical practice.

His early work in this area was the springboard that led to worldwide vaccination campaigns to rid the world of smallpox. Nearly 200 years after his first experiment using cowpox as a vaccine to prevent smallpox the disease was declared eradicated in 1980.

Thanks to Jenner's work greater developments in preventative medicine, and the now established science of Immunology, continue to save lives today.

Jenner was also a prolific natural scientist, surgeon and geologist and this is less well known than his work on smallpox and vaccination. Read more about his remarkable accomplishments and scientific studies in this section using the drop down menu above.

WHAT IS SMALLPOX?

Smallpox is caused by the virus variola. It enters the body through the lungs and is carried in the blood to the internal organs, which it infects. The virus then spreads to the skin where it multiplies causing a rash.

Smallpox is characterised by fever, headache, backache and vomiting twelve days after exposure to the virus. The rash appears three days later, beginning as small, discrete pink spots which grow bigger and become slightly raised. By the third day, these are tense blisters 6mm in diameter and deep in the skin. These eventually shrink, dry up and fall off, leaving a sunken scar. In severe cases, patients die of blood poisoning, secondary infections or internal bleeding. There is no effective treatment once infection has taken place.

A BRIEF HISTORY OF SMALLPOX

Smallpox is a very ancient disease. The scars on the mummified body of the Pharaoh Rameses V, who died in 1157BC, are believed to have been caused by smallpox. It spread throughout Europe and was carried to the Americas with the voyages of discovery. It killed far more Aztecs and North American Indians than ever died in battles with the white settlers.

Smallpox touched every section of society. It killed kings, queens and emperors as well as the common man. It altered the succession of the British royal family by killing Queen Anne's heir, Prince William, at the age of 11. Elizabeth I, Mozart, George Washington and Abraham Lincoln all experienced its terror. Those who recovered from smallpox were often left with skin scarred by the pocks which led to the fashion of ladies wearing beauty spots or veils to hide their blemishes.

Smallpox was the most feared and greatest killer of Jenner's time. In today's terms it was as deadly as cancer or heart disease. It killed 10% of the population, rising to 20% in towns and cities where infection spread easily. Among children, it accounted for one-in-three of all deaths. Jenner called it the 'Speckled Monster'.

VARIOLATION

Some communities tried to lessen the likelihood of death by scratching into their skin scab material from someone with a mild form of smallpox. Lady Mary Wortley Montagu introduced the practice of inoculating with smallpox into England from Turkey in 1721 where she had seen it practiced whilst staying there as the wife of the then British Ambassador.

This practice of deliberately giving people smallpox was later called variolation and many surgeons built up lucrative businesses administering it. Unfortunately, however, the identification of a suitable strain of the disease was not a precise science, and deaths from variolation were not uncommon.

Edward Jenner was himself variolated whilst at school. He was "prepared" by being starved, purged and bled; then locked up in a stable with other artificially infected boys until the disease had run its course. He suffered particularly badly. It was an experience he would never forget.

JENNER AND SMALLPOX

Like any other doctor of the time, Edward Jenner carried out variolation to protect his patients from smallpox. However, from the early days of his career Edward Jenner had been intrigued by country-lore which said that people who caught cowpox from their cows could not catch smallpox. This knowledge, his own experience of variolation as a boy, and of the risks that

accompanied variolation, led him to undertake the most important research of his life.

COWPOX

Cowpox is a mild viral infection of cows. It causes a few weeping spots (pocks) on the udders, but little discomfort. Milkmaids occasionally caught cowpox from the cows. Although they felt rather off-colour for a few days and developed a small number of pocks (usually on the hand), the disease did not really trouble them.

THE FIRST VACCINATION

A dairymaid, Sarah Nelmes, consulted Jenner in 1796 about a rash on her hand (pictured above). He diagnosed cowpox rather than smallpox. Sarah confirmed that one of her cows, a Gloucester cow called Blossom, had recently had cowpox. Edward Jenner realised that this was his opportunity to test the protective properties of cowpox by giving it to someone who had not yet suffered smallpox.

He chose James Phipps, the eight-year old son of his gardener. On 14th May, he made a few scratches on one of James' arms and rubbed into them some material from one of the pocks on Sarah's hand. A few days later, James became mildly ill with cowpox, but was well again a week later. So Jenner knew that cowpox could pass from person to person as well as from cow to person.

The next step was to test whether the cowpox would now protect James from smallpox. On 1st July, Jenner
variolated the boy. As Jenner anticipated, and undoubtedly to his great relief, James did not develop smallpox on this occasion nor on the many subsequent occasions when his immunity was tested again.

PUBLICATION

Jenner followed up this experiment with many others. In 1798 he published all his research into smallpox in a book entitled: 'An Inquiry into the Causes and Effects of the Variolae Vaccinae; a Disease Discovered in some of the Western Counties of England, Particularly Gloucestershire, and Known by the Name of The Cow Pox'.

In each of the next two years, he published the results of further experiments confirming his original theory that cowpox did indeed protect against smallpox.

Jenner's 'Inquiry' is an early example of tried and tested empirical research, and is certainly one of the first to market its findings. Jenner went to great lengths to have his 'Inquiry' illustrated, so that others would know exactly how to vaccinate against smallpox.

VACCINATION

OPPOSITION WITHIN THE MEDICAL PROFESSION

Jenner's newly-proven technique for protecting people from smallpox did not catch on as he anticipated. One reason was a practical one. Cowpox did not occur widely, and doctors who wanted to test the new process had to obtain cowpox matter from Edward Jenner.

In an age when infection was not understood, cowpox samples often became contaminated with smallpox itself, because those handling it worked in smallpox hospitals or carried out

variolation. This led to claims that cowpox was no safer than smallpox inoculation.

There were also many surgeons who did not want Jenner to succeed. They were the variolators whose large incomes were threatened by Jenner's safer and more effective cowpox treatment.

THE ANTI-VACCINATIONISTS

Soon even political cartoonists, such as James Gillray, were publishing engravings that showed people growing cow's heads on their bodies. People became fearful of the possible consequences of receiving material originating from cows, and opposed vaccination on religious grounds saying that they would not be treated with substances originating from God's lowlier creatures.

Variolation was forbidden by Act of Parliament in 1840, and vaccination with cowpox was made compulsory in 1853. This, in its turn, led to protest marches and vehement opposition from those who demanded freedom of choice.

JENNER - WORLD HERO AND SAVER OF LIVES

THE SPREAD OF VACCINATION

Edward Jenner spent much of the rest of his life supplying cowpox material to others around the world and discussing related scientific matters. He was so involved in corresponding about smallpox that he called himself 'Vaccine Clerk to the World'. He quickly developed techniques for taking matter from human cowpox pocks and drying it onto threads or glass so that it

could be widely transported. In recognition of his work, and as a recompense for the time it took him away from his general practice, the British Government awarded him £10,000 in 1802, and a further £20,000 in 1807

TARTAR EMETIC AND HEART DISEASE

Edward Jenner is remembered today as the pioneer of smallpox vaccination and father of Immunology. However, he was also a keen researcher in other fields of medicine and surgery.

Early in his career, in1783, Jenner developed methods for purifying Tartar Emetic. This rather poisonous chemical was widely used to treat parasitic diseases. Jenner's improvements made the drug more reliable and less toxic in its effects.

Dr Jenner even pioneered research into heart disease. A type of chest pain (angina) was a common problem, but its cause was not understood. Jenner performed post-mortem examinations on the bodies of patients who had died of angina. He observed that the large arteries around the heart were often lined with fatty and chalky deposits. In 1772 he speculated that this was probably linked with the angina. He also correctly associated unnatural changes to the heart valves, mitral stenosis, with a condition that is now known as rheumatic heart disease.

JOHN HUNTER

During his training in medicine, Dr Edward Jenner was a student of the great London surgeon John Hunter (pictured right). The two men became the greatest of friends over a period of more than 20 years until Hunter's death in 1793.

They corresponded frequently on matters of medicine and biology. Unfortunately, only Hunter's letters to Jenner survive. These reveal the great range of topics that interested the two men.

In their correspondence on hedgehogs during 1775, Hunter urged Jenner to follow a policy which shaped his attitude to research. "I thank you for your Expt on the Hedge Hog, but why do you ask me a question, by the way of solving it. I think your solution is just; but why think, why not trie the Expt."

HIBERNATION

Because Hunter lived most of his life in cities, their collaboration in the study of hibernation fell mostly to Jenner, the country dweller. They were intrigued by the way certain plants and animals could suspend their life processes during the winter.

Hunter encouraged Edward Jenner to cut into the bark of trees during the winter to discover whether the sap continued to flow. Jenner also measured the body temperature of hedgehogs through the changing seasons. He used a precious thermometer that had been given to him by John Hunter. When his first thermometer was accidentally broken after five years of use his friend sent a replacement. The letter accompanying it gently told him off for being clumsy.

Other experiments involved placing food in the stomach of hibernating hedgehogs, then observing whether it was digested. They also researched the body temperatures of bats, dogs and birds, as well as the temperature changes in inflamed tissues.

BIRD MIGRATION

This interest in hibernation was also linked with another topic that occupied Edward Jenner, bird migration. It was commonly

assumed that birds hibernated in river mud when they disappeared in the winter. Jenner was one of the first to comment that when birds first appeared in the spring, they were neither starving nor dirty.

He examined the contents of their stomachs, looking for signs of a recent meal. He also noted reports that these birds were sometimes seen flying far out across the oceans. Jenner speculated that the birds left the British Isles through the winter, returning the next summer.

In 1787 Jenner wrote to another of his close friends, the famous botanist Joseph Banks who sailed on Captain Cook's voyages to the Pacific Ocean, and promised a report on these ideas and observations on bird migration. Unfortunately, Jenner never did find the time to write up his studies. However, his family published them after his death.

A FELLOW OF THE ROYAL SOCIETY

In Edward Jenner's day, the greatest honour that could be bestowed upon a scientist was to be elected a Fellow of the Royal Society (FRS). Jenner was awarded that distinction in 1789 for a paper that explained the nesting habits of the cuckoo, a bird that had intrigued philosophers and naturalists since the days of Aristotle.

THE NESTING HABITS OF THE CUCKOO

The cuckoo is unique among birds owing to the way it parasitises other species of birds during the rearing of its young. It lays a single egg in the nest of a bird of another species, most commonly the hedge sparrow. The foster-parents then feed and raise the young cuckoo as if it were their own. Only the young cuckoo

survives. All the eggs and fledglings belonging to the birds that built the nest disappear.

WHAT JENNER OBSERVED

Jenner was determined to find out why only the cuckoo survives in each nest, and why its parents adopt this strange way of breeding. After a false start based on some rather careless fieldwork done by his 16-year old nephew Henry, Edward Jenner carried out his own observations and re-wrote the paper he had been on the point of sending to the Royal Society.

This revised presentation was submitted at the end of December 1787. It was accepted, and was read to a meeting of the Society on 13 March 1788. Jenner was elected a Fellow on 25 February 1789, in recognition of his contribution.

Jenner realised that it was not the parent cuckoo that ejected the foster parents' eggs and chicks from the nest, as had previously been believed. Jenner identified that this was done by the newly-hatched cuckoo. In its first few days of life, the fledgling bird worked its way backwards up the side of the nest, pushing behind it an egg or young sparrow until this could be thrown from the nest. It repeated this task until only it remained in the nest. It was therefore able to take over the food supply provided tirelessly by the foster parents.

By dissecting young cuckoos, Edward Jenner discovered that their bodies are specially provided with a depression in the back between the wings. The young bird uses this to cup the objects which it is pushing from the nest. The depression disappears before the fledgling cuckoo is 12 days old.

Edward Jenner made many observations and experiments to support his hypothesis. He removed young cuckoos from nests,

placed two in a single nest and replaced ejected eggs. He even fixed lead weights to the legs of young cuckoos to convince himself that only that fledglings could be responsible for the deadly deed. His findings remained contentious until the twentieth century when naturalists such as Eric Hosking were able to photograph the phenomenon.

In explaining the strange nesting behaviour, Jenner noted that the cuckoo did not appear in Britain until mid-April and had disappeared by about the first week in July. This period of only 11 weeks was not long enough for it to lay its several eggs, incubate and hatch them, and then rear its offspring to an age at which they could fly strongly. He noted that this process took at least 15 weeks. Fostering was its ideal solution.

FOSSIL HUNTER

Edward's interest in fossils began when he was a boy and it continued throughout his life. Some of his favourite fossil hunting grounds lay along the banks of the River Severn near Berkeley at Aust, Purton and Westbury.

His depth of knowledge of geology and fossils was acknowledged in 1809 when he was elected a member of the Geological Society. He joined with friends to form the 'Barrow Hill Club' which met and collected fossils at a local beauty spot.

In 1819, at the base of nearby Stinchcombe Hill, Jenner made his most spectacular find - the fossilised remains of the sea monster we now call a Plesiosaur. The work of a Frenchman, Georges Cuvier, was at that time arguing fossils were the remains of species that may be extinct. Previously, the over-riding opinion was that fossils represented species that were still alive in the present day, if only one knew where to find them. In 1816, Edward Jenner wrote that 'Fossils are ... monuments to departed

worlds.' In 1821 William Conybeare and Henry de la Béche, amateur palaeontologists from Bristol, first put forward the idea that the bones of these sea-monsters were a from a species distinct from the Ichthyosaur. They coined the name plesiosaur (the Greek for 'nearer to reptiles'). Their suggestions were proved to be right when the first complete plesiosaur skeleton was found by Mary Anning in Lyme Regis in 1824. An example of a plesiosaur skeleton is pictured below.

GEOLOGY

Jenner's interests extended to geology. On one occasion he expressed concern over the loss of a local geological feature that he thought should have been conserved. He wrote in a letter to a friend: "Our Giant's Causeway at the South-eastern extremity of Michael's Wood [Woodford] is most magnificent. The Cups and Balls are stupendous. Those of Antrim compared with them are mere pebbles. ... the workmen now supply the roads with them."

As with his interests in medicine, Jenner's study of geology and fossils was at the frontier of contemporary thinking. William Smith, the canal engineer from Bath, established the concept and discipline of stratigraphy with the publication in 1801 of his Stratigraphic Map of the Bath Area.

Erasmus Darwin, a correspondent of Jenner's, was one of the first to argue publicly (1794) that the great botanist Carolus Linnaeus was wrong in 1751 to reject the concept of the evolution of life forms. In 1809, Lamarck also proposed that animals evolved from simpler life forms. The world had to wait until 1859 before Erasmus Darwin's grandson Charles published a convincing theory for the origin of species, based upon natural selection.

JENNER AND THE ERADICATION OF SMALLPOX

VACCINATION IN BRITAIN

In 1801 Edward Jenner issued a pamphlet which ended with these prophetic words: '... the annihilation of the Small Pox, the most dreadful scourge of the human species, must be the final result of this practice'. It was to take nearly 180 years to fulfil this prediction.

Compulsory vaccination was introduced into Britain in 1853, long after countries such as Bavaria (1807), Denmark (1810) and Prussia (1835).

In continental Europe the vaccine was prepared in large quantities by growing the virus on calf skin. However, in Britain Edward Jenner's original technique of arm-to-arm transfer was still used until 1898. Despite compulsory vaccination, outbreaks continued to occur in Britain right up to the 1960s because the virus was imported by unsuspecting travellers from countries where it was still endemic.

In 1971 compulsory vaccination at last ended in Britain, though it had not been enforced for some time, except for those travelling abroad.

THE WORLD HEALTH ORGANIZATION'S SMALLPOX ERADICATION CAMPAIGN

SATURATION VACCINATION

In 1967 the World Health Organization (WHO) launched its campaign to eradicate smallpox worldwide. They estimated at that time that there were still up to 15 million cases of smallpox each year. The biggest problem areas were South America, Africa and the Indian subcontinent. Their first approach was to vaccinate every person in the areas at risk. Teams of vaccinators from all over the world journeyed to the remotest of communities.

RING VACCINATION

The last case of smallpox in South America was reported in 1971. As the number of cases in other countries dropped the medical teams were able to change their tactics. They travelled around looking for smallpox outbreaks. They even resorted to putting up posters advertising rewards for people who reported cases of smallpox. Once found, a smallpox sufferer was isolated at home with his family. They and all surrounding families were then vaccinated.

THE LAST CASE OF NATURALLY OCCURRING SMALLPOX.

The last case of smallpox in India occurred in 1975, but the disease persisted in Ethiopia and surrounding regions of Africa. In 1977 Ali Maow Maalim, a hospital worker who had nursed a family in a Somali hospital became ill; Ali had never himself been vaccinated! WHO officials literally sat on his doorstep, letting no one out or in until the last scab had fallen off his last pock. He recovered. He was the last person on Earth to catch smallpox by natural transmission and became dedicated to the encouragement of vaccination. He died in 2013.

VACCINATION TECHNIQUES

Near the beginning of the WHO campaign the invention of a vaccination gun that fired a jet of vaccine using compressed air was heralded as a breakthrough, cutting out the need for needle replacement and sterilisation. It was soon realised however that it required too much maintenance in the desert dusts. The disposable 'bifurcated needle' was adopted instead, its narrow, flattened forked end drawing up just enough vaccine by capillary action. This was then jabbed repeatedly into the skin, to give a painless vaccination.

SMALLPOX IS DEAD!

After an anxious period of watching for new cases, in 1980 the WHO formally declared: "Smallpox is Dead!" The most feared disease of all time had been eradicated, fulfilling the prediction that Edward Jenner had made in 1801. It has been estimated that the task he started has led to the saving of more human lives than the work of any other person.

The last remaining specimens of the smallpox virus are now held in just two laboratories, at VECTOR in Siberia, Russia, and at the Centres for Disease Control and Prevention in Atlanta, Georgia, USA. The samples, used for research, are afforded higher security than a nuclear bomb. One day they too will be destroyed. Smallpox will have become the first major infectious disease to be wiped from the face of the Earth.

JENNER'S LEGACY

Edward Jenner's Inquiry can be identified as the origin of one of the most important branches of modern medicine. All that is known about disease prevention by vaccination, our understanding of allergy, autoimmune diseases (such as rheumatoid arthritis), transplantation and AIDS follows from this fundamental work by Edward Jenner.

Jenner is acknowledged as the Father of Immunology - the science of our body's defence against invading bugs and chemicals.

JENNER'S LEGACY TO THE WORLD

Edward Jenner made the first rational approach to vaccination using a closely- related virus, cowpox, to protect people against the ravages of the smallpox virus(Enlarged smallpox cell pictured right). His work was the first controlled clinical trial of a treatment to prevent disease in man.

Many vaccines have been developed since the time of Edward Jenner. He knew little of the scientific basis for vaccination, nor could he identify the germs that cause disease. It was another 100 years before the French scientist Louis Pasteur introduced vaccines against rabies and anthrax. At about this time too, in Germany, Emil von Behring developed a vaccine for diphtheria from the antibodies produced by patients recovering from the disease.

In the 1980s the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) launched the "Expanded Programme for Immunisation", a worldwide programme of child vaccination. This has brought polio vaccination to over 80% of the world's children. The WHO estimates that 3.2 million lives were saved from measles, neo-natal tetanus and whooping cough in 1990.

Jenner is acknowledged as the Father of *Immunology* - the science of our body's defence against invading bugs and chemicals.

FOREIGN INVADERS

Every day our bodies are under threat from a huge variety of foreign invaders that can cause disease and even death. Colds, upset stomachs, chickenpox, malaria, tuberculosis and hundreds of other illnesses are caused by foreign invaders. Luckily our bodies have developed defences to protect us from these invaders. Grouped together, they make up our immune system which is very important and without which none of us would survive.

Invaders come in all shapes and sizes. The smallest can only be seen with an electron microscope that magnifies them 100 000 times. The largest can reach 4 metres in length. They also come in many forms: bacteria, viruses, fungi, parasites and poisons are all foreign invaders. They can be passed to us in many different ways from water droplets in the air, insect bites, domestic pets, dirt or infected food.

THE ROLE OF VACCINATION

Vaccination is the simplest, most efficient and cost-effective way to prevent life-threatening infections in the community. For thousands of years man has known that recovery from some diseases, which we now know to be infections, leads to freedom from the same disease again often for life. This is called immunity.

HOW DOES VACCINATION WORK?

Vaccination relies on the ability of the immune system to remember past infections and store products from that immune response in case of a future infection by the same disease.

Vaccination copies in a more directed and controlled way, the process of infection and immune response triggered by a foreign invader. When you are vaccinated against a particular disease, you are being injected with all or part of that disease-causing

organism. Your body mounts an immune reaction, producing specific antibodies. These then remain in your system to be activated in the event of a future attack.

Vaccine induced immunity works in four ways:

1. Antibodies in the gut and airways (the most likely sites of infection) bind onto the disease-causing bacteria or viruses and prevent them from latching on to and penetrating the cells lining these passages.
2. Antibodies in the airways, gut and tissues bind with and neutralise the poisons released by some disease-causing bacteria. This happens with the diphtheria toxin in the throat and tetanus toxin in the body tissues.
3. Immune cells called cytotoxic T-cells, kill virus-infected cells. The measles vaccine stimulates this response.
4. Another kind of T-cell helps other body cells to kill bacteria that have got inside them. They do this by releasing messenger molecules which act on the infected cells and cause inflammation. The BCG vaccine against tuberculosis does this.

WHAT ARE VACCINES MADE OF?

Immunisation is described as active or passive.¨ In*active immunisation*, part or all of the disease-causing organism which has been modified in some way is inserted into your body, This causes the body to set up an immune response, produce cells and antibodies to kill the disease and store protective cells in case of future infection. This uses:

LIVE VACCINES

1. Non-harmful organisms closely related to the disease-causing bacterium or virus, for example smallpox and cowpox.

2. The disease-causing bacterium or virus itself that has its disease-inducing properties removed. These are known as attenuated vaccines. This form of vaccine is used against measles, mumps, rubella and tuberculosis.

INACTIVATED VACCINES

1. The toxins (poisons) produced by disease-causing bacteria, modified to make them harmless. The current vaccines against diphtheria and tetanus use this method.
2. The dead disease-causing agent. Whooping cough, rabies and anthrax vaccines are examples of these.
3. Genetically engineered or purified molecules from the disease-causing organism. These are used against pneumonococal bacteria.

In *passive immunisation*, the antibody products of an immune response harvested either from a person who is recovering from the disease or made specifically for use in immunisation, are injected into the body.

The BCG vaccine against Tuberculosis. At the beginning of the 20th century over a period of ten years, two French scientists, Albert Calmette and Camille Guérin, cultured the bacterium that causes tuberculosis in cattle. During this time, the culture acquired stable changes that altered the bacterium to a new species called Bacillus Calmette Guérin (BCG). The changes resulted in a much less virulent kind of tuberculosis which, when used as a vaccine, protects you against the deadly tuberculosis infection.

HOW LONG DOES THE EFFECT OF VACCINATION LAST?

This depends on the type of vaccine. With inactivated vaccines, you need several booster vaccinations to build up a high state of immunity. With live vaccines the effect is more long-lasting, and one shot in infancy and a booster in old age is generally enough.

THE ROAD AHEAD

The impact of immunology on human health and welfare has been immense, since Jenner's first steps along the road in 1796. About three-quarters of all human diseases involve the immune system in one way or another. Immunology is now far more than the study of infection and the making of new vaccines. Immunological research is providing new approaches for the diagnosis and treatment of cancer, autoimmune disease, immunodeficiency and allergies, and has been a major contributor to the successful development of transplant surgery.

JENNER IS HONOURED - A BRITISH SCIENTIFIC HERO

"It now becomes too manifest to admit of controversy, that the annihilation of the Small Pox, the most dreadful scourge of the human species, must be the final result of this practice"
[Edward Jenner, 1801, on Vaccination (with cowpox)]

The technique of introducing material under the skin to produce protection against disease became universally known in Jenner's honour as vaccination, a word derived from the Latin name for the cow (vacca). His fame even led to him seeking favours from Napoleon during the war between Britain and France. He successfully negotiated the release of a number of important British prisoners-of-war. Napoleon is reported to have said: "Ah, Jenner, je ne puis rien refuser a Jenner" (Ah, Jenner, I can refuse him nothing).
[Napoleon, circa 1803]

Jenner received the freedom of many cities including London, Glasgow, Edinburgh and Dublin. Societies and universities around the world gave him honorary degrees and membership. Perhaps the most significant tributes were the minting of a special medal by Napoleon in 1804, the gift of a ring by the Empress of Russia, plus a string belt of Wampum beads and a certificate of gratitude from the North American Indian Chiefs. Statues to Jenner's honour were erected as far afield as London and Tokyo. The statue in London is now in Kensington Gardens but was originally situated in Trafalgar Square.

TRIBUTES THROUGH HISTORY

"Medicine has never before produced any single improvement of such utility... You have erased from the calendar of human afflictions one of its greatest... Mankind can never forget that you have lived."
[President Thomas Jefferson (1743-1826) to Dr Edward Jenner, 14 May 1806]

Your discovery of preventing the dreadful havoc made among mankind by the smallpox, by introducing into the system so mild a disease as the vaccine inoculation produces, may in time eradicate the smallpox from all civilized countries...it may occur that the christening and vaccination of children may always be performed on the same day"
[Erasmus Darwin to Edward Jenner 24 February 1802]

RECOGNITION TODAY

"Jenner’s bravery and persistence in his smallpox research has inspired generation after generation of scientists. I know; I’m one of them"

[Professor Anthony Hollander, Arthritis Research UK Professor of Rheumatology and Tissue Engineering, School of Cellular and Molecular Medicine, The University of Bristol]

The idea he came up with could be said to have saved more lives than any other in medical history.... He was, I think rightly, hailed as a hero"
[Professor Richard Dawkins, Genius of Britain – Channel 4, 2010]

"We live in a time when the words impossible and unsolvable are no longer of the scientific community's vocabulary. Each day we move closer to trial that will not just minimize the symptoms of disease and injury but eliminate them"
[Christopher Reeve (1952 – 2004) American actor and supporter of stem cell research]

VISITORS TO DR JENNER'S HOUSE

"Because of you I am here today"

"Thank you - I'm glad I was born in the 21st century. Thank you!"

"A small town doctor whose enquiring mind affected the health of the whole world. National Hero!"

"You are an inspiration to all doctors. Eradication of Polio next?"

"Very interesting. I didn't realise how awful smallpox was. What Jenner discovered is so amazing." (Penny, age 12)

"People need to understand science/disease better instead of being swayed by media sensations, gut feelings or reflexive emotions."

"Thank you, you are a hero to millions of people thank you x"

"You are a legend!" (Ed age 8)