Medicine for Managers

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The fight against germs – Pasteur and Koch

In the eighteenth century theories about infectious diseases were many and varied. Most of them were complete nonsense. Then along came Louis Pasteur, who has probably saved more lives than almost any other physician through his development of vaccines, and subsequently Robert Koch who proved to be more successful than Pasteur in convincing the medical world that bacteria cause disease.

Most traditional medical schools proudly lay claim to the doctors who trained or worked in their hallowed portals. None display a bust of Pasteur because he did not train in medicine. Born in Dole in France in 1822, he graduated in chemistry from the *Ecole Normale Supérieure*, the principal science school in Paris. He became Professor of Chemistry in Strasbourg and later moved to Lille as dean of the faculty of science and subsequently to Paris as director of scientific studies.

He is remembered more by some as the saviour of the wine industry and certainly his initial interest was in the process of fermentation and wine and beer making which resulted in his interest in micro-organisms such as yeast.

He was confronted by strongly held theories of how wine was made including the concept of 'spontaneous generation' of wine from grape juice. Fortunately, he did not accept the principle and, in a series of experiments, showed that wine could not be produced from sterile grape juice but needed organisms for fermentation.

He went on to show that invisible micro-organisms were responsible for the phenomenon of souring of milk. He developed a method for eliminating organisms from milk, which involved heating the milk to a prescribed temperature. The purpose of his work was to stop the spread of tuberculosis and typhoid, a technique which became known as ***pasteurisation.***

Pasteur developed his germ theories through his work on a range of animals. He started with silkworms and went on to explore microbiology in pigs, cattle and poultry, notably chickens. He used weakened cholera bacteria which he injected into chickens. They suffered only mild symptoms from which they recovered and

subsequently would not develop cholera when exposed to a culture of the virulent disease.

He turned his attention to anthrax and sensationally demonstrated the value of his anthrax vaccine in a dramatic experiment. In 1881 he injected twenty-four sheep with his vaccine, a process repeated after three weeks. After a further two weeks the vaccinated sheep, together with a control group of another twenty-four unvaccinated sheep, were injected with virulent anthrax bacteria. A few days later, the sheep were inspected. All the vaccinated sheep remained healthy; the unvaccinated sheep were dead or dying.


LE DON QUICHOTTE

L'ANGE DE L'INOCULATION (M. Pasteur), par Gilbert-Martin.

In 1885, Pasteur developed a rabies vaccine which was heralded as his greatest achievement.

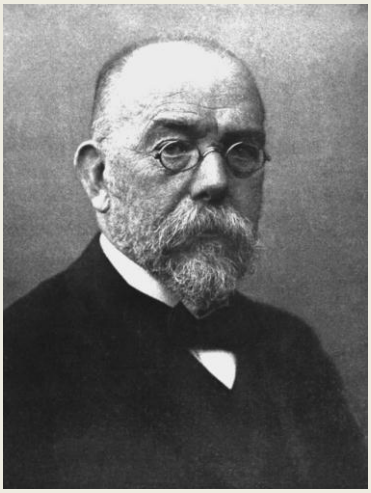
Vaccines had been discovered by Jenner (using cowpox to protect against smallpox) half a century earlier. Pasteur's work was ground-breaking because he created attenuated (weakened) bacteria to protect against virulent forms of the same organism.

In 1887 he established the ***Pasteur Institute*** and became its first director, remaining in that role until his death in 1895. In his later years he suffered repeated strokes. He was given a state funeral and is now buried in the Institute which still bears his name.

During his earlier years he married and had five children. Only two survived to adulthood, the remaining three dying of typhoid. It is said that these tragedies motivated him to find a cure for infectious diseases.

Pasteur championed the cause of the ***germ theory of disease***. He was a skilled micro-biologist and identified both ***staphylococci*** and ***streptococci***. Yet he encountered considerable resistance and struggled to achieve acceptance of his theory. . . .

Step forward ***Robert Koch***, a younger contemporary who became renowned for his



meticulous experimentation which demonstrated the bacterial cause of disease beyond doubt. Koch was born in Hanover in Germany in 1843 and he was trained by Wöhler at the University of Göttingen where he qualified as a doctor. He became one of the pre-eminent microbiologists of his time and became Professor of Public Health in Berlin. He published a paper on "the aetiology of traumatic infectious diseases" in 1879 that was the defining stage in the verification of the germ theory of disease. It recognised that there were different types of bacteria which could be differentiated, connected specific bacteria with specific diseases and settled the long-disputed issue of whether bacteria were the consequence of infection or the cause.

Koch developed a series of principles, later known as ***Koch's Postulates***. They are simple to understand and look obvious by today's standards but, at the time, they were the first document to show that a specific bacterium produced a specific disease. All four of his requirements had to be met before there was proof of bacterial cause.

1. The specific organism must be proven to be present in every instance of the infectious disease
2. The organism must be capable of being isolated from a host with the disease and cultivated in pure culture
3. In oculation of a pure culture into a healthy, suspectible, experimental animal would reproduce the disease
4. The organism could be recovered from the inoculated animal, must be identified as the same original organism and can be grown again in pure culture.

Koch went on to become a Government adviser with the Imperial Department of Health in 1880. Doing so gave him an authoritative base from which he could publish and his work was prolific and ground-breaking.

He developed a technique for gropwing cultures of bacteria using potato slices. It did work but not for all bacteria. He therefore started to use a nutrient broth to which he added gelatin. It was more successful but its main disadvantage was that it was liquid at body temperature (37°C was optimal for human pathogens). He subsequently added agar which resulted in a solid transparent medium at 37°C. His assistant, Richard Petri, developed the *Petri dish*. The technique remains the mainstay of bacterial cultivation.

Koch's achievements were enormous and he identified the causative organism of anthrax, *Bacillus anthracis* and the cause of cholera, *Vibrio cholerae*. In 1905, his ground-breaking work on the genesis of tuberculosis and the identification of the cause as *Mycobacterium tuberculosis*, resulted in the award of the Nobel Prize for Medicine.

His teachings resulted in his students (and some of his rivals) identifying the causative organisms of a host of hitherto undiscovered causal organisms including typhoid, diphtheria, gonorrhoea, meningitis, leprosy, tetanus, syphilis, whooping cough and streptococcal and staphylococcal infections.

He remained an acknowledged and revered leader in his medical field until his death in 1910 of a heart attack in Baden-Baden, only three days after giving a lecture on tuberculosis at the Prussian Academy of Sciences, which was named in his honour and outside which his statue stands.

Koch's work built on Pasteur's ***germ theory*** to prove the effects of bacteria. Having identified them he developed methods of staining them to better visualise and identify them. From Koch's work came the first advances in immunity and bacterial suspectiibility which would ultimately lead to another huge discovery, ***the antibiotic***.

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