LESSON 14

LOUIS PASTEUR

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Pasteur was born in quite humble circumstances, at Dole in the Jura district of France in 1822. His father as a young man had been one of Napoleon's conscripts and had won the Cross of the Legion of Honour on the field of battle, for valour and fidelity. Thus the son was fortunate in possessing forbears of character and strength. There is much evidence of the influence of the father on the son, Pasteur showing time after time the strength of his devotion to France. He was perhaps even more of a patriot than of a scientist, e.g., in 1848, when Europe was politically upheaved, Pasteur enrolled himself in the National Guard and seeing one day in the Place due Pantheon, a sort of altar labeled "autel de la patrie" promptly placed on it all his worldly wealth – 150 francs. Again, in 1870 he was returning from Germany to France, and at Strasburg, heard that France was on the verge of war with Germany whereupon he hurried to Paris and was exceedingly disappointed when the military authorities refused to enrol him in the National Guard – on the score that a half paralysed man was useless in the army. (He had a paralytic stroke two years before, in 1868, and never shook off the physical effects, though after two years he was able to continue his mental work as well as ever before.)

However, to return to his boyhood – when he was two years old the family moved from Dole to Arbois, where his father bought a small tannery, and here Pasteur was sent to school at the Communal College where at first he showed no interest whatever in books or study but devoted his attention to fishing and making sketches of his companions. However directly he grasped the fact that his education was a great drain on the family funds, he set himself in earnest at school and soon developed the passion for work which marked the whole of the rest of his life.

The College at Arbois did not teach philosophy and so, after a time, Pasteur went on to Besancon, a bigger place, with better educational provision. Here he graduated in Science and Arts and was given a post on the College Staff.

He was already much interested in Chemistry – too much so for the professor of that subject at Besancon, whom Pasteur used to embarrass with unanswerable questions. The Professor in question disapproved of saying "I don't know" – and used to try to keep Pasteur "in his place" by telling him that questions were to be asked by the Teacher of the Scholar and not vice versa.

In 1842, i.e., when he was twenty, he went in for the entrance examination to the great Ecole Normale in Paris and came out fourteenth on the list, whereupon he refused to enter, being so disappointed at not getting a higher place. He took the examination again in the following year and was fourth on the list, which apparently more or less satisfied him.

At this point one may say a word about his private affairs. In 1848, at the age of twenty-six he became Deputy Professor of Chemistry in the University of Strasburg, and here he met his future wife, who was the daughter of the Rector of the Strasburg Academy. They were married in 1850, and it seems that Pasteur was so buried in his work on the wedding day that he entirely forgot the ceremony and had to be fetched by a friend. The marriage, however, was extremely happy, and the wife seems to have been an important factor in her husband's work.

In 1860, the French Academy offered a prize for the solution of the problem whether spontaneous generation was or was not a fact, and Pasteur entered for the competition, and settled the matter once and for all in the negative, proving that if a substance be sufficiently heated to destroy all life and if the air in contact with it be filtered, so that it is free of germs, then the substance does not alter, i.e., bacteria do not develop in it. As usual, his opponents said they had obtained opposite results, so Pasteur asked for arbitration, and the Academy appointed a Commission, before which Pasteur and his adversaries were to repeat their experiments. On the appointment day, Pasteur appeared loaded with apparatus. His opponents, however, had none; they said the weather was unfavourable and they would like to wait. The Commission very reasonably refused; Pasteur did his experiment successfully and won the prize. In the course of these experiments Pasteur found that some germs are very difficult to destroy by heat; e.g., milk developed bacteria even after several minutes' boiling, but after raising the temperature 10°C above boiling point, he found that no bacteria were left alive. This work on spontaneous generation was of great value because it stimulated other scientists to study the habits of germs, and much of our modern knowledge of these invisible but very active plants sprang from Pasteur's discoveries.

This brings us on to 1870, when France and Germany were plunged into war, and Pasteur ever intensely a lover of France, was filled with sorrow and anxiety, and with loathing of Germany, he wrote to the University of Bonn, which had bestowed on him the degree of Doctor of Medicine, asking that his name should be removed from the Faculty of the University, and returning his diploma, of which he speaks thus:-

> "Today the sight of this parchment is odious to me, and I feel offended at seeing my name .... Placed under the patronage of a name doomed henceforward to execration by my country, that of Rex Guilelmus....."

Having offered himself as a soldier where now he was refused on the score of physical incapacity, this unconquerable man turned to the sword of Science and took up the study of brewing, in order to discover a method whereby France might produce beer as good as that manufactured in Germany. He imparted his discoveries to the English brewers as well as to the French, with the rather illuminating remark, "We must make some friends for our beloved France." In 1876 this work was published in a book called "Etudes sur la Biere," which has been translated into English and is the best known of Pasteur's books in England,

where it has been of tremendous value in the brewing industry. Huxley once said that Pasteur's work on fermentation alone saved France more than enough to pay the Indemnity of the Franco-German War.

However, Pasteur's work on fermentation did not stop short here; it had far more important effects on medicine, surgery, and public health, for it was the staring-point for Lord Lister's work on inflammation of wounds, which in those days caused endless trouble after operations, often making amputation necessary and frequently even this was not enough to save the patient's life. About 33% of deaths from major operations occurred in pre-Listerian days, with the result that surgeons were unwilling to operate except as a last and desperate resort.

Now Pasteur's discovery that fermentation was due to bacteria set Lister wondering whether inflammation was not also a type of fermentation due to bacteria getting into the wound. And as the result of a series of brilliant researches he proved that this was so, and that, if only germs were excluded from wounds, inflammation was averted.

The antiseptic method in surgery has led on to the aseptic method of today, where the ideal is to keep the patient's skin free from germs, so that the living tissues need not be soaked in carbolic, which tends to destroy the tissue as well as the germ. Hence though the instruments and the doctor's hands and everything else are rigorously disinfected, the wound is not thus treated, unless it be an old wound, already infected. The enormous value of this work is shown by the fact that the death-rate today in major operations has fallen to about 1%.

To return to Pasteur — the achievement by which he is best known to the man in the street, viz., his work on disease, was led up to by an investigation into which he was almost forced by the French Government. This was the result of a mysterious epidemic of silkworm diseases which for fifteen or sixteen years had been devastating the silk-industry in the South of France. Now, the keeping of silkworms was one of the chief home-industries of the peasantry of the part of France. Practically every family set aside the best room in the house for the rearing and tending of silkworms: the women got up even during the night to supply the worms with fresh mulberry leaves and to see that the temperature of the room was just right; and in that region the common greeting on meeting a friend is said to be not "How do you do?" but "How are your silkworms doing?"

Until 1849 the industry had flourished consistently, but in 1849 the moths were attacked by disease. It was thought at first that the eggs were a fault, and fresh ones were brought from other countries and for one season, this cured the disease; but it reappeared in the first generation of descendants of these imported worms, and so the inhabitants were driven to import fresh eggs each year. Soon, however, the disease spread to neighbouring countries, until Japan was the only silk-producing country free from the disease. This reduced the silk growers to despair, thousands of families were faced with ruin, and things

were so serious that in 1865 the Government asked Pasteur to investigate the disease. At first he refused, on the ground that he was a chemist and not a naturalist and had never touched a silkworm in his life, but he pleaded ignorance in vain. "So much the better," replied M. Dumas, who bore the message from the Government, "you will only have the ideas which come to you from your own observation." This coupled with his sympathy for the people of the devastated region, overcame his reluctance, and he set out for Alais, a town in the silk district.

Now earlier observers had noted microscopic grains or "corpuscles" in the bodies of the diseased worms, but nobody had succeeded in finding a remedy, until Pasteur suggested collecting the eggs, laid by each moth separately and only keeping those derived from healthy parents. The only way in which this could be done was by use of the microscope, and Pasteur realized that this instrument would be a strange and terrifying thing to the peasants, so he tried to reassure them by telling them that this little girl of eight years old was quite at home with it. In addition, he directed the silkworm rearers' attention to the need of avoiding over-crowding, un-cleanliness, over-heating, and unhealthy conditions generally, since these weakened the insects and made them more liable to the disease.

This treatment, though it was not at once adopted, was very successful in decreasing the epidemic. It has been estimated that before Pasteur came to the rescue, France had lost forty million francs through silkworm disease. An even more important result of this work was that it led Pasteur on to study the infectious diseases of the higher animals, including Man.

It was during his work on the silkworm that Pasteur suffered from a stroke, the physical effects of which he never shook off. It has been attributed to overwork on the silk problem. Providentially, however, his mind was not injured, and in 1877, at the age of fifty-five he began to study the cattle-disease named Anthrax. It had already been suggested that this was due to a germ, and Pasteur finally proved the truth of this theory and, further worked out preventive treatment. He cultivated the anthrax bacillus in such a way that it became only mildly poisonous and proved that these weakened germs introduced into an animal's blood gave rise to only slight symptoms of anthrax and protected the animal from taking the deadly form, much in the same way as vaccination prevents smallpox. This protective treatment has safeguarded millions of sheep and cattle from the disease. Reports from France and Hungary show that on many farms the death-rate from anthrax has fallen from 10% to 1% amongst sheep and from 5% to less than 1% among cattle.

And this brings us to the next stage of Pasteur's work – that on human diseases. Overcoming his dislike of seeing suffering, he visited hospitals, collecting infectious matter from patients, examining it microscopically and identifying the germs associated with various diseases, e.g., at the time the Maternity Hospitals were devastated by puerperal fever in every country, and an appalling number of women died from the disease. Pasteur

discovered its germ, and an interesting little episode is recorded by M. Roux in connection with the discovery. "One day, at a discussion on puerperal fever which was taking place at the Academy of Medicine, while one of the most distinguished authorities was eloquently descanting on the causes of epidemics of this disease at Maternity Hospitals, he was suddenly interrupted by Pasteur as follows:- 'It is nothing of all that which causes the epidemic; it is the doctor and his belongings which carry the germs from diseased to the healthy woman.' And when the speaker replied (with the superiority which we can all imagine) that he was afraid they would never discover that microbe, Pasteur rushed to the black-board and drew the germ, saying, "Stop, here is its picture." Nowadays, thanks to Pasteur and Lister, epidemics of this disease in Maternity Hospitals are unknown.

We now come to how he discovered the method of making vaccines, i.e., weakened germs, which can be inoculated in measured quantities into human beings as a cure or preventive of the disease caused by the ordinary un-weakened germ.

He had gone away from his laboratory for a holiday, in 1879, whilst working at fowl-cholera, and on his return found all his cultivations of the germs dead or dying. He proceeded in inoculate various birds with those dead or dying germs and found that the birds showed signs of illness but recovered. The idea then occurred to him of inoculating them with a fresh lot of virulent germs of chicken-cholera, and he was amazed at the result, viz., that the birds still resisted the disease, though others, which had not been previously dosed with the exhausted germs died. So he arrived at the method of attenuating germs, i.e., of cultivating them so that they were weakened, and also at the fact that such germs inoculated into a healthy animal produced a mild type of illness which protected the animal from attack by the virulent form of the disease.

The first human disease to which Pasteur applied inoculation was Hydrophobia or Rabies, the horrible illness produced by the bite of a "Mad" dog. To give one some idea of its horrors, one need only read such descriptions as the following, of a child of five, admitted to a French Hospital. "The unfortunate little patient presented all the characteristics of hydrophobia: spasms, restlessness, shudders at the least breath of air, an ardent thirst, accompanied with an absolute impossibility of swallowing, convulsive movements, fits of furious rage. The child died after twenty-four hours of horrible suffering suffocated by the mucus which filled the mouth." As a matter of fact, its germ has never been found, but it was known that the part of the body affected in hydrophobia was the nervous tissue, and Pasteur tried taking some of the nervous tissue of an animal which had died of the disease and attenuating it, which he found could be done by exposing the spinal cord of rabid rabbits to dry air, which weakened it until after fourteen days it was harmless. The attenuated spinal cord introduced into dogs rendered them immune to hydrophobia, but the treatment was not tried on human beings till 1885, when a boy, Joseph Meister, was brought to Paris for treatment from a little place in Alsace. He had been bitten by a mad dog two days before.

Now, human beings do not as a rule develop hydrophobia for a month or so after being bitten, and Pasteur, being as usual extremely anxious to ward off suffering, undertook the treatment of the boy by inoculations, which were continued for ten days. Meanwhile the boy was hardly ill at all and played about the laboratory very happily, though Pasteur was devoured by fears and anxiety about the results. However, the boy was absolutely cured, and two months later a shepherd, who had been bitten by a mad dog, was similarly cured, and three months later three hundred and fifty cases had been treated, with only one death. By 1899, more than twenty-three thousand people had undergone the treatment, and the number today must be larger still. The deaths amongst these were less than ½ %, and there is no doubt that many of the rest were saved from a terrible death by Pasteur's work.

But though this was the last of Pasteur's great discoveries, its results were by no means confined to the cure of hydrophobia, for the fame of his success stirred up other scientists to try similar between 1880 and 1890 they discovered the germs of consumption, diphtheria, typhoid, lock-jaw, cholera, and Malta fever.

In 1893 the antitoxin which cures diphtheria was discovered, and also the protective treatment for cholera. Before the discovery of the antitoxin 30.4% of diphtheria patients died; now 8.3% die. In 1894-95 the germs of plague and of the tsetse-fly disease in animals were found. In 1896-97 the protective inoculation treatments for typhoid and plague were discovered with the result that in Great War there was extraordinarily little typhoid in our Army compared with the amount of the disease which had occurred in earlier campaigns, such as the Boer War. In India during 1913, 93% of the British garrison were inoculated, and deaths from typhoid fell from usual 300 – 600 to only 20.

In 1898 – 1900 it was proved that malaria and yellow fever were conveyed by mosquitoes. Now malaria each year kills millions of men and weakens millions more. It was rampant in England, under the name of ague till comparatively recently, it was banished by draining the malarial districts. Now that we know the cause of the disease we can fight it in two ways by destroying the breeding-places of the mosquito and by protecting man from the bite of the mosquito. Thus, every puddle of standing water, every pond, etc., should be drained or oiled, and all cisterns and wells should be kept closed in a malarial district, for the mosquito lays its eggs in water. Windows and doors must have wire-gauze shutters. Beds must be protected by mosquito nets. Finally, quinine is invaluable as a preventative and cure. It was this knowledge that enabled the Americans to construct the Panama canal, after the French had failed hopelessly with enormous loss of life and money owing to the ravages of malaria and yellow fever.

In 1903 – 05 Bruce showed that sleeping-sickness, which devastates Central Africa, was conveyed by a species of tsetse-fly. In 1905 in Uganda it caused 8,003 deaths. In 1910 the number was reduced to 1,546.

It is impossible even to catalogue the list of the medical discoveries which have

sprung from Pasteur's work and especially since the Great World War, which forced us to deal with many hitherto little-known diseases and conditions and so to greatly increase our knowledge of them. For example, at the beginning of War tetanus (lock-jaw) was tremendously common amongst our wounded because the soil of Belgium and Northern France is full of the germs of the disease: hence arose the custom of giving every wounded man a dose of anti-tetanus serum, which reduced the number of cases of tetanus to a tiny proportion.

As an expression of world gratitude, the Pasteur Institute was built in Paris with subscriptions which came from all parts of the world. It was opened in 1888, and was the joy of Pasteur's few remaining years.

It had been well said that Pasteur "brought the facts of disease and death from the realm of the supernatural and miraculous into the realm of the natural. Disease and death were the great mysteries, where the occult held sway. The malign and mysterious influence of the moon caused lunacy: there was the evil eye with its morbific powers; in fever and in epilepsy the body was possessed by demons; tuberculosis was the King's Evil, to be cured by the "Sovereign touch." Far more than all other men, Pasteur abolished for ever these superstitions."

Pasteur died in 1895, at the age of seventy-three, and was buried in the Institute.

NOTES

Words Explained:

conscript :	man taken into military forces by law
valour :	bravery
fidelity :	loyalty, being true to
forbears :	persons earlier in family line, ancestors
altar :	structure on which offerings are made to higher powers
upheave :	put in difficulty
verge of war :	near war
on the score :	because of
paralytic :	one having paralysis, loss of feeling or power of motion caused by damage to nerves
sketching :	quickly done picture
directly :	straightaway
keep him in his place :	check him, snub him
vice versa :	the other way round

by path :	studies not in his own line, but near it
spontaneous generation :	production of living from non-living matter as inferred from appearance of life; due in fact to bacteria in some infusions
adversary :	person acting against one
execration :	curses
inflammation of wounds :	swelling, pain and redness
amputation :	cutting off part of body
last resort :	last step or measure or thing to be done
avert :	keep off danger
rigorously :	keeping narrowly to rules, here most carefully
man in the street :	ordinary man
flourish :	thrive, prosper
import :	take in goods etc., from another country
at home with it :	knows how to use it
liable :	tendency to catch the disease
epidemic :	disease generally among a group at a time
rescue :	get person out of danger
appalling :	causing fear or shock
episode :	event, occurrence
authorities :	experts
maternity hospital :	hospital for women during confinement
exhausted :	weakened
spasms :	sudden violent attack of pain
ardent thirst :	burning thirst
suffocate :	trouble in breathing, put to death by stopping breathing
mucus :	thick liquid produced inside nose or mouth
devoured by fear :	subject to great fear
conveyed by mosquitoes :	carried by mosquitoes
rampant :	raging, spreading quickly
puddle :	small hollow full of dirty water
ravages :	destructive effects of
mystery :	events or acts the cause of which is not known

occult : those who have secret knowledge

supernatural : due to some agency above the forces of nature; miraculous events looked on as caused by other than natural powers

malign : bad

lunacy : madness

morbific : causing disease

king's evil ... sovereign touch : scrofula, The belief that it could be cured by king's touch.

ANSWER THESE QUESTIONS

1. Describe the early life of Pasteur.
2. Give some instances of Pasteur's patriotism.
3. What do we mean by spontaneous generation?
4. How did Pasteur prove that spontaneous generation was not a fact?
5. Describe the importance and popularity of the silkworm industry in France. What help did Pasteur render in curing the silkworm disease in his country?
6. How did Pasteur discover the treatment for the cattle disease, Anthrax?
7. How did Pasteur discover the method of making vaccines?
8. Give an account of Pasteur's treatment of Hydrophobia and how he cured the first patient suffering from it.
9. How did Pasteur show the way to other scientists? Give an account of the discoveries.