SAHIB SINGH SOKHEY

1887-1971

Foundation Fellow 1935

MAJOR GENERAL SAHIB SINGH SOKHEY was born in Amritsar on the 15th December 1887. He came from a family of traditional engineers who took a leading part in the building of the Golden Temple at Amritsar. His father was a civil engineer who was connected with the irrigation schemes of Punjab and Burma.

Sokhey received his early education at the Central Medical School and then at the Government College, Lahore. He had a brilliant educational career standing first in his University Entrance Examination and Intermediate Science Examination. He took his B.Sc. degree of the Punjab University in physics and chemistry, with honours, in 1905. After spending a year at the Lahore Medical College, he proceeded to the United Kingdom in 1907 and joined the Edinburgh University for the study of medicine. He took his M.B.Ch.B. in 1911, M.A. in economics in 1912, and, later on, in 1925, his M.D. He also took the routine diploma of D.T.M. & H. He competed for the Indian Medical Service and stood first in the examination. He used to say that during all his studies, he found it difficult to stay awake in the classes listening to drab lectures. Education, even then, was a sanctimonious ceremony of filling the craniums of pupils with dry, dead facts which could easily be picked from books, and, for some, it was a horse-race competition to come out first. Very often, one's career depended upon how well one fared in this race which is very unreliable as an index of one's intellectual capabilities. This pedagogic miseducation has had even disastrous effects on some scientific geniuses. Sokhey used to speak and write often of the need of an educational system which can train pupils to educate themselves and to acquire proper disciplines of mind and attitudes to understand, face and tackle the problems of life and society effectively.

During his stay in the United Kingdom, Sokhey was not just a passive onlooker of things and events, nor was he confining himself only to his academic studies. He kept the windows of his mind fully open and involved himself in local political activities, so that he got into his grain the spirit and outlook which constitutes the "Western intellectual tradition". His interest in economics and politics was aroused then and this shaped and guided his activities throughout his life.

Sokhey joined the Indian Army as an I.M.S. officer and served in World War I in France, and then in Mesopotamia till 1921. On return to India, he commanded the Indian Military Hospital at Calcutta. This military training

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was responsible for his sense of discipline, administrative and executive abilities, observance of cleanliness and orderliness in laboratories, and his well-known capacity to judge and deal with men.

In 1923, he was awarded a Rockefeller Fellowship to do his postgraduate studies in U.S.A., Canada and England. From 1923 to 1925, he studied clinical biochemistry at Harvard under Professor Otto Folin. This training had an impact on, and shaped the style, and character of, his later scientific work. Then he went to Toronto and studied under Professor J. B. Macleod who was a co-recipient, with Frederick Banting, of the Nobel Prize for work on insulin. Later, he worked with Professor Frederick Gowland Hopkins, the father of British biochemistry, at the Trinity College, Cambridge, on nutrition. He had to cut short his work here because he was not allowed to starve his animals for his work, as he wanted to do. To anyone with earnestness and aptitude to acquire sound scientific thinking and training in biochemistry, few other places would have been more appropriate. He took biochemistry as his field of study.

On return to India, in 1925, Major Sokhey joined the Haffkine Institute, Bombay, as Assistant Director on the 18th August. Four days earlier, the name of the Institute had been changed from the prosaic "Bombay Bacteriological Laboratory" to the "Haffkine Institute", to commemorate the great contribution of its first and most distinguished Director, Dr. Waldemar Mordecai Haffkine, under whose regime the Laboratory was being called the "Plague Research Laboratory". After finishing his studies on sprue, Sokhey organised the Biochemistry Department with a grant of Rs. 73,000 from the Indian Research Fund Association (which metamorphosed after Independence into the Indian Council of Medical Research) and Rs. 15,000 from Bombay Government. "*It is now practically impossible to practice modern medicine without the aid of biochemical analytical work*" he observed in 1928. The problem of plague and improving the plague vaccine became his major task. His work was so promising that the Annual Report of the Institute for 1926 observed: "The youngest department is doing good work and promises to be of increased usefulness each succeeding year". He officiated as Director for many short periods, and, in 1932, became the permanent Director, the first Indian to be so, and occupied this post meritoriously, for 17 years, the longest term ever known. He got an extension of two years in service and retired in 1949, rather very reluctantly, as a sort of forced separation from his closest kin. By his outstanding contributions, he raised the prestige of the chair he occupied, and the Institute became a well-known Medical Research Institute with international repute.

In 1949, Dr. Brock Chisolm, Director General of the World Health Organisation, stayed with Sokhey in Bombay for three days and saw for himself what Sokhey had achieved and was planning to do. Dr. Chisolm was so much impressed that he offered Sokhey, in the World Health Organisation at Geneva, the post of Assistant Director General, Technical Services, dealing with epidemiology, biological standardisation, and health statistics,

in succession to Dr. Raymond Gautier. In announcing this appointment, the news release of WHO, Geneva, said: "The work Dr. Sokhey has done for many years in the Haffkine Institute is recognized widely. The initiative in research work and creation of that Institute is a tribute to the technical and personal qualities of General Sokhey". Obtaining the permission of Shri Jawaharlal Nehru, Sokhey accepted this post and went to Geneva in 1949. It was from here that he initiated and finalised the project for the establishment of the penicillin factory at Pimpri and the DDT factory, with the help of the WHO and the UNICEF. After completing his term in 1952, he returned to India and was honoured by the India Government by his being nominated to the Rajya Sabha. He had to retire before the expiry of his term as decided by the ballot. It was at this time he found his niche at 31, Western Court, New Delhi, which became his residence till his last days.

For some years, he was working at the Haffkine Institute keeping in touch with his old colleagues. He was also keeping himself busy with many types of activities, including the Presidentship of the Scientific Workers Association and the Indian Peace Council. He also served as the Chairman of the Pharmaceutical and Drugs Committee of the CSIR. In 1953-54, he started spade work on the big Drug Project in the public sector, consisting of an antibiotic plant, a synthetic drug plant, an intermediate manufacturing unit, and a phytochemical drug unit. This took shape later on as the IDPL, the biggest undertaking in the field of drugs in the country so far. He campaigned for a National Microbiological Laboratory under the CSIR, but this did not fructify, and became merged with the elusive National Biological Laboratory in the planning of which he was also connected. In 1962, Dr. Hussain Zaheer, the Director General of the CSIR, took him as his adviser. In 1965 he was appointed an Emeritus Scientist. From now on, he worked at the Head Quarters of the CSIR at New Delhi, residing at 31, Western Court. His end came in October 1971, at the ripe old age of 84.

Sokhey was a recipient of many honours. He was a Foundation Fellow of the National Institute of Sciences (now the Indian National Science Academy) and the Indian Academy of Sciences, Bangalore. He was a Section President of the Medical Section of Indian Science Congress in 1935. He was knighted in 1946 and made a Major General the same year. He was awarded the Lenin Peace Prize in 1947. He did not receive any decoration from the national Government.

As Director of the Haffkine Institute

Success in posts, or in assignments, is usually a result of a combination of many favourable circumstances, the right man being at the right job at the right time and place, and the capacity of the man also matching the demands of the job. When there are square pegs in round holes, the job suffers not being properly tackled, as also the man being on the wrong job. Sokhey had the vision, capacity and courage to bend the circumstances to his wishes

and to create his opportunities. He had the essential qualifications for a successful Director. He had the vision not only to see the immediate needs but also look ahead; had the capacity to identify the problems and chalk out the methods of tackling them; had the administrative and executive abilities to an uncommon degree; had the tenacity and courage to face all obstacles and not to give up things in the face of odds; and had tremendous drive and volcanic energy. He was a good judge of men and knew how to enthuse them and make them put forth their best. He himself worked hard and set an example of hard work for others. He had close friends in the higher walks of life, inside the Government and outside, and used them to achieve what he wanted to for the Institute.

Sokhey appreciated fully well that the crucial role in successful scientific and technical work is played by the men engaged on the job. Irrespective of cast or creed, he selected for all posts the best men available in the country and gave them all the encouragement. He was also ruthless in weeding out the inefficient and the incompetent. His work was organised around men; to find out the suitable men for the job and create a department around them, as Homi Bhabha did, with good results, in the Atomic Energy Commission. He wrote against the practice of first, building an institute and then going about in the market to find the persons and problems. He was convinced that medical research and work in a medical research institute can progress effectively only by the application of the fundamental scientific disciplines, chemistry, physics and biology, and by hybridisation of ideas and methods from all these. For this, he employed "non-medical men", as they were called, in the Bombay Medical Service (which appeared to be an outrage to many sacred and scared cows whose minds were working in outworn ruts) so that all could work as equal partners putting their heads and hearts together. The work was organised to solve pressing problems of the State and the country, and is today known as the task or mission oriented research. Lastly, he did not simply order about things sitting in his remote and high pedestal but moved about all over the place putting his shoulder to work with his own hands and enlisting the cooperation of everyone possible.

When he took over as the Director in 1932, ironically, the first communication he received from the Government was that the country was passing through a period of intense economic depression, the Government cannot be loosing Rs. 8 lakhs every year in running the Institute and desired him to make the Institute self-sufficient by increasing the price of the products, or to submit proposals for winding it up ! In his characteristic way, Sokhey replied back that he cannot agree to either of them but suggested instead the opposite—the prices of the products should be reduced and the Institute should expand. What he wrote and is found in the Annual Report of the Institute for 1932-35, is worth recording here:

> "The fact cannot be overstressed that true economy lies in not spending less money on the Institute, contracting its sphere of work—that way, per unit of work will cost more—but to enlarge the functions of the Institute and thereby not only better safeguard the health of the

people of this Presidency, but also actually get greater money returns. The full development of this Institute perforce must await a thorough overhaul of the system of medical relief and public health work of the Presidency. . . . Of a modernised health organisation, a much larger Institution like this would be a life centre; it would investigate, sift and record data, and give valuable assistance in formulation and carrying out of schemes for preserving the health of the people."

"The Institute can, and should, undertake the production of all the vaccines and sera and antitoxins used in the Presidency. Steps have already been undertaken in this direction; in addition to the production of plague and antirabic vaccines, the Institute now produces the cholera, typhoid, and meningococcal vaccines. But all the sera are imported, and in the absence of any laws for the control of the sale of these products in India, the market is flooded with products good and bad. . . . The case is that the Institute undertakes the preparation of more biological products instead of giving up the manufacture of even those that it produces at present. . . . "

"It must be clearly understood that research is not a mystic function which gets vitiated by contact with practical problems. On the contrary, best research arises from the contact of men trained in scientific methods and outlook with everyday problems which cannot await solution but demand handling. . . . They require leisure to pursue problems, but benefit by contact with, and supervision of, routine work which provides real problems for them."

The above, written in 1932, is remarkable for many reasons: they constitute the ideas ahead of times but today accepted as common place; they form the basic philosophy of action of Sokhey in institutional work; and they laid down the actual blue print for the programme of his work visualised with clarity and objectivity which is striking. The Government, those days, appreciated correct ideas without prejudice, and so agreed to his proposals, giving him a free hand to go ahead. He stuck to his program of work and proved, by actual performance, that his ideas and plans were correct.

The expansion of the activities of the Institute was taken up in right earnest. In 1938, the Entomology Department was created, with an eminent Cambridge-trained entomologist as the head, to undertake field investigations on the epidemiology of plague, the premier problem of the State. In 1940, the Serum Department was organised to produce the tetanus, diphtheria, dysentery and gas gangrene antitoxins; the tetanus and diphtheria toxoids; and the polyvalent antivenin. The horse stables built for the purpose were the finest in the country; the laboratory facilities were the best by any standard for laboratory and processing work. In the same year was born the Chemotherapy Department to produce sulphathiazole and carry out researches on synthetic drugs. The laboratory facilities for organic chemistry work were augmented and a very fine pilot plant was put up, the best in the country at that time. The first molecular distillation equipment in the country was installed here to separate vitamin A from shark liver oil. In 1943, the Pharmacology Department which was till then maintained by the IRFA, became part of the Institute, with a renowned Pharmacologist as the head. The job of drug testing and biological standardisation was also taken up and this ultimately fructified and branched off as the Drug Control Organisation, the best in the country. The Blood Bank was organised, with the working out of a method of freeze-drying (lyophilisation) of blood plasma; this Department dealt with blood group sera also. In 1944, the Nutrition Department was established which later on became a part of the Public Health Department. He wanted to establish a Department of Bio-

physics but retired before it could take shape. In 1946-47 great improvements were made in the manufacture of the plague and cholera vaccines by the introduction of the casein-hydrolysate liquid medium. In 1947 the Institute set up a record by supplying 47 million doses of the vaccine, almost ten times the quantity it produced in 1932. By all these increased activities, the Institute fetched a revenue of Rs. 30 lakhs a year, about ten times as when he took over as Director.

The whole place was modernised and maintained a high standard of cleanliness. Most modern equipment were procured and installed to do the various operations in the best possible manner. As the Health Survey Committee observed, the Institute was the best equipped one in the country. The convenience of the staff was not overlooked. He built within the compound a block of 100 three-roomed tenements for the lowest paid staff. It is truethat Sokhey found the Institute a stone and left it a marble; he made more than two blades of grass grow where one grew before. The Institute was the highlight of Bombay and no distinguished visitor failed to visit it.

In short, Sokhey so much identified himself with the Institute and gave so much of his energies to its development that it may be asserted that history of the Haffkine Institute from 1932-1949 is indeed the biography of Sokhey during his most productive years.

Scientific Work

To appreciate the significance and importance of the scientific work of Sokhey, one should understand his objectives and his philosophy of scientific work. First, he was a strong believer in the Baconian doctrine that knowledge is power to achieve things, and that scientific work not resulting in socially useful action, is just sterile academic vanity. He had no obscurantist ideas of science as some sort of esoteric activity, but considered it as an important social activity which generated reliable and fully tested knowledge to be used for successful social action. Science for science sake is a nonsensical cliche for him and he was a sworn enemy of ivory tower science. Secondly, he considered research as just a reliable way of solving problems—"research is the art of the soluble" as Medawar has so aptly put it—and he set himself the task of solving problems of pressing importance. He was out and out an experimentalist with a pragmatic bent of mind; he had his feet firmly planted on earth and did not navigate in the seas of speculation. Achievement of results was more important to him than publishing them as papers and he wrote his papers with utmost reluctance. So his publications are "few but ripe". Fortunately for him, he would not have perished if he did not publish in profusion that useless mass heap which are unreadable and remain unread. Thirdly, he fully understood that medical sciences to advance should leave the old, deep rut, and boldy take to modern techniques and thinking, and adopt the quantitative methods and thinking of the fundamental sciences, physics and chemistry. The spectacular advances in molecular

biology in recent years is a vindication of this outlook, not to speak of his own achievements. He introduced in his work, accurate, quantitative and reproducible methods which meant beginning from the very beginning and standardising every parameter involved, after laborious work. He did not indulge in the easy going method of stamp collection.

At Harvard, using Folin's micromethods, he showed that the body eliminates administered mineral acids by neutralising them with ammonia generated for the purpose and does not use sodium or potassium reserves. This is an interesting work on the mechanism of detoxication.

At Toronto, working with depancreatised dogs with fully stablised metabolism, he established that administration of insulin caused the disappearance of phosphates from urine, indicating the role of phosphates in carbohydrate metabolism. This is now a well studied field constituting one of the outstanding achievements in biochemistry.

His first work at the Haffkine Institute, when he joined it in 1925, was in the biochemistry of sprue. He studied the fat metabolism of the intestinal contents; the secretion of digestive juices; the fat, protein and calcium contents of blood; and the functional efficiency of the stomach, liver, pancreas and kidney. He detected the acute prevalence of anaemia, resembling pernicious anaemia, among men and women in Bombay. The two types of anaemia of sprue and of pregnancy had resemblance to pernicious anaemia and it was believed that the pregnancy anaemia was not a distinct entity but merely an aggravated condition prevalent in non-pregnant women. The cause of this was considered to be the deficiency of some factor present in the liver of healthy animals, and he employed liver and liver extracts for treatment.

He introduced modern micromethods for clinical biochemical work to aid diagnostic work. Such diagnosis is made by assessing quantitatively the deviation from the normal of the various constituents of the blood, urine and various fluids. Thus arose the problem of ascertaining what are the normal figures for the above for the avarage Indian men and women of our country and whether the standards established in foreign countries, where the climatic conditions and dietary habits are different, are applicable to us at all. This work was undertaken by adopting the most accurate techniques known and the best equipment available.

The study of the basal metabolic rates of normal men under standard conditions was found to be 10 to 23 per cent below Du Bois standards. The protein metabolism was lower, the urinary nitrogen excretion being only 5 to 7 grams per day. It was established that the average basal metabolic rate for Indians was about 8 per cent lower than that for Europeans.

Next, he determined the hemoglobin constant of healthy medical students and nurses, by the Van Slyke oxygen capacity method newly introduced for clinical investigations. Contrary to expectations, the hemoglobin constants were found to be 15·37 and 12·99 grams per cent for men and women respectively, tallying closely with the figures worked out in Western countries.

This meant that the hemoglobin content is a genetically controlled factor of evolutionary importance, not susceptible to dietary or climatic variations.

In the course of clinical investigations it was noticed that in the case of normal healthy Indians, the blood urea nitrogen was within the same limits as that of normal American subjects but the urinary nitrogen content was about half. Further work established averages for maximum (44 ml) and standard (34 ml) urea clearance in normal Indians. These standard values for reference were very useful in investigating kidney function tests.

In addition, normal standards for chemical analyses of blood and urine, as non-protein nitrogen, uric acid, creatinine, phosphates, plasma proteins, fibrin, albumin, cholesterol and fatty acids, were also established.

The studies on plague and plague vaccine, the hall mark of the Haffkine Institute, took up the major portion of Sokhey's time and efforts, and, in this, he made outstanding contributions which are of great value to the country. A well-known researcher in the field of plague, Dr. Karl Meyer, of Hooper Foundation, San Francisco, acclaimed Sokhey as a pioneer in the immunology of plague and that others like him are just putting up the super-structures on the foundations laid by Sokhey.

When Sokhey joined the Institute, complaints were pouring from all over India about the extreme toxicity of plague vaccine prepared and supplied by the Institute. He himself was a victim of it. The Director of Public Health, Punjab, came down to the Institute to complain in person. When Sokhey looked critically into the whole matter, he found that the production of the vaccine was relegated to staff-members not properly trained, the production methods were crude without proper control of conditions, and the method of standardisation of the vaccine was erratic. In taking up the task of the production of a plague vaccine free from these defects, he had to start investigation from the very beginning studying every detail involved. This was indeed a very laborious job. He took to this and this work claimed his energies from 1932 to 1940 and even later, when he could turn out plague vaccine not only of superior protective power but also free from the notorious toxic reactions and in far larger quantities than before. This meant also converting the laboratory methods into full fledged commercial operations, creating all the requisite, elaborate infra-structures. The specific problems that arose were: the identification of the factor responsible for the toxicity of the vaccine; the nature of, and the location in the bacteria, of the protective antigenic component of the vaccine; the comparative merits of the agar-grown versus the liquid culture vaccine; maintenance of the virulence of the plague organism and the selection of the best strains for the manufacture of the vaccine; a reliable method of measuring the virulence of various strains of the organism; production of a media of standard composition; the best conditions of growing the plague organism; an accurate and reliable method of counting the organisms in a culture and estimating the population density; the best way of killing the organism to produce a vaccine without loss of protective power; and the accurate biological standardisation of the

vaccine. Each of these was a problem by itself. All these were studied and solved very satisfactorily.

The customary Haffkine-vaccine employed an acid-digest of meat as the medium, and the incubation period was twelve weeks, which is indeed far too much. The conditions practised were not fully controlled. Sokhey found that the protective antigenic fractions were in the culture fluid and not in the residual bacterial debri, and so had a case to select the liquid vaccine in preference to the agar grown vaccine, as Haffkine himself had done. Later on, great improvements were made by replacing the meat digest broth with casein hydrolysate of Mueller and Johnson properly modified and well standardised. The techniques of production of this media on a large scale was worked out and standardised, which involved installing glass-lined kettles, and other auxilliary equipment to handle the subsequent operations. This was, in fact, a factory operation that frightened the orthodox bacteriologists who were at home with their small bottles and agar media. The optimum period of sterilisation was worked out as 15 minutes at 115°C, which may look shocking to the old timers who usually burnt up their media by over sterilisation to cover up their clumsy operations. Big sterilizers with recorders were installed for this purpose. The optimum temperature of maximum growth was found to be 27°C, and not 37°C as was taken before. The period of incubation was also cut down to about 2 weeks from 12 weeks. There was installed a huge incubating room which was accurately temperature-controlled and properly fitted up to handle, in an orderly manner, thousands of flasks wherein grew the deadly microorganisms. After trying out various methods of killing of the live organisms—by heat at specific temperatures which on a large scale would be very tedious, by phenyl mercuric nitrate, etc.—formalin was found to be the best. This standardised formalin treatment not only killed the organisms but also decreased the toxicity of the vaccine, without affecting its protective power. The use of formalin for killing and detoxifying gave rise to a semantic controversy with the sticklers for definitions, that what is produced is a toxoid and not a vaccine. What the public wanted was something which would effectively immunize without trouble, under any name ! The irony of the whole situation is that due to effective control measures adopted, today there is little demand for the plague vaccine ! A successful prophylatic agent, in the course of time, renders its own use superfluous.

The usual method of measuring the bacterial density (population) in a culture is the opacity one which has serious limitations, and it becomes unreliable when there is pronounced lysis of the organism. So Sokhey first attempted the measurement of carbon dioxide evolution by a culture as a result of respiration, as an index of microbial population. It is now known that this also is not a reliable method. Finally, he worked out the method of viable counts by plating on blood agar (found to be the most suitable for the growth of the plague organism) serial dilutions of a culture and counting the number of colonies that grew up. In this work, to make accurate dilutions,

he introduced the use of special micropipettes (the methods of bacteriologists till then was to measure volumes by drops and loops !). He established, by statistical analysis, that this was a reliable method of counting the number of viable organisms. Armed with this, he could produce a test dose containing a known number of organisms.

The maintenance of the virulence of a strain was another problem of practical importance. The usual method was to passage the culture through rats. With the idea of increasing the virulence of the microorganism, Sokhey subcultured the organism in blood agar repeatedly and, to his surprise, found that after about forty subcultures, the organism became avirulent ! Today we know the reason for this. Later on, the maintenance of the virulence was done by freeze-drying of the culture under suitable conditions, which is now a standard method to do. The virulence of a strain was tested in white mice, as described below.

Making use of the avirulent stains obtained, he made a live plague vaccine and compared its protective power with the usual killed vaccine using virulent strains, and found the latter to be superior. This was a subject wherein there was a lot of controversy with other plague workers. Different results obtained using different strains and test animals, is now understandable but not then.

Another important contribution of Sokhey was the working out of a method of accurate standardisation of the plague vaccine and measuring its protective power. Here again, he had to begin from the very beginning, standardising every parameter involved in the test—the standard test infective dose containing a known number of viable organisms, and the standard animal which responds in a reliable way to infection—to obtain reproducible, quantitative responses proportional to graded challenge doses. Previously, rats from Madras (which was free from plague) were used as the experimental animals. By quantitative studies, Sokhey showed that they gave erratic results. Others were using guinea pigs. He established that the Albino Swiss white mouse (previously considered to be unsuitable) gave reliable results and that this, bred under standardised conditions, was the animal of choice. He actually worked out all the practical details of breeding of the white mouse like the types of cages to be used, the bedding, diet, cleanliness, methods of upkeep, warding off of stray infections (a very serious problem), etc. The animal house maintained for this purpose was a model of cleanliness and a show-piece, which many copied. The sight of the healthy animals was indeed a delight to those who knew what it was.

The challenge infective dose of the plague organisms in standardising the vaccine previosuly was "0·003 mg. of the spleen of a rat dying of infection". Sokhey showed that this dose contained from 120 to 60,000 organisms in different tests and this was a serious source of error. He grew the culture in a liquid medium, counted the number of viable organisms, and by making appropriate dilutions kept the number of viable organisms in a test or

challenge dose almost constant. The result of using the inbred white mouse of fixed age group and weight, and using the standard challenge dose containing a specified number of organisms, gave remarkably reproducible infection in mice which took about 4 days to die in a consistent manner. This standardised experimental infection was useful to assay not only the potency of a vaccine or an anti-plague serum but also the protective power of chemicals against plague (plague chemotherapy). So very reproducible were the results that he used to say often that in plague the answer is yes or no.

Vaccines are used as prophylactic public health measures to prevent people from catching the infection. But they are of no use to cure an infection. The search for cures for plague were also made. The cures of infection are sought in two directions, by the use of chemical drugs (chemotherapy) and the antisera (biotherapy). The principles involved and methods used differ. In chemotherapy, we introduce specific drugs into the system to kill the parasitic organisms. In serotherapy, we introduce a biological agent to neutralise the toxins produced in the system by the microorganisms. These two methods against plague were studied.

Previously, an antiplague serum was prepared using buffaloes. Sokhey tried the horse as is done now. He worked out the methods of concentrating the plague anti-serum and standardised the product. This was given an extensive field trial under strictly controlled conditions and its efficacy was established, particularly to control the toxemia following a heavy infection. This was established to be an effective supplement to chemotherapy, in serious cases.

Using the mouse test, a large number of sulpha drugs synthesised in the Chemotherapy Department were tested against plague, and the remarkable curative properties of sulphathiazole was first discovered, in 1939. Later on, a number of other related supha drugs, sulfadiazine, sulfamerazine, were found to be effective. After the advent of the antibiotic era, it was found that streptomycin, and the broad spectrum antibiotics, the tetracyclines and chloramphenicol, also possessed striking curative properties. These results in the laboratory were immediately confirmed in the extensive field trials which were conducted with meticulous accuracy and under strict control. The results, after statistical analyses, established beyond doubt the striking curative properties of the sulpha drugs and the antibiotics mentioned above, and thus plague no longer remained such a dreaded disease as the metaphor indicated. This remarkable piece of work was published in a few crisp short papers, while many would have bulky volumes out of it.

According to the pragmatic philosophy of Sokhey, the value of any scientific work consists in the actual impact on society. By these tests, his contributions were impressive.

The techniques he worked out in connection with his work on plague vaccine were such that they could be extended to cholera vaccine also. He used here again the white swiss mouse as the test animal and he worked out the mouse protection test for the assay of the cholera vaccine. It must h

admitted that the two cases are not parallel. Plague is a natural infection of rats; in the case of cholera a heavy bacteremia is produced in the mouse and this does not strictly correspond to the cholera infection in human beings. Anyhow, in the absence of anything better, he used this method to compare the efficacy of the cholera vaccine he prepared in the casein hydrolysate medium, with the standard agar grown vaccine which were standardised only by the number of organisms judged by the opacity method. The cholera vaccine prepared in the liquid medium was found to be efficacious and was thus prepared in large quantities and supplied. The equipment and set-up organised for the manufacture of plague vaccine were used for this.

The next important work, in collaboration with the serum department, was the production of an effective polyvalent antivenin which could protect against the bite of the four poisonous snakes, cobra, Russels viper, echis and krait. Previously the antivenin prepared could protect only against the bite of cobra. The purified polyvalent antivenin was freeze dried and in this form it could remain without deterioration almost indefinitely. This was extremely useful during the Burma campaign for our troops during World War II.

The other work of importance was freeze-drying (lyophilisation) of blood plasma and applying this technique for other antisera and preservation of microbial cultures. The initial work was conducted with a locally fabricated equipment and later on, sophisticated equipment were obtained from abroad.

The special features of his work are worth noting. He never beleived in doing anything in a slipshod manner. Whatever was done was systematic, well standardised, reproducible, and with the best equipment available to control all variables and increase the degree of accuracy. Reproducibility of results and quantitative evaluation were his passions. He tried to stick to experimental results and did not indulge in elaborate theories, as seen from his work on the capsule of the plague bacillus. He produced his facts, in beautiful microphotographs, and allowed the other pundits to quarrel over terms as "capsule", "envelop", "slimy layer", etc. There were no messy operations anywhere, as is seen usually in bacteriological laboratories. He worked with his own hand and so knew first hand what was going on.

Initiation of New Projects

Many of our scientists believe that once the work in the laboratory has been completed and the results published, their responsibilities are over, and it is for somebody else to develop them, if at all it is possible, and put the results to practical use. Many results remain in cold storage and it is as well that the laboratory work had not been done at all. The late Lord Blackett, in his Jawaharlal Nehru Memorial Lecture, propounded the thesis that, especially for developing countries like ours, the scientific men who completed the laboratory work should "move along the innovation chain" as he called it, to the ultimate stage of the production of goods. This view is now being appreciated. In fact, Sokhey was a firm believer of this, even before

Lord Blackett enunciated this; but he was criticised by some that this meant taking up some other type of activity and that each one should stick to the field he was trained in.

When he realised the importance of the antimalarials, he was planning a unit at the Haffkine Institute, in the years 1937-39, to manufacture "atebrine" with the details of the method supplied by the Russian scientists. When the remarkable curative properties of sulphathiazole were established in the laboratory and in the field, he thought of the next step to produce it on a bigger scale. A pilot plant was set up at the Haffkine Institute where both sulphathiazole and the newer antimalarial, paludrine, were produced from the basic raw materials, at a price much below the prevailing market prices. The moment penicillin was established as a remarkable therapeutic agent, its production of a large laboratory scale was also taken up at the Haffkine Institute.

With a vision, rare courage, and strong nerve, an ambitious scheme was put forth to the Government for a project to manufacture the sulpha drugs, the synthetic antimalarials (paludrine and chloroquin) and penicillin. The proposal was accepted in principle—he never sat quiet till he got what he wanted and that *in toto*—and a team consisting of him and the writer was deputed in 1946, to visit the Western countries to study on the first hand the developments made and put up concrete proposals. This team went again in 1948 and submitted a report with more concrete details. After the submission of the Report, there were a series of meetings and deliberations involving the Governments of India and of Bombay and their officials, and the scheme was approved. Getting a scheme like this through with the Government is not an easy job. Because of the backing Sokhey had from Shri Jawaharlal Nehru, he could get the things through. In this scheme, the penicillin manufacture was the responsibility of the India Government and the other two of the Bombay Government. Due to some misguided advice, wherein mere personal pique played a prominent part, the Bombay Government, very unwisely, withdrew from the project. The Indian Penicillin Committee was formed, of which Sokhey was a member till he left India to take up his post in the World Health Organisation. It is from Geneva that he brought in both the WHO and UNICEF to handle this project. Even this was not a smooth affair but involved a lot of pulls and pushes. It is better that many of the unhappy things that happened are forgotten. Suffice to say that the bringing into being what is now known as the Hindustan Antibiotics, goes to his credit. He was not there to head it, for whatever reasons, including his age. The bitter irony of all these was that the man chosen by the Government to head it was the one who never missed an opportunity to talk ill about it ! But, then, this is the way things work in the country.

Next, using his influence with the Soviet scientific men and officials, Sokhey took up, in a bigger manner, of an integrated drug project for the manufacture of a greater range of drugs and intermediates for this. This composite project was to consist of four units, an antibiotic plant to manu-

facture penicillin, streptomycin, tetracyclines and others; a synthetic drug unit; a phytochemical unit to process the medicinal plants available locally, and a unit to produce the organic intermediates required for all. The writer again worked with Sokhey in Moscow, and visiting some plants in the Soviet Union, to make a concrete plan. This again involved a lot of bitter struggle between him and many others in the Ministry at Delhi. Ultimately the project saw the light of day and is now working as the Indian Drugs and Pharmaceuticals Ltd. (IDPL), one of the biggest of its type in the world. If it does not work as satisfactorily as it should, it only reflects on the type of management it has. In these efforts, Sokhey made full use of his influence with Shri Jawaharlal Nehru.

Sokhey was indeed very bitter about the way things were going on. He could not reconcile himself to the fact that when there are small men occupying big places we should not expect better things. In these projects, the main issue seemed to be who is to be where and who is to take credit, rather than what to do and how best to do things. The country is now paying for it, while those responsible for the muddle have got away with it, giving lame excuses.

Work in Committees

Persons occupying important positions always get involved in, or roped into, Committees whose number in the country is almost countless. The number of Committees one is a member of—irrespective of what one does, actively or decoratively—is also an index of one's importance. Sokhey was no doubt involved in many Committees but, in most of them, he did valuable work; in others he tried his best to do something but got nowhere.

He was Chairman of the Health Sub-Committee of the National Planning Committee of the Indian National Congress, under the Presidentship of Shri Subash Chandra Bose. Those days, a Government servant being a member of such a Committee was almost a crime. But he had the courage to be there. He was always fascinated by Planning, being an ardent admirer of the Soviet Union, because that was the most sensible method of deciding what required to be done, allocating priorities and our resources to particular tasks, in the overall interests of the country. His conviction was that the Drug Industry should be only in the Public Sector, free from profit motive. Shri Jawaharlal Nehru also subscribed to this, as could be seen from many of his speeches. The note Sokhey had submitted to this Committee is of interest.

Sokhey was a member of the Chetty Committee, headed by Sir R. K. Shanmugam Chetty (with Dr. S. S. Bhatnagar and Dr. J. C. Ghosh as other members) appointed to examine the question of starting the National Chemical Laboratory and the National Physical Laboratory, with the Rs. 40 lakhs or so of the money the Government had for the purpose. In this connection, he stressed that the Laboratories should be built around men and the problems of importance to the country.

He a was very active member of the Pharmaceutical and Drug Committee (1944-46) appointed by the Planning Department of India Government. This was the first Committee to take a look at the Drug Industry of the country as a whole. The information available then were not as extensive as today and the Report may look not up-to-date. But a good beginning was made.

He was a member of the Plague Sub-Committee of the IRFA, which is automatic as a result of his position. He was also a member of the Biological Standardisation Committee of the World Health Organisation. Herein he played an active role.

When the Haffkine Institute wanted to manufacture sulphathiazole, it discovered that there was already a patent held by a foreign firm. A compulsory license was applied for and the case went before the High Court, Calcutta. In the course of the proceedings, the defects of the Indian Patent Act, found to work against national interests, were discovered. Instead of resigning himself to the situation, he wrote to the Government of India (Dr. Jivraj Mehta, his friend, was then holding the post of the Director General in the Health Ministry) and wanted the Act to be changed. The Patent Enquiry Committee was appointed (with him as a member) to study the situation and report. An interim report was submitted and as a result the Sections 22 and 23 of the Act relating to Compulsory Licenses were amended as suggested. By then he left for Geneva. The work of amending the Patent Act got into many types of vicissitudes, pushes and pulls in many directions, including the foreign patentees and their local sympathisers, and it was only in 1970, after 25 years, the Indian Patent Act of 1911 was revised. Now Sokhey was taking an extreme position of complete abrogation of the Act in so far as they related to drugs. The Patent Act of 1970 is a compromise between two extremes.

Sokhey served as the Chairman of the Pharmaceutical and Drug Committee of the CSIR. His view had always been that in the prevailing situation of the country, our primary task should be to catch up with the advances made in the developed countries and we should first make full use of what we know already rather than trying to find out new things. He suggested that the money spent in financing so many schemes, many of which are of an academic nature, should be spent to work out methods of production of as many drugs as possible in the country. This view was not popular because the various Committees have as their main function keeping alive many professors by giving some research schemes to make up for the poor financial position prevailing in the Universities.

When he was adviser to Dr. Hussain Zaheer, Director General, CSIR, he was connected with the organisation of the National Biological Laboratory. This Laboratory is still to come.

His Family Life

His wife, Leila Sokhey, was the renowned dancer, under the stage name, Menaka, in the Kathak and Manipuri style. She was a very charming and

highly cultured lady, free from any type of snobbery. She devoted most of her time to dancing, touring Europe almost every year, and running a dancing school at Khandala, under the name "Nrityalaya". Many renowned dancers today are her pupils. Their house at the Haffkine Institute was an old style house, very spacious and full of trees and flowering shrubs to make the atmosphere congenial to those with artistic temperament. In this what was very conspicuous was smart simplicity, superb taste and unostentatious furnishings. The sitting and dining areas were in the verandah; Sokhey believed that in the tropics it is thoughtless to stay indoors. There were always many staying with them. Into this abode came and went so many illustrious personages. Here could be heard so many interesting and exciting discussions about almost anything under the sun.

After the death of his wife in 1947, Sokhey became lonely. They had no children. There was a big change in the style of his living when he rented a private house in Bombay and lived there almost alone. Later on, 31, Western Court, became his home till the time of his demise.

The Man

In many ways, Sokhey, the man, was more interesting and there are not many like him in the scientific field. He had such wide interests and activities that it is difficult to classify him into any of the usual categories. The public took him for a renowned medical man, the medical men thought of him more as a technocrat fond of latest gadgets, his scientific staff knew him as a stickler for cleanliness and hard work, the Government officials respected him as an able administrator, and his frineds liked him as a fascinating personality. Being inherently a very brilliant man with an unusual capacity for hard work, he would have shone in any type of work he took to. What he devoted to in his life, he deliberately chose as the most meaningful and worthwhile type of activity. He was a highly developed man with deep social consciousness and a passion for the development of the country of his birth. Because of his capacity to interest people, he gathered around him a circle of friends and admirers in all walks of life, including the top national leaders, high officials, artists, writers, pressmen, trade unionists and the elite of the local society. The American novelist, Louis Bromfield, has portrayed him in two of his novels, "*Night in Bombay*" and "*The Rains Came*".

What struck most of the people about him was his tremendous energy and drive, a capacity to concentrate all his power on the task undertaken, and the knowledge of how to go about in his tasks. He conceived things on a big, grand scale, and possibilities of error or failure never panicked him. While discussing the penicillin project in a meeting, one of the Ministers asked him, "Sokhey, you want two crores of rupees; what will happen if you do not succeed ?"; pat came Sokhey's reply, "You just loose two crores but look at the experience we would have gathered". If he achieved more than others,

it was because he strove more, applied himself more, and gave his best to the task. He made full use of his native talents.

He was a voracious reader. His routine reading consisted of a few dailies, many weeklies and monthlies of local origin, New Statesman, Nation, New Republic, Science and Society, Modern Quarterly, etc. His house was littered with books, many well arranged and a lot kept piled up in heaps. He read almost every book of general interest that came up. He got excited when something striking was there; it would be a topic of discussion with whomsoever he came across! The reader recollects the excitement in the Haffkine Institute when J. D. Bernal's "*The Social Functions of Science*" was received in the library. The other books, among others, that captivated him were C. P. Snow's "*The Two Cultures*", J. Bronowski's "*Science and Human Vales*", Gunnar Myrdal's "*International Economy*", E. C. Carr's "*Studies in Revolutions*", etc. His favourite and one who seems to have moulded his thinking, was the American educationist and philosopher, John Dewey. His "*Quest for Certainty*" was almost Sokhey's bible. He was so much sold out to Dewey that he was unnecessarily hard on the great Immanuel Kant.

He had a good general knowledge of philosophy but he used to dismiss most of it as a futile vocation. Epistemology was to him all fight with windmills—like swallowing something which is not there in the throat, as Einstein put it—and he could not make out anything of Logical Positivism. His main point was that we know and learn by doing things and not by endless discussions and subtle logic-chopping. Bridgeman's operationalism was more to his taste. He knew and read a lot of politics and economics; here he was a confirmed radical subscribing to "*leftist*" ideologies. One of his close friends used to say that Soviet Union was his spiritual home. He visited China and was very much impressed. He did not conceal his views and held them even when it was dangerous to do so. His conviction was that profit-motive rather than social benefit, gave an undesirable twist to production and was the root cause of the ills of the world, and communism, in theory, was the only solution. He had studied the literature so well and had such a fund of facts at his finger tips that few could argue with him and score over him. He was a great champion of the Public Sector and was instrumental in bringing into being the Hindustan Antibiotics, Pimpri, and the IDPL. He admired the efficiency and the innovative spirit of American technology but held that the profit motive embedded in it is causing all the aberrations. He did not subscribe to the view that monetary incentive was essential for one to put forth his best. Being essentially a man of action and being convinced that the urgent need of the country was getting things done to catch up with the developed countries, he considered democracy as unsuited to us; in fact, he used strong language against it.

Sokhey was a rationalist of an uncompromising and aggressive type. The practice of many meaningless customs, religious rituals, and the dichotomy in the lives of scientists who have one set of beliefs in the laboratory and another outside, provoked his anger. He even went to extremes. For example,

a churchgoer or a Nazi cannot be a good scientist. When the writer had purchased and was reading the, now famous, book "*What is Life ?*" by the great physicist Erwin Schroedinger, which is now acknowledged to be the door opener to the era of Molecular Biology, he seized the book from my hand, glanced through the pages and ordered me to throw it out ! What provoked him to this dictate was the occurrence of the words, Upanishads, Brahman, Vedanta, "I have become God", etc. in the Epilogue of the book ! He was not simply an agnostic but an aggressive atheist. What C. P. Snow wrote about the great English mathematician, Hardy, "God was his personal enemy", applies equally well to Sokhey. His views on sex, marriages and morals, are those of a type we read in Bertrand Russell, Ibsen, and Bernard Shaw, particularly the last mentioned's "*Mrs. Warren's Profession*" and "*Man and Superman*".

He had great interest in art, music, painting, etc. The famous Russian ballerina, Anna Pavlovna, was a friend of the Sokheys. Here also he held strong views. His wife, Menaka, was a great exponent of the Kathak and Manipuri style of dancing. "No one danced like her during the last three hundred years" he used to say. He objected to the now very popular South Indian style of dancing being called "*Bharatanatyam*" as is popularly done; he would quote texts and adduce evidence to assert that it should be called "*dasiattam*" (dance by courtesan), which was indeed true. He liked very much the pipe instrument "*shehnai*" but the writer could not convince him that the South Indian, "*nadhaswaram*" is more evolved. He did not like the use of violin in Indian music (his wife went to England to learn playing on the violin !), and held that we have many stringed instruments which are far superior. He had expert knowledge of Ajanta and Ellora and other art treasures. He said that he did not understand modern art.

He was a man of strong likes and dislikes and often things were either white or black. He was a personal friend of Jawaharlal Nehru and wrote to him often. He had great regard for Mahatma Gandhi, as a man who was sincere, not dogmatic or fanatical in views and beliefs, and was honestly open to conviction. The story of Gandhiji's visit to the Haffkine Institute and his demonstration of the method of controlling plague by *killing* rats which carried the fleas, which Gandhi approved, was told by him in a delightful way. He has also written about it. He deplored the tendency of many politicians using the name of Gandhiji to gain support to their own fads. He had a contempt for many politicians in high places because of their ignorance of economics and world trends.

He was well at home with English language and could write this very well; the Fowlers, Thesaurus and Gowers were always at his elbow. He was an advocate of the Hindustani (not Hindi) as our national language and the use of the Roman script as more rational. Though not good at giving lectures, he was brilliant at table talk, with a fund of anecdotes and his striking way of putting things. In polemics, he used the sledge hammer tactics loaded with sarcasm and had a touch of Voltaire in him. Many were afraid of

arguing with him. He showed utmost courtesy in correspondence and personal dealings. "Courtesy costs nothing; you can kill man also with courtesy" was his usual exhortation. He was a bit fond of dramatising things and sometimes, his fish would talk like whales.

There were some who did not like him. Of these, some were persons who did not extract from him what they wanted to, and the others were those who were snubbed for some dereliction or other. He did not suffer fools gladly and was intolerant of those who were inefficient or mediocre, or had or held obscurantist views. There were murmurs that he did not allow tall poppies near about but this is told by dwarfs who imagined themselves tall. The reward of a good thing is said to consist in having done it; but Sokhey would like to be the one doing it and known for it; he believed that he could do better than others.

In his last years he was very lonely. The persons he knew very well had all disappeared from the scene. The younger generation had their own problems, ideals and methods, and sense of values, and he could not establish intimate contact with them. He had trouble with his eye sight and had to undergo a major operation. Those who knew him in his prime and active life had a picture of the ravages time could do to a man; he was an entirely different man now. Due to isolation, he was also losing touch with realities. It may be said that he was experiencing the consequences of living for far too long after retirement and at a time when the craze is for younger men for all jobs.

The writer of this memoir had the privilege of coming into intimate contact with him in his formative years when being just out of the academic nest with illusions of various types. It was Sahib Singh Sokhey who was instrumental in shaping the ideas, ideologies, convictions and sense of values of the writer, after so many arguments and discussion, some of which were very heated and noisy. We agreed on many issues and also differed sharply in some but knew why this was so. If one has to guess what inspired Sokhey himself in turn to shape his own convictions, probably the following passage from the great book "*The Making of Humanity*" by Robert Briffault (1919), which Sokhey studied carefully, could be cited:

> "The man who has felt what it is to live in the glow of great and absorbing ideas, to be worn in the service of it, to feel his being identified with creative forces which shaped the world, declares that that alone is life, that the happiness of it, even though it entails bitterness of the struggle, of obliquy, and even death, is not to be exchangeable for anything life can offer."

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