



Bomkari



BISHNUPADA MUKERJI

(1903-1979)

Elected F.N.I. 1943

BISHNUPADA MUKERJI was a well-known pharmacologist of India. He was a great organiser, an erudite scholar, a prolific writer and an eloquent speaker. His unfailing amiability and graciousness endeared him to all who came in contact with him.

BIRTH, CHILDHOOD, SCHOOL AND UNIVERSITY EDUCATION

Mukerji was born on March 1, 1903 in an orthodox Brahmin family at Barrackpore, 24 Parganas, close to Calcutta. His father, Upendra Nath Mukerji, was an Administrative Assistant of the then Eastern Bengal Railway, and his grandfather was Vice-Principal of the Sanskrit College, Calcutta. His mother, Hemantakumari, was noted for her piety. They had five children; Bishnupada was the third.

From his early days, Bishnupada showed great promise. He had his early education in the Shyambazar Vidyasagar School where he passed the Matriculation Examination of the Calcutta University in 1919 with distinctions in Sanskrit, Bengali and Mathematics and was recipient of a Government scholarship and a gold medal. He then joined the Intermediate in Science course of two years of the Calcutta University at the Scottish Church College, Calcutta, and passed the final examination, with distinctions in mathematics, physics and chemistry and won the *Fyfe Scholarship* of the College.

With a good foundation in basic sciences, Mukerji opted for the Bachelor of Medicine course of six years at the Calcutta Medical College. He had a Government scholarship throughout this period and completed the course with Honours in Pharmacology, Obstetrics and Gynaecology in 1927, stood first in order of merit and won a number of gold and silver medals.

PROFESSIONAL CAREER

At the Calcutta Medical College, he came in close touch with the pioneer pharmacologist of the country, Col. Sir Ram Nath Chopra, Professor of Pharmacology at the famous Calcutta School of Tropical Medicine, situated at the northwest corner of the Calcutta Medical College campus. During 1927-28, he worked as Resident House Surgeon at the Eden Hospital of the Department of



Obstetrics and Gynaecology of the Calcutta Medical College. Here he impressed his teacher, Professor Greenarmitage, Head of the Department who had his assistance in his private practice. Soon after completion of his term as house surgeon, Mukerji joined the research team under R. N. Chopra in the Pharmacology Department of the Calcutta School of Tropical Medicine as an Assistant under the Indigenous Drugs Inquiry of the India Research Fund Association, now known as the Indian Council of Medical Research. This was the beginning of his research career as a pharmacologist.

During 1930–31, he was deputed as Assistant Secretary to the Drugs Enquiry Committee of the Government of India, New Delhi. In this position, he had the opportunity to travel around and acquire first hand information about the drugs situation prevailing in different parts of the country. Practical knowledge of different aspects of drugs and pharmaceuticals and their related problems, acquired by him at that early stage of his professional career, was well utilised by him during the rest of his active life in the development of the Pharmacopoeia of India, the Indian Pharmaceutical Codex and the newly started drug control system of the country.

He resumed research at the Calcutta School of Tropical Medicine in April 1931 and continued to work on some well-reputed indigenous drugs of the country e.g. species of *Artemesia*, Squills, *Chenopodium*, *Ipecacuanha* and *Makaradhwaja*. Two of his earliest papers with Chopra were on 'Value of the antimony test in the diagnosis of *Kala-azar*, Part II—the Finger Prick Blood Test' published in April, 1930, in the *Indian Medical Gazette*, 65, and 'Narcotine, its pharmacological action and therapeutic uses' published in July 1930, in the *Indian Journal of Medical Research*, 18. After these two, several papers followed with Chopra, mainly in these two journals. The most notable contribution during this period was a paper entitled 'Pharmacological action of an alkaloid obtained from *Rauwolfia serpentina* Benth.' by R. N. Chopra, J. C. Gupta and B. Mukerji. This important paper published in 1933 initiated the inclusion of extracts and alkaloids of *R. serpentina* in modern therapy, especially in hypertension and in insanity, throughout the world. A decade later, J. C. Gupta and B. S. Kahali published their interesting paper on the highly potent character of *Rauwolfia oleoresin* fraction, which used to be discarded during isolation of the total alkaloids of *R. serpentina*. This important finding led to the isolation of the natural tranquilliser, reserpine, an alkaloid with rather weak basic properties, by J. M. Mueller, E. Schlittler and H. J. Bein at Basle, Switzerland in 1952. Another important paper of Chopra and Mukerji was "Pharmacological action of 'thevetin' ", a glucoside occurring in *Thevetia nerifolia* (yellow oleander) in view of the cardiac activity of its active principle.

Considerable amounts of the alkaloid, narcotine, were being obtained in those days at the U. P. Government Opium Factory, Ghazipur, as a useless byproduct. Work on pharmacological action of narcotine was carried out by Mukerji with the object of finding a suitable use for the product. His work with Chopra on 'Pharmacological action and antimalarial properties of anhydrocotarnine-resorcinol hydrochloride (a derivative of narcotine)' was published in 1933.

In 1933, he was awarded a fellowship by the Rockefeller Foundation. For three



years it enabled him to carry out pharmacological researches in a number of countries, though for most of the period he worked in the laboratory of Professor Edmunds, Chief of the Department of Pharmacology, Michigan University, Ann Arbor, Michigan. He obtained his D.Sc. degree from this University in 1936 on the basis of his dissertation, 'The effect of certain therapeutic agents on thiocyanate metabolism in cyanide poisoning.' Subsequently, he worked in China and it resulted in the paper on 'Effect of pressor principle of the anterior lobe of the pituitary body on the liver-fat after the feeding of choline chloride' published in the *Chinese Journal of Physiology* in 1935.

On his return to India early in 1937, Dr Mukerji was appointed Pharmacologist at the newly started Biochemical Standardisation Laboratory of the Government of India at the Calcutta Medical College campus with Col. Chopra as its Director. The laboratory was charged with the important and responsible function of control and maintenance of standards in drugs and pharmaceuticals for use in the country. In 1941, after retirement of Col. Chopra, Dr Mukerji took charge of the Laboratory as Officiating Director. After independence in 1947, this Laboratory was named Central Drugs Laboratory and Dr Mukerji was appointed as its first Director. He also held charge of the Pharmacognosy Laboratory of the Government of India at the campus of the Indian Museum in Calcutta.

He ably managed the affairs of the Central Drugs Laboratory and developed it enormously starting from practically a scratch, in spite of all the difficulties he had to face at the formative stage, while he had his office room at the All-India Institute of Hygiene and Public Health, across the street to the Calcutta Medical College campus. As the Laboratory was situated in those days at the Calcutta Medical College campus and as he was continuing his researches during the period and was also vigorously working as the General Secretary of the Indian Science Congress Association, it was quite a strenuous job for him to manage with all these. He did the spade work for having the building at Kyd Street for the Central Drugs Laboratory. He also did the spade work for having the Science Congress building, which was built by Dr U. P. Basu, F.N.I., his successor as the General Secretary of the Indian Science Congress Association. The building stands on Dilkhusa Street, presently known as Bires Chandra Guha Street.

During this period, he was actively engaged in his researches, mostly on standardisation of drugs. Mention may be made in this connection about his work on dextrorotatory hydrocupreidine derivatives, effect of anterior pituitary extracts on smooth muscles under influence of some amines related to ephedrine, effect of sodium nitrate and methylene blue on thiocyanate formation in cyanide poisoning, method of determination of prothrombin time, medicinal value of *Alstonia scholaris* and *Caesalpinia bonducella*, antimony content and toxicity of Urea stibamine, assay of Indian ergot, physiologically active fractions of Indian hemp, assay of individual sclerotium of ergot, cantharidin content of *M. macilenta* beetles, protein hydrolysates, assay of insulin, quality of peptone for bacteriological work, snake venom as a therapeutic agent, unsaponifiable matter in shark-liver oil, prolongation of insulin effect by combining with casein hydrolysate, assay of globin-insulin preparations, biological standardisation of liver extracts by pigeon



method, assay of histamine content of tissue extracts using antihistaminic drugs, microbiological assay of vitamin B₁₂.

About the middle of July 1951, he took over charge of the newly started Central Drug Research Institute at Lucknow as its first permanent Director. This Institute is one of the National Laboratories under the Council of Scientific and Industrial Research. The famous Chattar Manzil Palace of Lucknow was fitted up as the Research Institute. This was quite a difficult task, but Dr Mukerji proved himself well up to the mark and immediately after his joining there he took up this task in all earnestness and pursued the programme of development of the Institute vigorously so that within seven months of his joining there, he could organise an International Symposium on the very interesting subject of "The recent progress in Hormone Research and the use of Hormones in Therapeutics" in February, 1952. This was practically the first symposium of its kind in this country and is one of the best so far held from the standpoint of general standard, objective approach, realistic presentation of the related information/problems, and seriousness of purpose in scanning all the various aspects of the particular area. It was indeed a great feat on his part and for this he had to work hard during the few months available to him. At the time of the symposium, the large number of delegates, who gathered from different parts of the country and from abroad, were highly satisfied to see a well-organised, multidisciplined, and progressive biomedical research Institute running smoothly as if the Institute were established a long time ago.

During the valuable twelve years he was at the helm of this Institute, most of his time was occupied in planning and management of research and further development of the Institute. This helped enormously the rapid growth and expansion of the Institute along right lines. However, he was still keenly interested in continuing his research activities. Among his research contributions during the period, mention may be made of pharmacological action of alkaloids of *Cissampelos pareira*, a method of isolation of dendritic cell from human and guinea-pig skin, evidence against corticotropin-like action of melanophore hormone on adrenal cortex of mice, studies on experimental atherosclerosis, studies on experimental diabetes, studies on experimental tuberculosis, studies on leucoderma including treatment, experimental peptic ulceration, action of *makaradhwaja* (Ayurvedic mercuric sulphide preparation).

With his keen sense about capabilities and prospective qualities of growing young scientists, he soon collected around him at the Institute a large band of very promising young scientists. As a result of the serious and well-disciplined activity of this band of research workers, the Institute soon became well recognised in the country and abroad as a progressive centre for biomedical research. By the time he retired from the Institute in 1963, all its different divisions had grown enormously and were throbbing with activity.

Particular mention may be made of his keen interest in looking after proper growth of the scientists working at the Institute and this special consideration towards them enabled him not only to have from them maximum help and cooperation for furtherance of the cause of development of the Institute but also to see them become competent for higher responsibilities. It is significant to note



in this connection that both the succeeding Directors of the Institute since his retirement and the first two Directors of the Industrial Toxicology Research Centre at Lucknow under the Council of Scientific and Industrial Research, as also the first Director of the Cholera Research Centre at Calcutta, under the Indian Council of Medical Research earlier worked in his team at the Institute for very long periods.

After his retirement from the Institute, he joined the Chittaranjan National Cancer Research Centre in under the Ministry of Health, Government of India Calcutta as its first wholetime Director in April 1963 and worked for five years upto 1968. Even during these last five years of his service life, he maintained his vigorous organisational activity and brought about immense improvement and expansion of this Centre and opened a Cancer Chemotherapy Field Research Centre at Chandernagore.

Shortly after completion of his term at the Chittaranjan National Cancer Research Centre towards the end of 1968, Dr Mukerji was in difficulty with regard to his health for a considerable of long period. In April, 1970, under a University Fellowship Programme, he started on a trip round the world as a Visiting Lecturer and attended a number of international conferences. On his return in 1971, he became associated with the Department of Biochemistry of the University of Calcutta as Honorary Visiting Scientist. Later, he was on a temporary assignment as a Consultant on Reproductive Biology at the Calcutta Office of the Ford Foundation. The writer fondly remembers his impressions regarding Dr Mukerji at work at his office during the last phase of his active career. He strictly maintained his regularity and sense of responsibility in discharging his duties, his objective approach and seriousness of purpose admirably well even during this period.

ORGANISATIONAL ACTIVITY

B. Mukerji will be remembered as a great organiser amongst the scientists of the country keeping in view the prevailing environmental conditions and the resources available to him. In this respect, his efforts were equally successful in development of drug testing laboratories of high standard, institutes for researches on drugs and diseases, scientific societies, etc. In the first instance, he gave a practical shape to the newly started Biochemical Standardisation Laboratory in Calcutta under the Ministry of Health, Government of India and ultimately developed it into the Central Drugs Laboratory of the present day as its first Director. Today, it is an organisation of great national importance.

The most important evidence of his organisational activity is provided by the development of the newly started Central Drug Research Institute at Lucknow as its first permanent Director. It grew up, during his time, into a very big research institute and in a short time became well known throughout the world as a great centre for researches on drugs and diseases. As its first wholetime Director, with his valuable organisational experience in development of multidisciplinary institute for biomedical research, he developed the Chittaranjan National Cancer Research Centre during the five years he was there.



The Indian Science Congress Association became a very important organisation after independence of the country in 1947. As the General Secretary of this Association during the five-year term, 1947–52, he worked not only hard but also efficiently for conducting the activities of this Association in the right direction and meeting the challenges the situation demanded. He was very eager to construct a building for this Association and through his initiative and efforts and later through his successor as the General Secretary, Dr U. P. Basu, it was possible to have the building where the Association is at present functioning smoothly. He was a founder member of a number of scientific societies. Mention may be made about his efforts for the establishment of the Indian Brain Research Association, Indian Association for the Biological Sciences and the Indian Biophysical Society.

Mukerji's chief contribution is with regard to the development of the *Indian Pharmacopoeia*. He also worked hard for the publication of the *Indian Pharmaceutical Codex*. In fact, he had initiation in this field at a very tender age in 1930, i.e., within three years of his graduation in medicine, when he was deputed as Assistant Secretary to the Drugs Enquiry Committee. Since then, he was all the time very intimately associated with developments in this area resulting in development of huge drugs and pharmaceuticals industry in the country.

Of particular mention is his high standard of knowledge in chemistry. It may be recalled that in his early college days he was highly accomplished in physics, chemistry and mathematics. His proficiency at the initial stage in the natural sciences in addition to his specialisation in medicine was of immense help to him in organising and conducting the activities of the multidisciplinary biomedical research institutes. His keen interest in chemistry may be evident from the fact that though a medical man he was a Fellow of the Indian Chemical Society and a Foundation Fellow of the Institution of Chemists (India). He was President of the latter body for the two years, 1972–73. His *H. K. Sen Memorial Lecture* of this body for 1963 on 'Indian Drug Industry—past, present and future' is a valuable document in this field based on his long experiences in research, standardisation and control of drugs, development of the *Indian Pharmacopoeia* and his intimate contacts with the developing drug industry of the country at the different stages, *vis-a-vis* his knowledge about up-to-date developments in this area in the world acquired through his contacts, visits and critical studies.

HONOURS AND AWARDS

He was elected a Fellow of the Indian National Science Academy in 1943, and was a member of the Council of this body during 1947–65, 1967–68 and 1974–75. He served this Academy as a Vice-President in 1954–55 and 1962 and as the Foreign Secretary in 1957–60 and 1967–68. He was the President of the Physiology Section of the Indian Science Congress in 1945, its Acting General Secretary in 1946–47, its General Secretary during 1947–52 and the General President of the Congress in 1960–61. He was a member/fellow of a very large number of scientific societies in India and abroad. He was the President of the Asiatic Society in 1972–75, the Indian Pharmaceutical Association in 1959–60, the Indian Pharmaceutical Congress Association in 1960–61, the Physiological Society of



India, the Institution of Chemists (India) in 1971-72, the Indian Science News Association in 1972. Amongst his membership of foreign scientific societies, mention may be made of American Society of Pharmacology and Experimental Therapeutics, American Pharmaceutical Association, Sigma Xi, American Association for Advancement of Science, New York Academy of Sciences, American Society of Pharmacognosy, British Pharmacological Society, Pharmaceutical Society of Great Britain, Deutsche Pharmakologische Gesellschaft, La Societe Helvetique des Sciences Naturelles, etc., and an Honorary Member of the Egyptian Pharmaceutical Association.

He was awarded a large number of medals and prizes. Mention in this respect may be made of the following : *Griffith Memorial Prize* for 1938, *Nilmony Brahmachari Medal* for 1938, *Asutosh Mookerjee Medal* for 1940 and *Coates Medal* for 1941 of the University of Calcutta; *Indian Science Congress Medal* for 1951 and *Barclay Medal* for 1954 of the Asiatic Society; *Squibb International Award* for 1962; *H. K. Sen Memorial Medal* for 1963 of the Institution of Chemists (India); *Acharya P. C. Ray Medal* for 1975 of the Indian Pharmaceutical Association; *Shree Dhanwantari Prize* for 1976 of the Indian National Science Academy. His services towards development of scientific research in the biomedical field was duly recognised by the President of India by the award of *Padma Shri* to him in 1962.

FAMILY LIFE AND LAST DAYS

On November 18, 1933, just a few days prior to his departure for U.S.A. for higher studies and research, he married Susama, daughter of Benoy Krishna Banerjee, Principal, D.A.V. Art College, Lahore, and Lakshimoni. He had a very peaceful and happy family life. Dr Mukerji was highly sociable by nature and in this respect Mrs Mukerji was always by his side. She was of immense help to him, and a great source of inspiration in his varied activities. For twelve years at the Central Drug Research Institute, Lucknow, they were residing at the Institute campus and this environment was very much helpful to them for developing friendly personal relations with practically all the members of the staff. In later years, when the writer had opportunities to visit the Institute and stay at the attached Guest House, on numerous occasions he heard from old members of the staff, even of the very junior categories, how they loved and held in high esteem Dr and Mrs Mukerji.

Amongst their two sons and one daughter, the eldest son, Mr Debangshu Mukerji is working with the Metal Box Co. Ltd., Calcutta and the other son, Dr Sudhangshu Mukerji is a scientist working at the Indian Drugs and Pharmaceuticals Ltd., Hrishikesh. Their daughter, Miss Sucheta Mukerji, is a scholar in English, at present working at Loreto College, Calcutta.

Throughout his life, Dr Mukerji was very methodical and regular in his habits, very prompt in attending to his letters and correspondence. He used to rise up early in the morning and worked throughout the day without recess. A good part of the day he used to read and write. His total number of publications may be well around four hundred including the review articles and special informative scientific articles. Only the more important ones are listed under 'Bibliography'. He was very



regular in attending meetings and liked to take active part at such meetings. As he was intimately connected with numerous organisations and was a member of a large number of Committees, Commissions, Delegations, etc. attendance at such meetings was a regular part of his daily programme throughout his active life extending up to his last day. He never felt tired even after return from his rather frequent trips to foreign countries.

During his last few years, he was not keeping well. Though he was not negligent to his health and was taking all possible measures for recovery, he was carrying out his usual duties more or less normally up to practically the last day without giving any chance to any of his numerous friends and colleagues to know that he was not keeping well.

The end came on July 30, 1979 with his wife, two sons and his daughter by his bedside along with a host of his friends, admirers and relations. His passing away was deeply mourned by a very large number of individuals and organisations throughout the country and abroad.

R. N. CHAKRAVARTI

BIBLIOGRAPHY

1930. (With CHOPRA, R. N.) The value of the antimony test in the diagnosis of *Kala-azar*, Part II—the finger prick blood test. *Indian med. Gaz.*, **65**, 4, 203–206.
 — (With CHOPRA, R. N., and DIKSHIT, B. B.) Narcotine—its pharmacological action and therapeutic uses. *Indian J. med. Res.*, **18**, 35.
1931. (With CHOPRA, R. N.) Indian species of *Artemesia*. *Indian med. Gaz.*, **66**, 622–625.
 — (With CHOPRA, R. N.) Indian Squills. *Indian med. Gaz.*, **66**, 666–667.
1932. With CHOPRA, R. N.) Indian *Chenopodium*. *Indian med. Gaz.*, **67**, 5–7.
 — (With CHOPRA, R. N.) Indian *Ipecacuanha*. *Indian med. Gaz.*, **67**, 88–90.
 — (With CHOPRA, R. N.) Musk—its pharmacological action and therapeutic uses. *Indian med. Gaz.*, **67**, 321–326.
 — (With CHOPRA, R. N.) Thymol, menthol and camphor from Indian sources. *Indian med. Gaz.*, **67**, 361–365.
 — (With CHOPRA, R. N.) A preliminary note on absorption of *Makaradhwaja* (sulphide of mercury). *Indian med. Gaz.*, **67**, 448–451.
1933. (With CHOPRA, R. N., and GUPTA, J. C.) The pharmacological action of an alkaloid obtained from *Rauwolfia serpentina* Benth., a preliminary note. *Indian J. med. Res.*, **21**, 261–271.
 — (With CHOPRA, R. N., and CAMPBELL, H. G. M.) The pharmacological action and antimalarial properties of anhydrocotarnine-resorcinol hydrochloride (a derivative of narcotine). *Indian J. med. Res.*, **21**, 255–260.
 — (With CHOPRA, R. N.) Pharmacological action of 'thevetin', a glucoside occurring in *Thevtia nerifolia* (yellow oleander). *Indian J. med. Res.*, **21**, No. 3, January.
 — (With CHOPRA, R. N.) Toxic effects of ephedrine—a warning. *Indian med. Gaz.*, **68**, 622–626.
1935. The effect of pressor principle of the posterior lobe of the pituitary body on the liver-fat after the feeding of choline chloride. *Chinese J. Physiol.*, **9**.
1937. Action on smooth muscles of some ephedrine-like amines. *Indian J. med. Res.*, **25**, 113–129.
1938. (With IYENGAR, N. K.) Determination of atebirin in urine by Pulfrich photometer. *Curr. Sci.*, **6**, 381.
 — The ergot problem and the practitioner. *Indian med. Gaz.*, **73**, 355–364.
 — (With CHOPRA, R. N., and CHAKRAVARTY, M.) Studies on some dextrorotatory hydrocupreidine derivatives, Part I—comparative haemolytic activity. *Indian J. med. Res.*, **26**, 279–288.



- (With IYENGAR, N. K.) Studies on some dextrorotatory hydrocupreidine derivatives, Part II—comparative action on digestive enzymes. *Indian J. med. Res.*, **26**, 289–293.
- 1938. (With CHOPRA, R. N., and DAS, N. N.) Action of certain cardiac drugs on embryonic heart explants. *Indian J. med. Res.*, **26**, 271–278.
- (With GUHA, R. C.) The effects of anterior pituitary extracts and choline on the liver fat of rabbits. *Indian J. med. Res.*, **26**, 290–302.
- (With CHOPRA, R. N., et al.) Choline esterase in cobra venom. *Curr. Sci.*, **7**, 51–53.
- (With IYENGAR, N. K., and SEHRA, K. B.) Studies on the protease of cobra venom. *Indian J. med. Res.*, **26**, 487–492.
- Comparative studies on smooth muscles of certain amines related to ephedrine. *Chinese J. Physiol.*, **13**, 339.
- 1939. (With SMITH, RALPH G.) Effect of sodium nitrate and methylene blue on thiocyanate formation in cyanide poisoning. *J. Pharmac. experiment. Therap. (Proc.)*, **66**, 34.
- (With GHOSE, R.) Diet and detoxication. *Curr. Sci.*, October, 411–414.
- (With GHOSE, R.) Elimination of administered chloral hydrate in the urine as a test for liver function. *Nature (London)*, **144**, No. 3637, July, 112.
- (With GHOSE, R.) Blood clearance of free chloral in normal and liver-damaged dogs. *Nature (London)*, **144**, No. 3649, October, 636.
- (With GHOSE, R.) Urinary clearance of free chloral in normal and liver-damaged dogs and the possibility of using it as a test for liver function. *Indian J. med. Res.*, **27**, 757–764.
- 1940. (With SMITH, RALPH G., and SEABURY) *J. Pharmac. experiment. Therap. (Proc.)*, **68**, 351.
- (With GHOSE, R.) A new test for measuring the detoxicating efficiency of the liver. *Calcutta med. J.*, **37**, 73–86.
- Detection of adulteration in 'ghee' by the ultraviolet fluorescence technique. *Curr. Sci.*, **9**, 120.
- 1941. (With GHOSE, R.) Differences in the rate of chloral clearance in blood in normal and liver-damaged dogs. *Indian J. med. Res.*, **29**, 639–645.
- (With SEHRA, K. B., and CHOPRA, I. C.) Experimental liver and biliary damage and serum phosphatase. *Indian J. med. Res.*, **29**, 647–654.
- (With IYENGAR, N. K., and SEHRA, K. B.) An improved method for determination of 'prothrombin time'. *Curr. Sci.*, **10**, 326–328.
- (With CHOPRA, R. N., and KAUL, K. N.) An indigenous mounting medium for microscopic work. *Curr. Sci.*, **10**, 486–488.
- 1942. (With DUTTA, N. K.) Bioassay, on tadpoles, of thyroxine and similar preparations. *Curr. Sci.*, **11**, 104.
- (With IYENGAR, N. K., and SEHRA, K. B.) A modified method for the determination of 'prothrombin time'. *Indian J. med. Res.*, **30**, 339–343.
- (With DUTTA, N. K., and GANGULY, S. C.) Studies on some dextrorotatory hydrocupreidine derivatives, III. *Indian J. med. Res.*, **30**, 325.
- (With BOSE, B. C.) On the suitability of guinea-pig method of digitalis assay. *Indian J. med. Res.*, **30**, 611–618.
- (With BOSE, B. C., and DUTTA, N. K.) Standardisation and potency of adrenaline solutions. *Curr. Sci.*, **11**, 435–437.
- Can the deterioration of ergot extracts be prevented in the tropics? *Indian med. Gaz.*, **77**, 286.
- (With DEY, N. K., and BOSE, I. B.) Determination of ergometrine in solution. *Curr. Sci.*, **11**, 432.
- Proteolytic system in normal and various pathological conditions. *Indian med. Gaz.*, **77**, 409.
- *In vivo* action of some substances on the proteolytic system in blood. *Indian med. Gaz.*, **77**, 409.
- Search for an antimalarial drug in the indigenous materia medica, Part I : *Alstonia scholaris*. *Indian med. Gaz.*, **77**, 723.
- 1943. (With GUHA, R. C., and DUTTA, N. K.) Antimony content and toxicity of ureastibamine. *Nature (London)*, **151**, January 23, 108.



- (With DEY, N. K.) Assay of Indian ergot. *Curr. Sci.*, **12**, 87–88.
- (With DUTTA, N. K., and MOOKERJEE, G. C.) Toxicology of food colours and the need for their pharmacological examination. *Curr. Sci.*, **12**, 117–119.
- (With GHOSH, B. K., and SIDONS, L. B.) Search for antimalarial drug in the indigenous materia medica, Part II. *Caesalpinia bonducella*. *Indian med. Gaz.*, **78**, 285–288.
- (With BOSE, B. C.) Physiologically active fractions of Indian hemp. *Nature (London)*, **152**, July 24, 109.
- Thyroxine-iodine content of thyroid gland powders of Indian manufacture. *Curr. Sci.*, **12**, 256.
- Biological standardisation of drugs. *Curr. Sci.*, **12**, 263–267.
- Indian rhubarb as substitute for 'official' rhubarb. *Curr. Sci.*, **12**, 275.
- (With GHOSH, S. K., and GUHA, R. C.) A rapid colorimetric method for the estimation of morphine in certain pharmaceutical preparations. *J. & Proc. Inst. Chem. (India)*, **15**, 97–102.
- (With SMITH, RALPH G.) Cyanide detoxication in the rabbit and the dog as measured by urinal thiocyanata excretion. *Ann. biochem. experiment. Med.*, **3**, 23–34.
- 1944. (With DEY, N. K.) Method for the assay of individual ergot sclerotium. *Curr. Sci.*, **13**, 128.
- (With BOSE, B. C.) Use of trichloroethylene as an anaesthetic agent : an experimental study on laboratory animals. *Indian J. med. Res.*, **32**, 65–69.
- (With IYENGAR, N. K., and BOSE, B. C.) Vitamin C in pine needles. *Indian J. med. Res.*, **32**, 165–170.
- (With (With HOSSAIN, T., and KARIM, B. A.) Cantharidin content of *M. macilenta* beetles. *Curr. Sci.*, **13**, 315–316.
- 1945. Protein hydrolysate. *Pharma. J. (London)*, August 4.
- (With BOSE, B. C., and IYENGAR, N. K.) On the assay of ureastibamine. *Indian J. med. Res.*, **33**, 151–156.
- (With GHOSH, S. K.) *Lobelia nicotianaefolia* as substitute for *L. inflata* B. P. *Curr. Sci.*, **14**, 198–199.
- (With IYENGAR, N. K., and BOSE, B. C.) Observation on the assay of insulin in India. *Ann. biochem. & experiment Med.*, **5**, 45.
- (With BOSE, B. C.) Observation on the physiologically active fraction of Indian hemp. *Indian J. med. Res.*, **33**, 265–270.
- Quality of peptone for bacteriological work. *Pharm. J. (London)*, September 15, 122.
- (With GUHA, R. C.) Assay of Indian Ipecacuanha. *Sci. Cult.* **11**, 204–205.
- Malt and extract of malt. *Pharm. J. (London)*, December 1.
- 1946. Snake venom as a therapeutic agent. *Pharm. J. (London)*, January, 12.
- (With CHAUDHURY, B. N., and BOSE, B. C.) Potency of injectable Digitalis preparations. *Curr. Sci.*, **15**, 22–23.
- (With CHAUDHURY, B. N.) Life of liquid preparations of adrenaline under ordinary storage conditions in India. *Indian med. Gaz.*, **81**, 76–79.
- Possibility of using pigeons in toxicity determinations of organic antimony compounds. *Q. J. Pharm. Pharmac. (London)*, **19**, No. 2, 89.
- Antimalarial drugs of the indigenous materia medica of India and China. *Nature, (London)*, August 3, **158**, 170.
- (With DUTTA, N. K., and CHAUDHURY, B. N.) Studies on some dextrorotatory hydrocupreidine derivatives, Part IV. Comparative spermicidal effects on cavy (guinea-pig) sperms. *Indian J. med. Res.*, **34**, 305.
- Assay of prolactin by crop-gland stimulation in Indian pigeons. *Indian J. Physiol.*, **1**, 27.
- Standards of protein hydrolysate. *Pharm. J. (London)*, September 7.
- 1947. (With IYENGAR, N. K., and HOSSAIN, T.) 'Unsaponifiable matter' in shark-liver oil. *Curr. Sci.*, **16**, 221–222.
- (With IYENGAR, N. K., and BISWAS, H. K.) Prolongation of insulin effect by combining it with casein hydrolysate. *Curr. Sci.*, **16**, 314–315.



- The value of the 'antidiuretic' method in the assay of post-pituitary extract. *Indian J. Physiol. all. Sci.*, **1**, 37-42.
- (With BISWAS, H., and IYENGER, N. K.) Assay of globin-insulin preparations. *Curr. Sci.*, **16**, 352-353.
- 1948. Biological assay of adrenaline. *J. Physiol. all. Sci.*, **2**, 7.
 - Determination of ergometrine and ergotamine in solution in tropical condition. *Indian Pharmacist*, **3**, 81.
- 1949. Chemotherapeutic action and toxicity of dimidium bromide. *Indian J. Physiol. all. Sci.*, **3**, Nos. 1 & 2.
 - Assay of riboflavin by microbiological method. *Indian Pharmacist*, **5**, 17.
- 1950. (With GHOSH, D. P.) Biological standardisation of liver extract by the pigeon method. *Indian J. med. Res.*, **38**, 269.
 - Observation on the keeping property of digoxin. *Indian J. Physiol. all. Sci.*, **4**, 78.
 - Assay of histamin content of tissue extracts by employing an antihistaminic drug. *Indian J. Physiol. all. Sci.*, **4**, 34.
 - Assay of sex hormones. *Indian J. Pharm.*, **13**, 121.
 - Assay of sex hormones (The regulation of enzyme activities by sex hormones). *Indian J. Pharm.*, **13**, 185.
 - Microbiological assay of vitamin B₁₂ and its role in evaluation of liver extracts. *Indian med. Gaz.*, **86**, 403.
 - (With CHOPRA, R. N., and CHOPRA, I. C.) *A Treatise on Tropical Therapeutics, I & II*. U. N. Dhur & Sons Ltd., Calcutta (2nd Edition).
 - (With DUTTA, S. C.) *Pharmacognosy of Indian Root and Rhizome Drugs*. Government of India Press.
- 1951. Analysis of patent and proprietary medicines, Part I. *Indian Pharmacist*, **5**, 175.
- 1952. (With ROY, P. K. *et al.*) A preliminary note on the pharmacological action of the total alkaloids isolated from *Cissampelos pariera* Linn. (False *Pariera brava*). *Indian J. med. Res.*, **40**, 95.
 - (With GHOSH, B. *et al.*) Studies on the chromatophoretropic hormone of the pituitary, Part I. *Indian J. med. Res.*, **40**, 243.
 - (With KARKUN, J. N., and GHOSH, B.) Studies on the chromatophoretropic hormone of the pituitary, Part II. *Indian J. med. Res.*, **40**, 251.
- 1953. (With SHUKLA, R. C., and KARKUN, J. N.) A method for isolation of dendritic cell from human and guinea-pig skin. *Curr. Sci.*, **22**, 211.
 - (With KARKUN, J. N., and KAR, A. B.) Evidence against corticotrophin-like action of melanophore hormone on the adrenal cortex of mice. *Acta Endocrinol.*, **13**, 188-191.
 - (With KARKUN, J. N.) Studies on chromatophoretropic hormone of the pituitary gland, Part III : the influence of melanophore hormone upon synthesis of melanin pigments in the skin of frogs (*Rana tigrima*). *Indian J. med. Res.*, **41**, 467-471.
- 1954. (With SHUKLA, R. C., and KARKUN, J. N.) Studies on the chromatophoretropic hormone of the pituitary, Part IV : site of melanogenesis and the dendritic cell system in guinea-pig skin. *Indian J. med. Res.*, **42**, 125.
 - (With KARKUN, J. N., and KAR, A. B.) Response of the pars intermedia of the cat's hypophysis to adrenocorticotropic hormone. *J. Endocrinol.* **10**, 124-126.
- 1955. Biological assay of preparations of *Rauwolfia serpentina* Benth. for their hypopoietic potency. *Bull. natn. Inst. Sci. India*, **4**, 67-70.
 - Pharmacological activity of resinous residue of *Rauwolfia serpentina* Benth. *Bull. natn. Inst. Sci. India*, **4**, 71-74.
 - (With CHAKRAVARTY, R. N., and DEY, U. N.) Preliminary observations on experimental cholesterol atherosclerosis in rabbits with special reference to reticulin structure of the arterial wall. *Indian J. med. Res.*, **43**, 79-87.
 - (With MUKHERJEE, S. K., and DEY, U. N.) Studies on experimental diabetes, Part I : Effect of administration of different sugars on blood glutathione and its relation to the incidence of experimental (alloxan) diabetes. *Indian J. med. Res.*, **43**, 149-156.



- (With SHUKLA, R. C.) Studies on the chromatophorotropic hormone of the pituitary, Part V : the melanocyte (dendritic cell) and its system in human skin. *Indian J. med. Res.*, **43**, 433–439.
- (With MUKHERJEE, S. K., and DEY, U. N.) Studies on experimental diabetes, Part II : effect of sodium β -glycerophosphate on the incidence and course of alloxan diabetes in rats. *Indian J. med. Res.*, **43**, 463–472.
- (With KOHLI, J. D.) Comparative activity of reserpine and total alkaloids of *Rauwolfia*. *Curr. Sci.*, **24**, 198–199.
- (With ROY, S. N., and SUR, R. N.) Bioassay of adrenal oxycorticoid hormone : evaluation of assay methods. *Indian J. med. Res.*, **43**, 383–389.
- 1956. (With AGARWALA, S. C., and SHARMA, R.) Urinary 17-ketosteroid excretion in leucoderma. *J. Endocrinol.* **13**, 185–188.
- (With CHAKRAVARTI, R. N., and DE, U. N.) Studies on experimental atherosclerosis, Part I : effect of feeding different fats on the pathogenesis of atherosclerosis in animals (rabbit). *Indian J. med. Res.*, **44**, 49–57.
- (With MUKHERJEE, S. K., and DE, U. N.) Studies on experimental diabetes, Part II : effect of oestrogen therapy and its combination with intravenous glucose and intravenous sodium glycerophosphate in experimental (alloxan) diabetes in rats. *Indian J. med. Res.*, **44**, 59–66.
- (With GUPTA, S. K., and GUPTA, B. M.) Experimental tuberculosis in C.D.R.I. mice, Part I. *J. scient. ind. Res.*, **15C**, 33–35.
- (With GUPTA, S. K., and GUPTA, B. M.) Experimental tuberculosis in C.D.R.I. mice, Part II : comparison of time-weight curve with time-mortality curve. *J. scient. ind. Res.*, **15C**, 36–38.
- (With GUPTA, S. K.) Combined therapeutic action of *p*-ethylamino-*p'*-aminodiphenyl sulphone (+S.N. 44) and dihydrostreptomycin (DHS) in experimental tuberculosis of guinea-pigs. *J. scient. ind. Res.*, **15C**, 53–56.
- Role of ultraviolet radiation in the treatment of leucoderma. *Indian J. Radiol.*, **1**, 1–4.
- (With GUPTA, S. K.) Combined therapeutic action of *p*-ethylamino-*p'*-aminophenyl sulphone (S.N. 44) 3*d* isoniazid (INH) in experimental tuberculosis of guinea-pigs. *J. scient. ind. Res.*, **15C**, 56–60.
- Role of trace elements in animal nutrition with reference to their haematopoietic activity. *Bull. natn. Inst. Sci. India*, **8**, 107–112.
- (With MUKHERJEE S. K., and DE, U. N.) Studies on experimental diabetes, Part IV : tissue phosphatase activity in protected and in alloxan diabetic rats. *Indian J. med. Res.*, **44**, 415–420.
- (With GUPTA, S. K., and CHAKRAVARTI, R. N.) The combined effects of *p*-ethylamino-*p'*-aminodiphenyl sulphone (S.N. 44) and dihydrostreptomycin sulphates (DHS) in experimental tuberculosis of guinea-pigs. *Indian J. med. Res.*, **44**, 421–426.
- (With ROY, S. N., and ROY, S. K.) Effect of testosterone propionate on the thyroid of young male rats. *Indian J. med. Res.*, **44**, 427–432.
- (With ZAIDI, S. H.) Histamine and the nature of eosinophil response. *Indian J. med. Res.*, **44**, 433–442.
- (With SRIVASTAVA, G. N. *et al.*) Hematological investigations in experimental cholesterol atherosclerosis. *J. scient. ind. Res.*, **15C**, 170–173.
- 1956. The effect of *p*-ethylamino-*p'*-aminodiphenyl sulphone (S.N. 44) and *p*-isobutylamino-*p'*-aminodiphenyl sulphone (S.N. 47) on dihydrostreptomycin sensitive and resistant experimental tuberculosis of guinea-pigs. *Arch. int. Pharmacodyn.*, **107**, 281–295.
- (With SHARMA, R., and CHAKRAVARTI, R. N.) Investigation into some of the coagulation factors in cholesterol atherosclerosis of rabbits. *Indian J. med. Res.*, **44**, 691–695.
- (With CHAKRAVARTI, R. N., and DE, U. N.) Studies on experimental atherosclerosis, Part III : effect of desiccated thyroid and oestrogen on the regression of experimental cholesterol atherosclerosis. *Indian J. med. Res.*, **44**, 683–689.



1957. (With MUKHERJEE, S. K., and DE, U. N.) Studies on experimental diabetes, Part V : effect of treatment with vitamin E and vitamin K and their combination with oestrogen on the course of alloxan diabetes in rats. *Indian J. med. Res.*, **45**, 23-31.
- (With CHAKRAVARTI, R. N., and DE, U. N.) Studies on experimental atherosclerosis, Part V : therapeutic effect of ascorbic acid and vitamin B₁₂ in cholesterol atherosclerosis. *Indian J. med. Res.*, **45**, 315-318.
- (With MUKHERJEE, S. K., and DE, U. N.) α -Cell activity and its relation to glycaemic level and insulin sensitivity in albino rats. *Indian J. med. Res.*, **45**, 337-344.
- (With BALKRISHNA, and CHAKRAVARTI, R. N.) Effect of lipid intake on the serum protein and lipoprotein pattern in experimental atherosclerosis. *Indian J. med. Res.*, **45**, 549-555.
- The combined therapeutic action of isobutyl sulphone (S.N. 47), dihydrostreptomycin sulphate (DHS) and isoniazid (INH) in experimental tuberculosis of guinea-pigs. *Indian J. Tuberc.* **5**, 14-19.
1958. (With ZAIDI, S. H.) Experimental peptic ulceration, Part I : the significance of mucous barrier. *Indian J. med. Res.*, **46**, 27-37.
- (With MUKHERJEE, S. K., and DE, U. N.) Effect of 'Nadisan' on the course of alloxan diabetes in rats and rabbits. *Indian J. med. Res.*, **46**, 57-62.
- (With MUKHERJEE, S. K., and DE, U. N.) Further studies with Nadisan, effect on blood cholesterol, blood glutathione and sugar tolerance in albino rats. *Indian J. med. Res.*, **46**, 185-191.
- The influence of ethylsulphone (S.N. 44) and isoniazid (INH) on chronic reinfection in experimental tuberculosis of guinea-pigs. *Archs. int. Pharmacodyn.*, **114**, 364-372.
- (With MUKHERJEE, S. K., and DE, U. N.) Studies on experimental diabetes, Part VI : effect of desiccated thyroid and corticotrophin and their combination with insulin on alloxan diabetes in albino rats. *Indian J. med. Res.*, **46**, 403-411.
- Morphology and physiology of four strains of yeast from human faeces and their *in vitro* sensitivity to nystatin. *J. Indian bot. Soc.*, **37**, 65-69.
- Effect of prolonged administration of high doses of testosterone propionate on the adrenal cortex of young male rats. *Archs. int. Pharmacodyn.*, **116**, 402-409.
- (With RAO, K. R. K., and AGARWALA, S. C.) Studies on the action of *Makaradhwaja*, Part I : effect on the succinic oxidase of rat liver homogenate. *J. scient. ind. Res.*, **17C**, 177-179.
1959. (With GUPTA, S. K., and MATHUR, I. S.) The therapeutic activity of some sulphides, quinazolones and pyrimidines in experimental tuberculosis of guinea-pigs. *J. scient. ind. Res.*, **18C**, 1-5.
- (With ROY, S. N., and KARKUN, J. N.) Effect of graded doses of testosterone propionate on the adrenal cortex of prepubertally castrated male mice. *Indian J. med. Res.*, **47**, 30-35.
- (With RAO, K. R. K.) Studies on the action of *Makaradhwaja*, Part II : influence in the oxidation of ascorbic acid. *J. scient. ind. Res.*, **18C**, 61-62.
- (With RAO, K. R. K.) Studies on the action of *Makaradhwaja*, Part III : influence on the oxidation of tyrosine by rat liver homogenate. *J. scient. ind. Res.*, **18C**, 82-84.
- (With SHUKLA, R. C., and ZAIDI, S. H.) A method of absolute count of melanocytes in the skin. *J. scient. ind. Res.*, **18C**, 153.
1960. (With RAO, K. R. K., and AGARWALA, S. C.) Studies on the action of *Makaradhwaja*, Part V : permeability through intestines. *J. scient. ind. Res.*, **19C**, 90-92.
- (With SAGAR, P., and AGARWALA, S. C.) Incorporation of carbon from labelled glucose and glycine in non-growing cells of *V. cholerae*. *J. scient. ind. Res.*, **19C**, 131-134.
- (With KAR, K., and CHATTERJEE, J.) Chemotherapeutic studies on INH and its derivatives in experimental tuberculosis. *J. scient. ind. Res.*, **19C**, 159-161.
- (With SHUKLA, R. C.) Fractional gastric analysis in vitiligo. *Indian J. med. Res.*, **48**, 714.
- (With MUKHERJEE, S. K., and DE, U. N.) Comparative study of the hypoglycaemic action of sulphonylureas and their nature of action. *J. scient. ind. Res.*, **19C**, 268-274.
- (With SRIVASTAVA, S. K., and RAY, G. K.) Assay of chloramphenicol. *J. scient. ind. Res.*, **19C**, 456.



- (With BOSE, P. C. *et al.*) Studies on the colourization of vanaspati. *Ann. Biochem. experiment. Med.*, **20**, 105–116.
- 1961. (With KAR, K., and CHATTERJEE, J.) Chemotherapeutic studies on INH derivatives and other compounds in experimental tuberculosis. *J. scient. ind. Res.*, **20C**, 85–88.
- Nutritional aspect of the use of spices and flavourings. *Federation Proc. (USA)*, X Suppl. **7**, 20. 1, Part III, 247–252.
- (With BISHT, B. S., and KUNDU, B. C.) Pharmacognostic study of the root of *Onosma echioides* Linn. *J. scient. ind. Res.*, **20C**, 218–222.
- (With RAO, K. R. K.) Studies on the action of *Makaradhwaja*, Part VI : influence of certain tissue constituents of rat liver. *J. scient. ind. Res.*, **20C**, 234–236.
- (With MISRA, A. L., and AGARWALA, S. C.) Mode of action of psoralen in pigment production, Part I : action of ultraviolet radiation on psoralen. *J. scient. ind. Res.*, **20C**, 339–341.
- 1962. The effect of crotoxylidene isonicotinic acid hydrazone (CIH) and merityloxyde hydrazone (MIH) in experimental tuberculosis. *Archs. int. Pharmacodyn.*, **125**, 179–186.
- 1963. (With CHEN, K. K.) *Pharmacology of Oriental Plants (Proc. Second int. Pharmacol. Conf., 7, (Book).*
- 1964. Indian drug industry—past, present and future. *J. Proc. Inst. Chem. (India)*, **36**, 31–39.
- 1965. Perspective in cancer chemotherapeutic research. *Indian J. Cancer*, **2**, No. 1.
- 1967. Human anticancer effect of *Podophyllum* derivatives (SPG & SPI) : a preliminary report. *British J. Cancer*, **21**, No. 1, 33.
- 1968. (With PAL, M., and CHAKRAVARTI, R.) Serum transaminase estimation in human cancer. *Sci. Cult.*, **34**, 89–90.
- (With BHATTACHARYA, K. I.) Effect of ionising radiation at the cellular level. *Sci. Cult.*, **34**, 97–99.
- 1972. Human brain and mind—laboratory scientist's view point. *Manab Mon*, **1**, 55–70.
- 1974. New outlook on mental illness. *Sci. Cult.*, **40**, 478–481.
- 1976. Early research studies on *Rauwolfia serpentina* at the School of Tropical Medicine, Calcutta. Indian National Science Academy Dhanwantari Prize, 1976 publication.

