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Communicable Diseases and Germ Theory in Colonial India – An Assessment*

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The transition from miasma to germ theory in the late nineteenth and early twentieth century has been widely documented in narratives about the discovery of microbes, the evidence of contamination, or the procedures for sterilizations. This was a radical change in the history of understanding disease, treating and preventing it, and that shift marked a new era in medicine. However, it is important to find out how did that shift happen, what was it actually like to live through the transition while dealing with the disease, contagion, infection, transmission, treatment or prevention? This project was aimed to investigate the establishment of germ theory as the central paradigm in tropical medicine and the impact of germ theory on the indigenous physicians in colonial India. The study consists of the five following chapters:

I. The Indo-Portuguese exchange of medical knowledge in colonial Goa.

II. Bacteriological Investigations by Europeans in British India.

III. The Debates on the Contagion as the origin of diseases.

IV. The Impact of Germ Theory of Disease on Indigenous Practitioners.

V. Bacteriology in the Service of Communicable diseases in Colonial India.

First chapter presents the Indo-Portuguese exchange of medical knowledge in colonial Goa. By 1510 the Portuguese established themselves on the west coast of India with their capital at Goa and became regular visitors to India as traders, soldiers, sailors, adventurers, missionaries, naturalists, physicians and surgeons. Though, all the trading companies sent out physicians and surgeons with their expeditions, they had little experience of tropical diseases. The early traders faced formidable medical problems; they were the first Europeans who had encountered tropical diseases for

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which they had no remedies. At first they had no option but to learn anything they could from the local medical practitioners. Moreover, the early trading posts were often short of medical men, who died as often as their patients and it usually took at least a year before a replacement could arrive from Portugal.

This shortage led to the employment of local Goan physicians where necessary. Portuguese were the first of the Europeans who came in contact with Indian culture and found that India was not only the land of contrasting civilization and religion, it was above all an awesome reservoir of plants and herbs that the local physicians used for medicinal purposes. So, they initiated documentation of indigenous knowledge of medicine for their own use. One of the earliest books in this direction was written by Tome Pires who was sent to Malacca in 1512 as the Controller of drugs. In his book *Suma Oriental* written between 1512 and 1515, he made intensive study of Indian drugs and their uses. The famous letter he wrote to the King of Portugal from Cochin dated 27 January 1516 describing the drugs with detailed location where these plants and herbs were grown and how they could be procured. Among the several observations on the Malabar social scene, he referred to how the patients were medically treated by the Indian medical men. However, the well known physician, Garcia da Orta's interaction with Indian medicine was of a decidedly and quantitatively different kind. Garcia da Orta reached Goa in 1534; as a physician his perspective eye went beyond mere observation; he contrasted the difference between the Indian and Western medical systems. His famous book titled *Coloquios dos simples e drogas da India* was published in Goa in 1563. He was concerned to have knowledge about the drugs of pharmacy as known in the subcontinent.

The Portuguese experienced terribly high mortality rates during monsoon in India. Portuguese explorer Gasper Correa described cholera death of 20,000 men in the army of the Sovereign of Calicut as early as 1503 in the *Lendas da Indie* published in 1543. Therefore, Portuguese efforts to establish colonial enclaves in India included, almost from their inception, the founding of health care institutions. Moreover, Portuguese colonialism was depended on an active Catholic missionary effort, and most ecclesiastical orders considered caring for the sick – whether European colonists or newly converted indigenous people – to be an integral part of their activities. So,

Portuguese India had a tradition of supporting medical facilities that blended western and eastern influences. By the last quarter of the 16th century, the city of Goa became highly populated and an unhealthy place. The city suffered from constant epidemics that reduced its population. Several Viceroys and large number of soldiers died of cholera, scurvy, enteric fever, venereal diseases, dysentery, typhoid and other infectious diseases. Because of the scarcity of Portuguese medicos, Indian physicians, the *vaidyas* enjoyed the patronage of their new rulers in part because the Goan doctors better understood the proper treatment of tropical diseases. Several *vaidyas* held important posts in Goa through 16th and 17th centuries serving as personal physicians to at least one Governor (in 1574), one Viceroy (in 1644) and other members of the aristocracy.

In the late 19th century medical officers practicing in the colonies lacked specific background to deal with the communicable diseases. Tropical fevers were not well differentiated; cholera and malaria, the most feared diseases, were identified as the main cause of European mortality in the tropics. When tropical medicine was established as an autonomous specialty in Portugal in 1902, with the foundation of the School of Tropical Medicine and the Colonial Hospital in Lisbon, the Medical-Surgical School of Nova Goa had already existed for sixty years. During 20thcentury Portuguese India, particularly Goa, was an unhealthy place with recurrent epidemics of cholera, plague and smallpox and where population was most affected by endemic diseases such as malaria, typhoid and gastro-intestinal diseases. Sanitary measures since the early days of Portuguese rule were never strictly implemented due to the lack of financial conditions and communitarian participation, and a prevailing weak administration. Moreover, there was almost no impact of the discovery of the 'germ theory of diseases' among the doctors in Goa. However, in the beginning of the 20th century, successive epidemics of malaria, typhoid, cholera, smallpox and dysentery took the Portuguese government to favour hygiene and public health. As a consequence, governmental agencies started to implement some generalist measures of sanitary policy aiming the improvement of health conditions and some diseases control. The Bacteriological Laboratory (Laboratorio Bacteriologico) was established in 1907 which was attached to the School.

Second chapter elaborates the bacteriological investigations by European bacteriologists in combating communicable diseases in colonial

India. One of the most important fields of application and development for germ theory was the understanding of tropical diseases that afflicted those living in European colonies or other tropical areas. The amount of illnesses experienced in the tropics provided a vast field for the exercise of discovery, naming, microscopic observation, and testing and theory production. By the early twentieth century, under the influence of germ theory, tropical medicine was a flourishing field for medical men. Robert Koch published a widely read essay on contagion where he postulated that living agents caused diseases. He began his microscopic studies of bacteria and developed one of the most important techniques to produce a transparent back ground for examining microorganisms using gelatin on a glass slide. Hence, germ theory and bacteriology with all their implications became the focus for future medical science and public health. From mid-nineteenth to early twentieth century many European bacteriologists came to India as medical officers in the Indian Medical Service or as a member of different Commissions set up by the Government of India to review epidemics of cholera, plague and other infectious diseases.

Henry Vandyke Carter, British anatomist and physiologist came to India in 1858 and joined the Bombay Medical Service as Assistant Surgeon. He took interest in leprosy during his 30-year tenure in India. He was the most energetic and influential teacher of the principles and practice of the emerging science of bacteriology, not only for the students but for the less informed Grant Medical College staff members as well. Besides he was the Chief Physician at the Jamsetjee Jeejeebhoy and Goculdas Tejpal Hospital in Bombay and Civil Surgeon at Satara. His request to conduct leprosy surveys led him to express his "increased conviction that the subject of leprosy as the malady exists in India, is one both worthy of and highly becoming the attention of the rulers of this country; and it is solely under the impress of such conviction that I venture again to invite the necessary aid in carrying on enquiry here". There had been three severe epidemics of Asiatic cholera since 1831 in Europe. This disease was comparatively new to Europe. Nothing was then definitely known of the manner of communication of cholera, although Dr. John Snow had published his paper *On the Mode of Communication of Cholera* in 1849, with an account of his theory of the propagation of this disease by means of the intestinal discharges and the part played by the sewerage of London in its dissemination. The

whole subject was very complicated and the English Government sent two Army Medical officers, Timothy Richards Lewis and David Douglas Cunningham to India for extensive investigations on cholera. Lewis was a British Bacteriologist and Cunningham, a British Army Surgeon and Physiologist. They played a definite role in the development of the science of bacteriology in India. Both of them were based in Calcutta from 1869 and were attached for special duty to the Sanitary Commission of the Government of India. Ernest Hanbury Hankin was a British bacteriologist, aeronautical theorist and naturalist. He worked mainly in India and studied malaria, cholera, plague and other infectious diseases. In 1892 he accepted the position of Chemical Examiner and Bacteriologist to the Government of the United Provinces and of the Central Provinces in India. The brilliant results of his investigations of the outbreaks of cholera at Cawnpore (Kanpur) and Lucknow, and of his study of the well waters of India as local sources of cholera, and the means of prevention of waterborne cholera, had given him a wide reputation. In his laboratory at Agra he noticed that the unboiled water of the Ganga and Jamuna could kill the cholera germ in less than three hours. In 1896, Hankin published through the Pasteur Institute a paper entitled, "L'action bactericide des eaux de la Jumna et du Gangesur le vibrion du cholera", in which he described the antibacterial activity of an then unknown source in the Ganges and Jaumna rivers. He suggested that it was responsible for limiting the spread of cholera in India. While Hankin did not study this phenomenon further, his work was nonetheless recognized a generation later as being among the first observations of bacteriophage activity when Félix Hubert d'Herelle, Canadian bacteriologist witnessed it at the Pasteur Institute. He is chiefly known for his work on bacteriophage. He came to India in 1928 when during his short stay he worked extensively on cholera and dysentery bacteriophages. Heinrich Herrman Robert Koch, German Physician and Bacteriologist arrived in Calcutta on 11 Dec. 1883 as head of the German Cholera Commission/Expedition. He was accompanied by two bacteriologists, Bernhard Fischer and George Gaffky. While working with autopsy samples from a 22 year old patient obtained from the Sealdah Hospital, Koch confidently proclaimed the isolation of 'Comma-shaped bacillus' as the causative agent of cholera. However, it was not until 1894 that the medical profession generally accepted this theory. Initially Cunningham and others denied that there was any relationship between the number of comma bacilli

present in the stools and the severity of the disease. Bacteriological examinations of a large number of stools in the acute evacuation stage of cholera cases in Calcutta, however, convinced Leonard Rogers that as a general rule such a relationship did hold good to a considerable extent. Moreover, the toxicity of different strains of cholera comma bacilli was found to differ considerably. Waldemar Mordecai Haffkine, Russian scientist, a student of the great Louis Pasteur, arrived in India in 1893, and was fighting a lone battle against cholera in Calcutta by inoculating the population with the cholera vaccine developed by him in Paris. This work evoked so much interest that in 1896, when an epidemic of plague broke out in Bombay and Poona, the then Governor of Bombay invited Dr. Haffkine to Bombay and provided some laboratory space to him on the campus of the Jamsetjee Jejeebhoy Hospitals to work on plague vaccine. Dr. Haffkine accepted the challenge and successfully developed the plague vaccine and on January 10, 1897. In 1899 he became the Director in Chief of the "Plague Research Laboratory" in Bombay. Finally in 1925, due to the efforts of Lt. Col. F.P. Mackie, the Institute was aptly named as "Haffkine Institute". The institute under the guidance of Dr. Haffkine developed the technology for the production of plague and cholera vaccines. George Lamb, British physician came to India in 1894 as a member of the Indian Medical Service. He carried out extensive bacteriological investigations on Malta fever in India and on transmission of plague by fleas. Major William Boog Leishmann, British Pathologist, joined the Royal Army Medical Corp in 1887, and rose to be Director-General of Army Medical Services. It was during his service in India that he began to take a close interest in bacteriology especially in relation to dysentery with which he found himself in perpetual contact. In 1903, he reported that in 1901 he had found small bodies of characteristic structure, which he believed to be a form of parasite, in a spleen smear taken at autopsy from a British soldier suffering from prolonged fever in Calcutta. The fever was known as 'dum-dum' fever. Shortly afterwards *Major C.Donovan*, IMS recorded that a month before Leishman's paper appeared, he had found similar bodies in a spleen puncture from a patient in Madras General Hospital. Neither Leishman nor Donovan, however, suggested any relationship between the bodies they described and Kala-azar. Leishman thought that they might be degenerated trypanosomes. Donovan's smears, showing parasites of similar morphology, were made from ante-mortem spleen

punctures, thus disproving the suggestion of degeneration. He too considered they were related in some way to trypanosomes, so that both Leishman and Donovan came very near to the truth.Stewart Ranken Douglas, British bacteriologist, joined Indian Medical Service in 1898. He studied the serological grouping of *vibrios*. Later became Director of Bacteriological Department of the National Institute of Medical Research.Sydney Domville Rowland, British bacteriologist came to India in 1905 as a member of the Advisory Committee for Plague Investigation and worked in the laboratory at Parel, Bombay. He worked on the relation between fleas and plague and also on the preparation of curative sera for plague. During his formative years Leonard Rogers developed an absorbing interest in medical research, and being advised by two elder brothers who were serving in India that unrivalled opportunities for original work were to be found there, he entered and successfully passed the competitive examination for the Indian Medical Service in 1893. He never regretted his decision to adopt this career. Despite limited facilities at his disposal, he applied himself to the study of the febrile illnesses which were common among the troops under his medical charge, and in 1894, and again in 1895, travelled to Calcutta to read papers on the observations he had made. In 1895, he was selected to investigate an epidemic of kala-azar which was at that time devastating Assam. Kala-azar was first reported from the west of Assam in 1872, and slowly spread eastwards along the southern bank of the Brahmaputra. The disease was characterized by prolonged fever, severe anaemia and wasting, a grossly enlarged spleen, and a dark coloration of the skin. When Rogers began his investigations, the theory that kala-azar was an atypical form of malaria was firmly held by some and was also firmly rejected by others. An alternative suggestion was that it was related in some way to a heavy infection with a parasitic worm, *Ancylostomaduodenale*, but Rogers found it difficult to accept this concept. In the search for a causative organism he examined large numbers of blood smears and found that the majority contained malaria parasites and also showed a very low leucocytes count. He administered standard anti-malaria treatment to a series of cases of fever; some were cured, others went on to develop typical kala-azar. Somewhat reluctantly, he came to the conclusion that kala-azar was, in fact, an unusual and resistant type of malarial infection. In his report, however he added, ‘it is open, however, for anyone to say that there is something in the disease additional to malaria, which I have not

discovered, but which accounts for the spread of the infection'. However, at that time he was firmly supported by Ronald Ross, who proved his point by means of a mathematical equation. He completed this mission but without solving the problem of aetiology in 1897. After the return to his unit he contracted dysentery and was granted six months' sick leave out of India. Before his return to India he passed M.D. and M.R.C.P. examinations and was sent on temporary duty as head of the All India Veterinary Bacteriology Laboratory at Muktesar in the Kumaon Hills. Early in his Indian service Rogers made acquaintance with cholera in an outbreak in a British regiment in Lucknow, which caused ninety deaths in three weeks. However, he had no real opportunity for studying this disease until he came to Calcutta, where he was fortunate in having the co-operation of his friend Major Megaw, then resident physician at the medical College Hospital and in charge of the cholera wards. Together they were able to exploit the many ideas born in Rogers's fertile brain. He first turned his attention to the blood picture and in a series of examinations in advanced cases found that the average number of red blood corpuscles was increased from five million to as much as eight million per cubic millimeter, with corresponding increase in the specific gravity of the blood. His first systematic work with Megaw on the treatment of cholera began 1905, when they tried the effect of intravenous injections of normal saline, a form of therapy which had been explored at an earlier date, but had been found of no real value. Rogers believed that these previous failures might have been due to the injection of insufficient quantities of saline, and gave three or four pints, repeated when necessary. However, he could not reduce the mortality rate drastically. He undertook different experimental measures to reduce the mortality rate from cholera and the net result of all these measures was a reduction to about one-quarter of the previous figure. Where cholera patients could be efficiently treated and nursed in a well-equipped hospital, and particularly if treatment was started at an early stage, this long dreaded disease was robbed of most of its former terror.

Third chapter deals with the debates on contagious nature of communicable diseases in colonial India. In the mid-1800s, there was debate about the origin or 'exciting cause' of various diseases. While it was generally accepted that some diseases were contagious – smallpox, syphilis and leprosy, for example – there was much discussion surrounding the transmissibility of

other diseases, such as cholera, typhus, typhoid fever, plague, malaria and tuberculosis. In particular there was much debate about cholera and plague – not just its origin but also about its contagious nature. The 'filth' theory of disease and observation on cholera, plague, yellow fever and cattle distemper gave anticontagion high favour among laymen and physicians of the early 19th century. From the early 19th century, we find anticontagionism in the activities and ideas of Charles Maclean in Britain. He joined the East India Company as a surgeon in 1788. In 1792, he came to Calcutta to practice medicine and took charge of a hospital where sailors and poor white people were treated. The working environment at Calcutta influenced his medical practice as he devoted significant time and energy on the issue of contagion. Maclean concluded that disease did not invariably depend on contagion and his investigations and observations in the East and West Indies prompted the conviction that plague was an epidemic but not a contagious disease. He argued that consequences would necessarily follow from contagion, which did not actually take place. He observed that epidemic diseases had stated seasons of recurrence, these seasons were the months most remarkable for alteration in the atmosphere. Repeatedly he put importance on atmosphere, climate and health condition of the inhabitants of a place. He declared that nowhere had the true cause of pestilential diseases been set forth. As a result, men applied 'absurd and injurious' means which increases mortality and aggravated disease by forcing exposure to pestilential atmosphere and removing the means of subsistence. Maclean did not support quarantine laws that according to him sickened the healthy and killed the sick. However, the contagionists themselves admitted that infection extended only a few paces; therefore, if the sick kept five paces from the whole, segregation was unnecessary. Maclean reported that in India, although tremendous mortality had swept certain areas, the size fell far short of what it might have been, had the Hindus believed this dogma. Contagious diseases, in his opinion were never epidemic in nature and vice versa. Maclean died in late 1824 or early 1825, but his theories about the role of the atmosphere in the production of epidemic diseases remained till Pasteur and Koch experimentally validated the germ theory of disease in 1860s. During the early decades of the nineteenth century, 'germ theory of disease' was in its initial phase; European as well as indigenous Indian physicians did follow anticontagion theory of Maclean. However, Indian indigenous practitioners

believed that ola-ota (cholera), plague, enteric fever were not contagious whereas small-pox, measles and leprosy were contagious or infectious in nature.

The idea that bacteria acted as contagion was unfamiliar to lay people even in the 1870s. The indigenous practitioners were not convinced of the bacterial origin and contagious theory of diseases. Despite the increasing influence of contagion theories of the spread of cholera in medical circles in Europe, the British medical authorities in India continued to reject it, seeing instead "'a fixed relation between cholera and special climatic conditions". By identifying specific sources of pestilence, Southwood Smith was able to elucidate a far more comprehensible etiology of disease than was possible with climatic factors, whose operation he regarded as largely unknowable. In 1830, Southwood Smith published *A Treatise on Fever*, which was perhaps his most important medical text. "The immediate or exciting cause of fever", he argued, "is a poison formed by the corruption or the decomposition of organic matter. Vegetable and animal matter, during the process of putrefaction give off a principle, or give origin to a new compound, which, when applied to the human body, produces the phenomena constituting fever". In a complete inversion of Maclean's theories, filth had now become the only necessary cause, the sine qua non, of fever. Thus, Southwood Smith argued, in a potent expression of the "sanitary idea". It was Southwood Smith who was primarily responsible for formulating the "sanitary idea".

Chapter four explains the impact of germ theory on indigenous medical practitioners in colonial India. In the 1860s, the decades old hypothesis that living entities (germs) were agents of infectious diseases brought about a paradigm shift in theorization about contagious/infectious diseases. It was proved that germs were varieties of microscopic life forms, each specific for a particular disease. The science of bacteriology emerged for etiology, treatment and control of epidemic diseases. But, while germ theory may have revolutionized the understanding in the causes of disease, it did not necessarily revolutionized treatment. Some of the doctors of the Indian Medical Service were not convinced of the bacterial origin of epidemic diseases that caused havoc among the British army and the European officers stationed in different cities and provinces in India. Ronald Ross remarked,

"The great bacteriological discoveries of Pasteur and Koch were scarcely recognized or were ridiculed". Before the experimental validation of the germ theory, most medical men believed that disease causing germ arose from spontaneous generation. Another theory was based on the idea that diseases such as plague and cholera were caused by foul-smelling miasma, air containing particles of rotting matters. Moreover, traditional medicine used to play a very important role in colonial India. The indigenous system of medicine that was practiced in the 19th century India was Ayurveda, Siddha, Unani or Homeopathy. Folk medicine used to provide some medical care to the rural Indians as well. The Ayurvedic movement successfully established a parallel set of institutions devoted to indigenous as well as western learning. From late 19th century a series of vernacular journals emerged in Bengal and other parts of the country that dealt with illness, health and healing. Many of these journals were edited and run by native doctors. Going through the articles published in these medical periodicals one observed that the native doctors on one hand supporting the new discoveries and knowledge about communicable diseases, on the other hand opposing new theories and methods of treatment. In an article on 'Bacteriology' in *Vishaka Darpan* in 1897 the author remarked, "Modern day physicians have opened up a new area of medicine to understand the etiology of disease…..When microbes enter the human body leaving their place of origin then infection occurs."This author supported the germ theory of disease but he had no knowledge about the infectiousness of malaria through mosquitoes. In another article on 'germ theory' the author remarked, "Distinguished medical practitioners have started expressing their confusion about the germ theory of disease. Dr. Lorry has opined that no microbe is found in the blood of malaria patient. If this is true, then what is the basis of this theory?" There were a number of theories about the cause of cholera and that confused the indigenous practitioners. Though bacteriology opened a new era in medical science and with the help of microscope different bacilli were easily identified helping in the understanding of the etiology of disease, a microscope was not easily available to medical practitioners as is evident from the Government Report on leprosy of 1876-78. Early 19th century witnessed the peaceful co-existence of Indian and Western systems of medicine. During this period the number of ayurvedic practitioners was large and they constituted an important body in the medical community.

Notwithstanding the introduction of Western medicine they held their own and commanded considerable respect from their countrymen. When the germ theory of disease was established in late 19th century Indian indigenous practitioners could not accept the new knowledge as this theory did not provide any solution to the treatment of cholera, the disease that had raised the mortality rate among the army and caused panic among the common people. It seems the native doctors were confused about the new knowledge of germ theory of disease as the physician was more concerned in the treatment and cure of the disease that the new theory of bacteriology did not provide. There was cooperation between the various groups of indigenous medical practitioners. It can be concluded that germ theory of disease or scientific medicine was not easily transplanted from the colonial center to the Indian periphery; rather, scientific medicine was negotiated and accommodated.

Chapter five identifies the role of bacteriology in the understanding of communicable diseases in colonial India. The principal diseases that devastated the population of India from the beginning of the nineteenth century were leprosy, cholera, plague, malaria, kala-azar, typhoid fever, dysentery and influenza. The problems of filariasis and tuberculosis were not any less important.

The discovery of cholera comma bacillus by Robert Koch in India was a landmark in the history of bacteriology. In 1890, he published the "Four Postulates" (four rules) on which modern bacteriological studies have been built. At a later date (1885-1895) the careful and prolonged bacteriological researches at Calcutta conclusively proved that the comma bacilli of cholera differed widely from one another in morphology and cultural characters and were very far from being a single clearly defined form as originally described by Koch. However, the discovery of 'bacteriophage' advanced our knowledge of the disease. The constitution of the ultramicroscopic particles of bacteriophage that develops along with the bacteria of certain diseases like dysentery and cholera and subsequently brings about its complete destruction was one of the most marvelous advances in Tropical Medicine and completely revolutionized the ideas about the treatment of cholera and allied diseases. The researches in this direction were carried out in the Pasteur Institute in Rangoon and the Pasteur Institute

in Shilong. Morrison showed remarkably destructive action of the bacteriophage on cultures of different strains of cholera bacilli. Between 1934 and 1940 extended inquiry into the epidemiology of cholera was carried out in India under the auspices of the Indian Research Fund Association. The review stated, "The problem of primary importance in the epidemiology of cholera is the existence of endemic areas in which cholera is permanently present. Cholera is eminently a controllable disease". The most valuable contributions to our knowledge of plague were made by the Indian Plague Commission (1898-1900). Bacteriological studies revealed that the plague bacillus is extremely virulent. The probable cause of the plague was discovered during an epidemic in HongKong in 1894 where research teams isolated the bacillus *Pasteurellapestis* (now called *Yersinia pestis*) that was found to be responsible for plague. The disease was reported as being prevalent in Bombay at that time. In 1874, a Norwegian physician Gerhard Hansen discovered that leprosy was caused by a bacillus, *Mycobacterium leprae* and could be transmitted by contagion. This bacillus, however, was found not to conform to Koch's postulates because leprosy bacillus could not be cultivated artificially and the disease not could be reproduced in animals. The only basis of the belief that the bacillus *leprae* could be the cause of leprosy was the fact that this bacillus was practically always found in the lesions of leprosy patients. *Leprae* bacillus resembles *tubercle* bacillus and it was not easy to distinguish them under the microscope. The leprosy research gained international recognition contributing to the understanding of the disease. Henry Vandyke Carter (1831-1897), a British anatomist and bacteriologist joined the Bombay Medical Service in 1858 and was the most energetic and influential teacher of the principles and practices of emerging science of bacteriology, not only for the students but for the less informed Grant Medical College staffs. Carter contributed to tropical pathology that included important studies on leprosy confirming the role of *Mycobacterium leprae*. Many workers all over India devoted their time to the study of the problems connected with the disease. During 1914-38, there had been many valuable contributions to our knowledge of leprosy. Many bacteriologists in India attempted to grow Hansen's bacillus by in vitro culture in various special media including tissue culture medium. A large number of cases were studied and it was considered that in probability the disease was transmitted through contact with infectious cases. Various useful laboratory

techniques for the detection of *leprae* bacilli in nasal scrapings, gland-puncture material, scrapings of skin and pieces of nerves from anesthetic cases were developed. Extensive epidemiological studies were conducted on leprosy in India. An important contribution by bacteriologists in India was the demonstration of the fact that leprosy in majority of instances was a curable disease. By successfully treating several thousand of cases physicians showed that early cases of leprosy could be cured and infective cases could be rendered non-infective through appropriate treatment. For several years after the disease was first described in 1882, medical officers were of the opinion that Kala-azar was of malarial origin and that it was not contagious. The microscopic pathology of Kala-azar was already well-known,however from the microscopic examination of the blood and organs of the body and more especially from a bacteriological examination, the nature of Kala-azarwas determined. By 1904, it was established that *Leishmaniadonovani* bodies were the causative agents of Kala-azar. Soon after the discovery of the parasite of Kala-azar, *Leishmaniadonovani,* Rogers succeeded in cultivating the Leishman-Donovan bodies and demonstrated the flagellate forms of the parasite in culture. Raghabendra Row succeeded in inducing experimental leishmaniasis in the monkey and the mouse by the injection of the parasites in culture. Later the morphology and development of the parasites had been worked out exhaustively by researchers in India. Prior to 1913 there was practically no specific treatment for Kala-azar. It was a highly fatal disease and 95 percent of the persons attacked died of it within a period of two to three years. During 1918-1938 much attention had been directed in India towards the improvement of the diagnostic methods in Kala-azar. The researches were conducted at the Calcutta School of Tropical Medicine and the Kala-azar Commission in Assam conclusively proved that the sand fly, *P. argentipes* was the cause of transmission of Kala-azar in India. The whole cycle of development of Leishman-Donovan bodies in the sand fly, *P. argentipes* was demonstrated by the workers of the Commission. U.N. Brahmachari synthesized a series of pentavalent organic antimonies (antimonials), which was named ‘urea stibamine’, possessing remarkable therapeutic properties. The therapeutic value of the drug was tested with sera of Kala-azar patients. In Assam, the Government initiated mass treatment with urea stibamine and as a result the prevailing epidemic of Kala-azar was controlled. The discoveries by Laveran and Ronald Ross in the late 19th

century confirmed that mosquito bites by anopheles mosquitoes carrying protozoan parasite called 'plasmodia' were the cause of malaria. This opened up new avenues of laboratory research in the problems of malaria prevention in India.

Conclusions

The project explores the impact of germ theory of disease in colonial India especially from 1840 to 1920 when this theory was experimentally validated by Pasteur and Koch. A number of European medical men who were trained in bacteriological science joined the IMS and did research on tropical disease. Painstaking researches by Europeans proved that fevers known medically as 'pyrexia', is not itself a disease but only a symptom of an underlying disorder caused by infection. Some of the classical examples of such studies by these early bacteriologists are those of Vandyke Carter on leprosy, mycetoma and spirulla, Cunningham and Macnamara on cholera, Hankin on the nature of immunity and alexins, D'Herelle on cholera and dysentery bacteriophages, Lewis on filariasis and trypnosomiasis, Leishman on leishmaniasis, phagocytosis and anti-typhoid inoculation and Giles on Kala-azar. It was the work of Haffkine in India which showed that India, of all the countries of the world, most needed the development of this branch of medicine so as to protect its millions from dying of epidemic diseases. Hankin was the first to lay the foundation of bacteriological laboratory at Agra in 1892. Ronald Ross was awarded Nobel Prize in 1902 for the discovery of the mosquito transmission of malaria. The European bacteriologists in India were not restrained by conventions, traditional medical authority and legal injunction; they could perform postmortem, dissections, clinical trials and therapeutic experiments in a way that they could not at home. Therefore, it can be said that India as a colony helped the British to work on natural history of disease as well as on morbid anatomy – both of which contributed a good deal to the development of tropical medicine. India was an important site of innovation and had a profound effect on the development of medicine in general and communicable disease in particular, in Europe.

The contagious nature of disease was known to both traditional and western medical men. Since there was no reasonable proof of how did disease transmit from diseased to a healthy individual – the 'miasma theory' of disease continued. Traditional Indian medical practitioners considered

small-pox, measles, and leprosy as contagious in nature. However, cholera, plague, malaria were not considered as contagious. The idea of contagion was taking shape in man's mind but at first he was confused in the mist of miasma. Some European medical men argued that if cholera was a contagious disease then how did the attendants of cholera patients in hospitals did not fall prey to the disease. There was disbelief about how a microscopic animal could create a disease like cholera. European medical men in India believed that advances in medicine due to the new science of pathological anatomy had created a gulf between Hippocratic/allopathic medicine and traditional Indian medicine. During the first epidemic outbreak of cholera in 1817, the colonial government and the medical authorities did not pay attention to the incidence and the disease spread all over India. The colonial authorities considered the atmosphere, climate and seasons of India as the causative agent of cholera. When cholera took the pandemic form from 1823, the medical men both in Europe and India became concerned about the contagious nature of cholera. The practitioners of traditional Indian medicine were confused with the new theories on the communicable diseases. Since they were emotional about their own medicine, it was difficult for them to accept the germ theory of disease at the beginning. Even doctors educated from the Calcutta Medical College like Manehdra Lal Sircar, Dwarka Nath Roy did not accept germ theory of disease as it could not provide a treatment and cure for epidemics of cholera and plague. However, in the problematic interplay of the indigenous and allopathic medicine from the beginning of the nineteenth century, we find eminent kaviraj (indigenous practitioner) of Bengal trying to uphold the prestige of Indian medicine. The traditional practitioners in India had their own way of dealing with epidemic disease in which diet used to play an important role in the prevention and treatment of disease. People were advised by the vaidyas to follow strict dietary regimens and personal cleanliness in different seasons so as not to fall prey to epidemic diseases like plague, cholera, enteric fever, etc. Moreover, it was a regular practice that during an epidemic the people fled from their homes and stayed in some distant places for a month at least and then returned to their village. During 1890s some indigenous practitioners understood that if the germs for each disease could be identified, it would be easier for the physician to treat and cure the patient. They supported the discovery of 'germ theory of disease'. However, the traditional practitioners

were trying to understand the importance of the new theory in the treatment of infectious diseases. They argued that disease was diagnosed on the basis of symptoms and the kaviraj treated the symptoms and cured the patient. While the germ theory of disease revolutionized the etiology of disease it could not provide any remedies for the patients. However, some indigenous practitioners understood the importance of modern germ theory of disease and advised the traditional practitioners or kaviraj to gain knowledge from the western medicine and implement the knowledge while treating a patient.

The final observation by the investigator is that during the late 19th and early 20th centuries, a hybrid medical culture combining both the traditional and western systems of medicine was practiced in India.

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