Sahara Ahmed
Suvobrata Sarkar *Editors*

Decolonizing Science and Modernity in South Asia

Questioning Concepts, Constructing Histories

Springer

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"*Decolonizing Science and Modernity in South Asia* elucidates issues vital to the history, present, and future of South Asia. The volume celebrates the astounding diversity of the continent's historical and contemporary engagement with the sciences, technology, and indigenous and imported healing traditions and practices. Especially welcome are the perspectives on medical pluralism inclusive of Perso-Arabic medicine, the growth, and nature of the Indian scientific community, vernacular science, and the accommodations and adaptations of knowledge practices and technologies required under the challenges of colonialism and independence".

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"Sahara Ahmed and Suvobrata Sarkar have put together an innovative and exciting collection of essays, that challenge many received views on the place of science in the development of modern India. The authors provide new perspectives and insights on familiar topics and explore new topics, mining novel sources with new interdisciplinary approaches. The collection will be essential reading for understanding the place of science in modern India".

—Michael Worboys, *Centre for the History of Science, Technology and Medicine, University of Manchester*

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Presented to our teachers
Professor Deepak Kumar
and
Professor Arun Bandopadhyay

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The volume explores the production of new knowledge and changing understandings of science in South Asian terminologies and focusses on the individuals and institutions that translated 'Western' modernity and science in South Asia. Chronologically, our first debt is to our contributors who agreed to be a part of this volume. We would like to thank them all. Could it be possible to decentre the West and recentre South Asian modes of thinking? They induce us to explore new methodologies, research questions, and sources to conceptualize the theme. We also put on record our sincere thanks to the editor of the *Economic and Political Weekly* for the necessary permission to reproduce the article by Prof. Shiv Visvanathan.

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Kolkata, India

Sahara Ahmed
Suvobrata Sarkar

Introduction

The hydraulic machine for supplying London with water is a stupendous work. By its means, an ample supply of water is raised from the river Thames, so as constantly to keep full of lofty reservoir, whence, by means of conduits and leaden pipes, it is conveyed all over the town, and even to the upper rooms of houses four stories high, to the great comfort and ease of the inhabitants...the English carry their passion for machines to such an extent, that machinery is introduced into their kitchens...

Mirza Abu Taleb, the erudite Lucknow-born scholar, thus wrote in his travelogue (1810)

This foreign language has been a real hindrance to rapid spread of literacy in the country. In an educational institution, it encourages cram and effectively damps all creative efforts. The first fifteen years of independence have not brought about any spectacular increase in literacy. If there be no rapid spread of modern ideas among our people, our attempts at industrial and technical progress would have to lean heavily on foreign support, and we would be always counted among the underdeveloped nations of the world.

Satyendranath Bose, the renowned scientist, while delivering his convocation address at the University of Calcutta (1962)

The present volume endeavours to analyse the appropriation of modern knowledge in South Asia. The contributors focus on how scientific, technical, and medical knowledge and practices were reshaped within a specific socio-historical context. Mirza Abu Taleb Khan (1752–1806) was one of the most prolific writers in the late 18th and early 19th centuries. His travelogue, *Masir-i Talibi fi Bilad-i Afrang*, based on his travels from February 1799 to August 1803, comprehensively covers the state of England before and after the Industrial Revolution. However, he was not alone—Munshi Itesamuddin (1730–1800) talked of the advanced navigational science of England and admired Oxford's octagonal observatory and the exhibits in the medical institute. He produced his *Shigurf Nama-i Velayet* (1765), much before Abu Taleb,

based on his year-and-a-half stay in Britain.[1] The Muslim intelligentsia which was, at that stage, struggling for its identity against all odds, recognized the achievements of modern science and technology. During the first hundred years of British rule, scientific activities and continued display of new and improved technology became a regular feature under colonial relations. Indians were not averse to the adoption of new scientific theories and modern technologies. On several occasions, they had exhibited considerable appreciation for Western knowledge—Botanical Garden at Sibpur, for example, created considerable interest among the Calcutta elites, and many of whom, including the orthodox-minded Raja Radhakanta Deb (1784–1867), used to visit the garden to listen to the discussions by the then superintendent Nathaniel Wallich.[2]

Pre-colonial India was no tabula rasa. It had a vigorous tradition in different branches of science and medicine. However, gradual colonization brought forth a huge cultural collision. This encounter was initially disturbing, argues Deepak Kumar. It also had within the question of attitude towards each other, an uneasy acceptance, a quest for identity and, finally, the seeds of decolonization.[3] Under colonial milieu, the pattern and scope of relationship between Indian and the Western medical system took an altogether different shape. The *daktari* medicine, Bengali vernacular forms of Western medicine, have largely remained absent from the accounts of nineteenth-century South Asian medical history. Little detailed account, according to Projit Mukharji, has been available of the varied Bengalis who came to practice Western medicine at various strata of colonial establishment, ranging from the lowly hospital assistants to the grand Edinburgh-or London-trained MDs.[4] Radhagobindo Kar (1852–1918), Licentiate of the Royal College of Physicians (LRCP) from Edinburgh, was a teacher at the medical school in Calcutta and published extensively on various aspects of health and medicine in Bengali.[5] Unfortunately, he rarely appears, until recently, in the academic discussion on South Asian medical history. Considering the rapid progress of the history of medicine as it relates to India under British colonial rule, now at least he deserves a well-researched biography!

In the context of early nineteenth century, argued Tapan Raychaudhuri, a major intellectual exercise on the part of South Asians was to determine what they could

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[1] Mushirul Hasan (ed.), 'Westward Bound: Travels of Mirza Abu Taleb', *Exploring the West: Three Travel Narratives*, New Delhi: Oxford University Press, 2009, pp. ix–x.

[2] Satpal Sangwan, 'Indian Response to European Science and Technology 1757–1857', *The British Journal for the History of Science*, Vol. 21, No. 2, 1988, p. 231 (211–232).

[3] Deepak Kumar, 'The Culture of Science and Colonial Culture, India 1820–1920', *The British Journal for the History of Science*, Vol. 29, No. 2, 1996, p. 195 (195–209).

[4] Projit Bihari Mukharji, *Nationalizing the Body: The Medical Market, Print and Daktari Medicine*, London and New Delhi: Anthem Press, 2012, p. 35.

[5] For example, once he elaborated upon the dreadful disease plague, 'This pamphlet is a short treatise on the disease known as the plague. In compiling this pamphlet, my aim has been to place before the vernacular medical profession as well as the public at large a short history of the disease, its causes, characteristics, and rational treatment, so far as I have been able to gather them from all available sources. It is well known that a good deal of misapprehension exists in the public mind regarding the disease itself, as also the measures adopted by the government for its prevention'. Radhagobinda Kar, *Plague: Ihar Sangkhipto Biboran O Etatsambandhe Adesh, Biggyapan O Niyomadi*, Kolkata: Gurudas Chatterjee, Bengal Medical Library, 1898, p. 1.

adopt from the West and, as important, what elements in Western life must be rejected at all cost.[6] A few decades later, by mid-nineteenth century, it converted into a cultural synthesis. Such idea gave them the best of both worlds—initially, it prepared them to absorb culture-shock and ultimately assured a possible opportunity to rise above the obstacles imposed by the foreign rulers.[7] The indigenous medical traditions and their interactions with the colonial health establishment are worth a mention here. The facilities afforded by state (allopathic) medicine were at no point of time sufficient to supplement the indigenous systems. An important implication of the limited reach of colonial medical facilities was that indigenous medicine had enough space to operate, particularly in rural and semi-urban areas. However, fears of possible marginalization due to the onslaught of Western medicine, the protagonists of indigenous medicine were forced to take a critical look at the state of their art. Their assessment of the situation, according to K. N. Pannikar, was a complex amalgamation of past pride, discontent with the present, and anxiety about the future—ultimately efforts to revitalize indigenous systems during the late nineteenth and early twentieth centuries.[8]

Another interesting dimension was, in the last decades of the nineteenth century, some of the individual 'native' scientists gathered sufficient strength to collaborate (and sometimes differ) with their metropolitan peers and fight colonial bureaucracy. The Royal Institution of Great Britain occupies a prominent place in the annals of science. Jagadis Chandra Bose (1858–1937), an Indian physicist, for the first time, spoke at this institution, of his discoveries of the optical properties of 'electric' waves, in January 1897. For the Royal Institution, Bose's lecture was, just one more entry in its record books. For science, the occasion was yet another addition to its vast corpus. For Bose and for India, Subrata Dasgupta emphasizes, it was a moment of profound history—'Western science, the science of Galileo and Newton, had finally taken root in India among Indians, and on that January evening in 1897, the West tacitly acknowledged that fact'.[9] However, Bose was not lone pioneer of modern Indian science. There were a small handful of others. In particular, there was his contemporary and colleague at Presidency College, Prafulla Chandra Ray (1861–1944), a chemist who discovered mercurous nitrite in 1896, and founded a chemical works—Bengal Chemical and Pharmaceutical Works Ltd. The next generation of Indian scientists—Meghnad Saha (1893–1956), Satyendranath Bose (1894–1974), and others—were taught at Presidency College by Bose and Ray. By the early 1940s, the Indian scientific community made its intellectual presence felt in the international scientific world. There were at least nine fellows of the Royal Society as well as a

[6] Tapan Raychaudhuri, *Europe Reconsidered: Perceptions of the West in Nineteenth-Century Bengal*, Delhi: Oxford University Press, 1988, p. xi.

[7] During 1860–80, Deepak Kumar has referred to a number of cultural essayists (Bankimchandra Chattopadhyay, Rajendralal Mitra, Maulvi Ubaidullah, among others) who tried to articulate modern scientific rationality in terms of indigenous traditions and requirements. Kumar, *Science and the Raj: A Study of British India*, New Delhi: Oxford University Press, 2nd edition, 2006, pp. 192–201.

[8] K. N. Panikkar, 'Indigenous Medicine and Cultural Hegemony', *Colonialism, Culture, and Resistance*, New Delhi: Oxford University Press, 2007, p. 173.

[9] Subrata Dasgupta, *Jagadis Chandra Bose and the Indian Response to Western Science*, Ranikhet: Permanent Black, paperback edition, 2009, pp. 2–3.

Nobel laureate in physics.[10] A prominent member of this group, Satyendranath Bose sent a letter accompanying his manuscript on Planck's blackbody to Albert Einstein in 1924:

> I have ventured to send you the accompanying article for your perusal and opinion. I am anxious to know what you think of it. You will see that I have tried to deduce the coefficient $8\pi\nu 2/c3$ in Planck's law independent of the classical electrodynamics only assuming that the ultimate elementary regions in the phase-space has the content $h3$. I do not know sufficient German to translate the paper. If you think the paper is worth publishing, I shall be grateful if you arrange for its publication in *Zeitscrift fur Physik*.[11]

In July 1924, Einstein sent Bose a postcard that accepted his paper on radiation statistics and acknowledged its importance. The rest, as they say, is history!

More than past three decades, a number of studies have explored and critiqued science as colonial knowledge and as a tool of imperial dominance.[12] With the anti-diffusionist, constructionist, and global turns in the discipline more widely, recent researches have declined to see science as a set of ideas and Western construction, rather wanted to analysis sciences as practices and bodies of knowledge that embedded in particular spatial contexts, and practised by local actors in locally relevant political and cultural contexts.[13] The geographical scope of the essays collected in this book focussing on South Asia is designed to elucidate a shift in scholarly focus from the imperial sciences to the colonized subjects—not as the passive recipients of Western knowledge, but as practitioners and participants in global scientific, technological, and medical modernity.

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[10] V. V. Krishna, 'The Emergence of the Indian Scientific Community', in Binay Kumar Pattnaik (ed.), *Sociology of Science and Technology in India*, New Delhi: Sage, 2014, p. 48.

[11] Quoted in Kameshwar C. Wali (ed.), *Satyendra Nath Bose: His Life and Times*, New Jersey and London: World Scientific, 2009, p. xx.

[12] George Basalla, 'The Spread of Western Science', *Science*, New Series, Vol. 156, No. 37, 1967, pp. 611–22; Roy Macleod, 'On Visiting the "Moving Metropolis": Reflections on the Architecture of Imperial Science', *Historical Records in Australian Science*, Vol. 5, No. 3, 1982, pp. 1–16; Daniel R. Headrick, *The Tools of Empire: Technology Transfer in the Age of Imperialism, 1850–1940*, New York: Oxford University Press, 1981; Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance*, Ithaca, NY: Cornell University Press, 1989; Roy Macleod and Deepak Kumar (eds.), *Technology and the Raj: Western Technology and Technical Transfers to India 1700–1947*, New Delhi: Sage, 1995.

[13] David Wade Chambers and Richard Gillespie, 'Locality in the History of Science: Colonial Science, Technoscience, and Indigenous Knowledge', *Osiris*, Vol. 15, No. 1, 2000, pp. 221–240; David Arnold, *The New Cambridge History of India: Science, Technology and Medicine in Colonial India*, Vol. III:5,, Cambridge: Cambridge University Press, 2000; Gyan Prakash, *Another Reason: Science and the Imagination of Modern India*, New Delhi: Oxford University Press, 2000; Dhruv Raina, *Images and Contexts: The Historiography of Science and Modernity in India*, New Delhi: Oxford University Press, 2003; Pratik Chakrabarti, *Western Science in Modern India: Metropolitan Methods, Colonial Practices*, New Delhi: Permanent Black, 2004; Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Scientific Knowledge in South Asia and Europe Seventeenth to Nineteenth Century*, Delhi: Permanent Black, 2006.

Decolonizing South Asian Past: Science and Modernity

Decolonization has emerged as a new meaning of colonialism. It originally referred to as the political process of withdrawal of European powers from their colonial possessions. However, one simply cannot think of political modernity without referring to certain European categories and concepts—Dipesh Chakrabarty rightly reminds us that '...all bear the burden of European thought and history'. The modern Indian educated middle-class warmly embraced science and humanism that the European Enlightenment propagated. The very critique of colonialism itself is unthinkable, argues Chakrabarty, 'except as a legacy, partially, of how Enlightenment Europe was appropriated in the subcontinent'.[14] Today, we all know that the ethos and function of colonialism can be extended to the realm of science as well. Like colonialism itself, colonial science[15] is more than a set of institutions or structures; it is an economic as well as a cultural intervention. Thus, decolonization now signifies the need to historicize the development and domestication of modern science in formal European colonial territories. It requires not simply an awareness of European science's hidden colonial past, but necessitates seeing science itself as colonial/imperial episteme. The task of doing history of science in the Global South need not be one simply tracing the mobility of Western knowledge, putting them in Afro-Asian contexts, and commenting on their behaviour in different environments, but taking seriously what the new knowledge means from the perspective of the local people. It requires not merely looking at how people respond to external agencies, as Clapperton Mavhunga emphasizes, but situating the latter's arrival, meanings, and materialization within the locals' techno-scientific *longue durée*. He further argues that it is important to explore what science and innovation might mean from Africa in lieu of outside introductions or influences.[16] One can ask similar questions in the context of South Asia. Can one see South Asians as intellectuals thinking about and doing science based on intellect? Also, can one identify use of vernaculars by South Asians as modes of theory, even if they engaged Western modes of thought and practice?

Recently, a handful of scholars have argued that South Asia should not be treated simply as a 'site' to which the conventional analytics and methodologies of the broader field of history of technology can be extended. Rather, it should be a location to unravel new analytics and methods—a direct engagement with the question of the modern and the place of technology in the construction of the modern.[17]

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[14] Dipesh Chakrabarty, *Provincializing Europe: Postcolonial Thought and Historical Difference*, New Delhi: Oxford University Press, 2001, p. 4.

[15] Deepak Kumar's pioneering work reveals that the entire gamut of the relationship between science and colonization can be precisely expressed by the term *colonial science*. Kumar, *Science and the Raj*, op.cit., p. xii.

[16] Clapperton Chakanetsa Mavhunga, 'Introduction' (ed.), *What Do Science, Technology, and Innovation Mean from Africa*, Cambridge, Massachusetts and London: The MIT Press, 2017, p. 1–4.

[17] Prakash Kumar, 'Introduction: New Histories of Technology in South Asia', *Technology and Culture*, Vol. 60, No. 4, 2019, p. 933 (933–952). According to Kumar, the contributors aim to demonstrate how looking at the history of technology from South Asia changes what it means to do history of technology.

The meaning (s) and significance of modernity have been prominent in the South Asian historiography for quite some time. A number of interpretations arise from the literature on science and modernity in particular. One of these is whether a concept of modernity originating in the discourse of Western societies can be useful elsewhere. Similarly, is there a single modernity or many? To some scholars working on South Asian science, the notion of 'alternative modernities' has proved attractive as it allows the possibility that modernity can be understood in multiple ways. The use of this concept, as Warwick Anderson proposes, legitimates local adaptations and reworkings of Western knowledge.[18] For example, Projit Mukherji demonstrates how the incorporation of various medical technologies has affected the non-biomedical therapeutics, and, thus attained their own distinctive modernity. He argues that the use of modern stethoscope as a new therapeutic technology in Ayurvedic medicine has evidently been mentioned in ethnographic accounts in Bengal rather than in the conventional archives.[19] Thus, writing for science and modernity in a South Asian tradition is to contribute simultaneously in the task of decolonizing ways of knowing the past.

What then are or should be the common talking points of Asia-centred concerns in scholarly discussions on science, technology, and medicine? What are the best ways to conduct this objective in a geographically focussed study of science and modernity? Is conceptualization of science through a deliberate reversal of colonial constructions, therefore bringing to light identities, knowledge, and practices that have been often erased, can serve the purpose? The discipline of history of science in South Asia has been enriched with significant borrowings from many fields—area studies, cultural studies, ethnography, feminist studies, post-colonial studies, etc. Debating modernity in studies of science in South Asia is a unique example of this trend wherein area studies concerns have been reflected into studies of science, technology, and medicine in South Asia.[20] Science was more than just a practical or ideological project when it came to empire. The modern Western science was inextricably connected with colonialism, especially British colonialism. It was highly exploitative in character. In this context, Rohan Deb Roy has recently expressed his concern—'The empires may have virtually disappeared, but the cultural biases and disadvantages they imposed have not'. He talks about a 'cosmopolitan model' which

[18] Warwick Anderson, 'Introduction: Postcolonial Technoscience', *Social Studies of Science*, Vol. 32, Nos. 5–6, 2002, pp. 643–658.

[19] Projit Bihari Mukharji, 'Akarnan: The Stethoscope and Making of Modern Ayurveda, Bengal, c. 1894–1952', *Technology and Culture*, Vol. 60, No. 4, 2019, pp. 953–978. See also, Mukharji's *Doctoring traditions: Ayurveda, small technologies and braided sciences*, Chicago: University of Chicago Press, 2016.

[20] Prakash Kumar, Projit Bihari Mukharji and Amit Prasad, 'Decolonizing Science in Asia', *Verge: Studies in Global Asias*, Vol. 4, No. 1, 2018, p. 38 (24–43).

recognizes the true achievements and potential of scientists from outside the Western world.[21]

It would be helpful to link some of the logic to modern-day practices, so that current readers can identify the colonial nature of their scientific and technological activities.[22] Extraction of knowledge from interlocutors and unnamed locals is a practice that continues even today. A number of top-ranking Global North institutions run programmes in Afro-Asian countries, and then never acknowledge local participation in that project.[23] The laying down of long-distance telegraph cables that connected the empire[24] is similar to the laying down of Google's undersea cables around the world today. In many instances, technological innovation is driven from Silicon Valley and the rest of the world becomes an outpost for implementing, marketing, or attempting to regulate these technologies and their impact. Of course, individuals from former colonies now form a significant workforce in the Silicon Valley. The IITians who emerged as the biggest Indian names in Silicon Valley got their B.Tech. degrees no later than the early 1980s. It was also the early days of the computer revolution. Many IITians who came to the USA for advanced degrees in other branches of engineering, Ajantha Subramanian mentions, eventually switched to software.[25] The focus on decolonization is very timely and invites the readers to (re)frame the ways in which we think about techno-scientific advancement and success.

Emerging Disciplines and Science in Vernacular

Scholarship over the last few decades has pointed out how modernity has become a fundamental analytical category while discussing history of science in South Asia. The entangled nature of knowledge production attracts considerable attention[26]—the encounter between modern science and the South Asian knowledge systems dates back to the early modernity. If one carefully observes the interaction between the

[21] He rightly opines, 'Decolonization promises to make science more appealing by integrating its findings more firmly with questions of justice, ethics, and democracy'. Rohan Deb Roy, 'Science Still Bears the Fingerprints of Colonialism', *Smithsonian Magazine*, 9 April 2018. https://www.smithsonianmag.com/science-nature/science-bears-fingerprints-colonialism-180968709/ (Accessed on 12 February, 2023).

[22] Warwick Anderson, 'Racial Conceptions in the Global South', *Isis*, Vol. 105, No. 4, 2014, pp. 782–792.

[23] Virginia Gewin, 'Decolonization should extend to collaborations, authorship, and co-creation of knowledge', *Nature*, 22 November 2022. https://www.nature.com/articles/d41586-022-03822-1 (Accessed on 12 February, 2023).

[24] Deep Kanta Lahiri Choudhury, *Telegraphic Imperialism: Crisis and Panic in the Indian Empire, c. 1830–1920*, Basingstoke: Palgrave Macmillan, 2010.

[25] Ajantha Subramanian, *The Caste of Merit: Engineering Education in India*, Cambridge, Massachusetts and London: Harvard University Press, 2019, p. 286.

[26] Sheldon Pollock, 'Forms of Knowledge in Early Modern South Asia', *Comparative Studies of South Asia, Africa and the Middle East*, Vol. 24, No. 2, 2004, pp. 19–21.

intellectuals of two linguistic genres—Sanskrit and Persian—can find several examples of constellations in the fields of philosophy and science. Above all, one should consider the proliferation in knowledge production in the vernaculars during 1550 and 1750. Hence, Dhruv Raina argues, a shift of focus is required from the history of science to the history of knowledge.[27] The encounter between modern science and the multiple knowledge systems of South Asia, according to him, is epistemological in nature while at the same time part of the larger politics of knowledge. The process of making new cultural practices (of science) local can be done through (a) translating modern science into local languages of South Asia and (b) revisiting these traditional knowledge systems through the frame of modern science.[28]

Some of the most interesting encounters between the so-called traditional sciences of South Asia and modern science date back to the end of the eighteenth century which produced interesting results in different branches of science and mathematics. What was the nature of the interaction between traditional mathematics and a modern discipline like calculus? Master Ramchandra, mathematician and science teacher at the Delhi College had developed an alternative way of solving problems of elementary calculus in the nineteenth century. Although initially a few British orientalists sought to promote Ramchandra's book in English schools, the project was later aborted in India as subsequent government policy did not encourage cultural assimilation at the level of pedagogy.[29] The first chapter in the volume by Santanu Chacraverti situates Śubhaṅkarī, a tradition of computing and mathematical instruction, in its social, cultural, and pedagogic context of early modern Bengal. The term usually denotes a corpus of computational instruction enshrined in verses, most commonly used for mathematical instruction in the *pāthśālā*s—the elementary schools in rural Bengal. On closer examination, one finds that the contents of the Śubhaṅkarī corpus can be divided into three categories—algorithms for practical computation; arithmetical and simple algebraic problems; and playing with and exploring the properties of numbers. This tradition was largely oral, with the quantity of written material being relatively small. More importantly, as claimed by the author, the terminology and the system of numerical notation used became almost undecipherable by the late twentieth century.

The appropriation of modern science by the indigenous elite in South Asia is discussed at length in the literature. It seeks to demonstrate how some of the ideas associated with modern science—reason, universalism, progress for example—were deployed by the elite in their imagination of nationhood and modernity. With their

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[27] Dhruv Raina, 'Revisiting Social Theory and History of Science in Early Modern South Asia and Colonial India', *Extreme-Orient Extreme-Occident*, Vol. 36, No. 2, 2013, p. 202 (191–210).

[28] Raina talks about three terms apparently used interchangeably in the literature to refer the adaptation of the practices of modern science into the frame of the existing South Asian knowledge systems—'domestication', 'naturalization', and 'localization'. Dhruv Raina, 'The Naturalization of Modern Science in South Asia: A Historical Overview of the Process of Domestication and Globalization', in Jörgen Renn (ed.), *The Globalization of Knowledge in History*, Berlin: Max Planck Institute for the History of Science, 2012, pp. 345–366.

[29] Dhruv Raina and S Irfan Habib, *Domesticating Modern Science: A Social History of Science and Culture in Colonial India*, New Delhi: Tulika, 2004.

crucial role in the interface between new opportunities and the existing social realities, the interlocutors set up an agenda for modern science to take deeper roots in South Asian soil. They started interpreting modern science for their fellow countrymen and devised strategies for its acceptance under colonial conditions.[30] From Akshay Kumar Dutta (1820–1886), Rajendralal Mitra (1823–1891), Ramendra Sundar Trivedi (1864–1919) in Bengal to Balaji Prabhakar Modak (1847–1906) in Maharashtra and Ruchi Ram Sahni (1863–1948) in Punjab—with their various ideas of science, their critiques of indigenous society, and their strategies to deal with the situation—left a distinctive mark on the nature of adoption and adaptation of modern science in South Asia.[31] Kamlesh Mohan in her chapter evaluates Ruchi Ram Sahni's contribution towards spreading of scientific awareness among the Punjabis in pre-independence era. For a deeper understanding of his mission, the chapter decodes his perception of the relationship between science and religion. How far it was influenced by his association with Brahmo intellectuals in Punjab and his teachers in Calcutta? Like other contemporary Indian interlocutors, the author argues, Sahni had faced with two crucial issues—(a) tension between the practice of nationalism and cultivation of Western science within the colonial framework, and (b) conflict between the agenda of imperialist science and aspirations of the Indian people. Finally, she contextualizes Sahni's mission with the long-term project of modernizing Indian society.

Although modern science had been introduced in Indian schools and colleges from the early nineteenth century, the non-English reader's introduction to the theories, concepts, and practices of modern science originally took place through vernacular publications. Here, Charu Singh argues, the authors brought novel inventions, new technologies, and unfamiliar instruments into the cultural imaginary of South Asian readers. The vernacular publications emerged as a key medium for creating science-literate publics who otherwise had very limited exposure to scientific experiments in laboratories.[32] Despite a considerable growth of Hindi writings on the issues of science in the early twentieth century, it soon faced with the limitation of the language—in terms of the inadequate terminology in Hindi that could be used to define scientific concepts and practices. The third chapter by Sandipan Baksi is an attempt to trace the process that went into creating a dictionary of scientific terms in Hindi. It is based primarily on a survey of the content of one of the significant popular science periodicals of India—*Vigyan*. It emphasizes on the debates around the foundational principles for creating a glossary of scientific terms. The central point of these debates was the source of vocabulary to be used for constructing scientific terminology in Hindi. According to Baksi, these debates were indicative of

[30] J. Lourdusamy, *Science and National Consciousness in Bengal 1870–1930*, New Delhi: Orient Longman, 2004, p. 4.

[31] Suvobrata Sarkar (ed.), *History of Science, Technology, Environment, and Medicine in India*, London and New York: Routledge, 2022.

[32] Charu Singh, 'The shastri and the air-pump: Experimental fictions and fictions of experiment for Hindi readers in colonial north India', *History of Science*, Vol. 60, No. 2, 2022, pp. 232–254.

the larger political conflict coloured by linguistic nationalism framed in conjunction with a revivalist perspective.

Plural Healing and Multiplicity

While writing the introduction of a volume titled *Plural Medicine, Tradition and Modernity* (2002), Waltraud Ernst remarked on the rapid growth of 'colonial' or 'imperial' medicine as it relates to British India, while the study of 'indigenous' or 'folk' medicinal practices of South Asia received much less attention.[33] Since that time, several scholars ventured into this uncharted terrain and explored the underlying dynamics that led to the perceived marginalization of 'indigenous' medicine, the problematic nature of categorizations—'traditional' and 'modern' medicine, the scope and limitations of medical pluralism in diverse geographical and cultural settings, etc. The rise of subaltern and post-colonial theories eventually inclined social and cultural historians to consider the development of non-Western medical paradigms and indigenous medicine worthy subjects of historical investigation. These studies refuted the claim of Western medicine's epistemological and therapeutic superiority and argued that a number of profoundly effective and highly sophisticated 'traditional' systems of healing not only preceded the advent of modern Western medicine in South Asia, but also adapted successfully to the changing circumstances of a colonial situation.

The increasing use of therapeutics other than biomedicine, and the import, especially of alternative forms of medicine from South and Southeast Asia to America and Europe have initiated curiosity in indigenous medical traditions, such as Ayurveda, Unani, and Siddha. The pharmaceutical industry of Ayurvedic medicine is part of a larger process of transformation, bringing Indian forms of knowledge and practices under the influence of Western science and modernity. In this context, Madhulika Banerjee has shown how the growth of modern pharmaceutical production of Ayurveda has been shaped by the colonial history, encounter with biomedicine and its epistemology, the demands of globalized market and international trade regimes.[34] Recently, Rachel Berger has shown how Ayurveda during early twentieth century, a period of critical modernization, was defined by structures of colonial governmentality. He has further discussed how these experiments in governance were operational at the local level rather than a centralized planning.[35]

In the first chapter of this part, Saurav Kumar Rai argues that the distinctive colonial context of the late nineteenth and early twentieth century in India led to the

[33] Waltraud Ernst (ed.), *Plural Medicine, Tradition and Modernity, 1800–2000*, London and New York: Routledge, 2002.

[34] Madhulika Banerjee, *Power, Knowledge, Medicine: Ayurvedic Pharmaceuticals at Home and in the World*, Hyderabad: Orient Blackswan, 2009.

[35] Rachel Berger, *Ayurveda Made Modern: Political Histories of Indigenous Medicine in North India, 1900–1955*, New York: Palgrave Macmillan, 2013.

creation of various 'modernized traditions' around this time. This unique combination of oxymoronic traits was peculiar to colonial set-up manifesting 'the rule of colonial difference'. In the sphere of medical modernity, this peculiar phenomenon was substantially manifested through the emergence of 'modern' Ayurveda. In their revivalist quest, the Ayurvedic practitioners and proponents of the time dramatically reshaped and redefined it which was remarkably different from its pre-colonial version. It was very well reflected in Ayurvedic incorporation of the traits on the basis of which Western medicine was claiming its superiority (such as scientificity, standardization, professionalization, institutionalization, etc.). Yet at the same time, it attempted to contest the epistemological absolutism of Western medicine as well in a very subtle way. Thus, the author argues that even while the Ayurvedic revivalism was a product of (colonial) modernity, it does not necessarily symbolize the victory of modernism as the refurbished Ayurveda had been trying to derive its sanctity both from being 'traditional' as well as 'modern' at the same time.

Traditional medicines have generally been reduced to an inferior position and forced to justify itself as adequately 'modern' and 'scientific' even as these exercises created contradiction and controversy during colonial times. In South and South-east Asia, as recently claimed by a group of scholars, these indigenous medicines have been forced to adopt the systematic disciplining and rationalizing processes of biomedicine and so on (licensing for example). They further argue that there are hierarchies between different types of alternative medicines—'some of which have been accorded different validity based on affinity with scientized modes of assessment'.[36] Although scholarly writings on indigenous medicine in colonial India have done justice to Ayurveda, there has been a paucity of literature on Unani over the same period. Guy Attewell's study fills this gap by providing a comprehensive account of the domains in which the Unani profession was in dialogue with itself, with other therapeutic practices—Ayurvedic, allopathic, and folk practices and traditions, and most significantly with the public—those who looked for its services, as practitioners of *tibb* attempted to define authentic and legitimate Unani knowledge and practice.[37]

Probing the area of popular healing of South Asia, recently another group of scholars have looked at the way that it is marginalized by the state and medical establishments while at the same time being very crucial in the everyday lives of the ordinary people. They have examined the domain of 'subaltern therapeutics' that both interacts with and resists statist and elite forms of medical practice.[38] Neshat Quaiser in his chapter in the present volume deals with the *bazaari*-subaltern Unani medical practices, demonstrating how contrary to the predominant view within the studies of South Asian medical practices, Unani has been a dispersed and discursive terrain since the beginning with simultaneous presence of the two broad paradoxical

[36] Paul T. Cohen, Chris Lyttleton and Thapin Phatcharanuruk, 'Western and Traditional Medicine in India, Myanmar and Thailand', *Sojourn: Journal of Social Issues in Southeast Asia*, Vol. 37, No. 2, 2022, p. 263 (262–289).

[37] Guy Attewell, *Refiguring Unani Tibb: Plural Healing in Late Colonial India*, Hyderabad: Orient Longman, 2007.

[38] David Hardiman and Projit Bihari Mukherji (eds.), *Medical Marginality in South Asia: Situating subaltern therapeutics*, London and New York: Routledge, 2012.

spheres of Unani practices, such as textual Unani on the one hand, and bazaari-subaltern Unani on the other in different geographical, social, and cultural locales. This chapter, however, forcefully argues that the relationship between the textual Unani and bazaari-subaltern Unani medical practices cannot be comprehended properly through a blanket totalizing elite-subaltern binary framework. Moreover, the concept of subaltern itself is to be re-examined contextually, particularly to account for the ways in which a textual tradition such as Unani itself can be rendered to a state of subalternity, particularly in post-colonial situation. Quaiser further examines the ways in which bazaari-subaltern Unani medical public sphere remained outside the textual Unani and statist medical imaginations and control, therefore, was declared inauthentic for its practitioners were considered untrained, and yet it catered the medical requirements of vast masses during the colonial and post-colonial periods. Illustrative cases are drawn from provinces of Bihar, Bengal, Tamil Nadu, Telangana and Delhi, United Provinces.

The bone-setters of Bosipur village in Burdwan district of West Bengal are traditional orthopaedics specializing in treating broken bones using indigenous medical knowledge. However, due to lack of patronage from both the government and the local elites (including patients), Arabinda Samanta has recently emphasized, they are marginalized. They are neglected in official healthcare schemes for a variety of social, economic, and political reasons.[39] Most of the primitive communities with their close association with the nature gradually developed healing techniques and methods with the available flora, fauna, and other naturally occurring substances. Apart from the so-called indigenous forms of medicine (Ayurveda, Unani, Siddha, etc.), there also existed several little known and un-institutionalized therapeutic practices—folk medicine for example. In this context, Rup Kumar Barman explores the sub-Himalayan Bengal (Jalpaiguri, Alipurduar, and Cooch Behar districts of West Bengal) and identifies the folk medicinal traditions of the indigenous communities in general, and of the Rajbanshis, a dominant community, in particular. Like the bone-setters of Burdwan district, the Rajbanshi healers are ordinary people engaged in different occupations (farmers, labours, domestic helps, even teachers). But unlike the bone-setters, one can find female practitioners of medicine among the community. Another point of departure from the bone-setters was the tendency to institutionalize their medicinal knowledge and practices. As Barman mentions about Rajmohan Eshor, the royal physician of the Cooch Behar state, who developed a special school for the cure of fracture and arthritis at Nishiganj. Later, his family members have built up several such clinics in different parts of West Bengal and Northeast India. Thus, a number of recent publications by social scientists indicate the continued engagement by the scholars with the indigenous medical systems of South Asia.

[39] Arabinda Samanta, 'Revisiting a Marginalized Community: The Bone-setters of Bengal', in Bipasha Raha and Subhayu Chattopadhyay (eds.), *Mapping the Path to Maturity: A Connected History of Bengal and the North-East*, New Delhi: Manohar, 2018, pp. 255–267.

Institutionalization and Professionalization of New Knowledge

The emphasis on 'original' research and the push to create conditions for young Indians to engage in scientific enterprise came from Indians themselves. In 1869, long before the opportunity for scientific research at the university level, Mahendra Lal Sircar (1833–1904), a graduate of the Calcutta Medical College, set forth before the citizens of Calcutta a plan for founding an institute equipped with a library and laboratories. He wrote, 'We want an Institution which will combine the character, the scope and objects of the Royal Institution of London and of the British Association for the Advancement of Science' and then added, 'I want freedom for this Institution. I want it to be entirely under our own management and control. I want it to be solely native and purely national'.[40] The Indian Association for the Cultivation of Science (1876) was the first attempt at an institutional manifestation of the relationship between scientific research and nationalism in the backdrop of colonialism. At the turn of the twentieth century, Chandrasekhara Venkata Raman (1888–1970) came to carry out his research at this institute, first in acoustics and later in optics, X-rays, and magnetism. Those researches culminated in Raman's discovery of the new 'scattering' phenomenon of light, named the Raman Effect, for which he received the Nobel Prize in physics in 1930.[41]

The first decade of the twentieth century saw intense debate on what Indians had received at the end of a century and a half of British rule: amelioration was sought through the slogans of *Swadeshi* (self-reliance) and *Swaraj* (self-rule). The new vision of India debated continuously in the years to come and the quest for techno-scientific knowledge preceded and facilitated the emergence of this vision. As Vice-Chancellor, Asutosh Mukherjee (1864–1924) had been working relentlessly to institutionalize science teaching and research at the University of Calcutta. He was keen to bring Meghnad Saha, a pioneer astrophysicist, to Calcutta University with a professorship in physics (1921):

> I have read with indescribable interest and pleasure the account of your work. I had already seen the notice in the Nature…I am now endeavouring to provide for you an independent position and a suitable laboratory when you return here and I have little doubt that my efforts

[40] M. L. Sircar, 'On the Desirability of National Institution for the Cultivation of Sciences by the Natives of India' (1869); quoted in Deepak Kumar, 'India', Hugh Richard Slotten, Ronald L. Numbers, and David N. Livingstone (eds.), *The Cambridge History of Science*, Vol. 8: Modern Science in National, Transnational, and Global Context, Cambridge: Cambridge University Press, 2020, p. 466.

The inauguration of the institute in 1876, according to Kumar, was no less important than the establishment of the Indian National Congress (1885), a political organization that was to spearhead the national movement.

[41] G. Venkataraman, *Journey into Light: life and science of C. V. Raman*, Bangalore: Indian Academy of Sciences, 1988.

> will be successful. I do not think you will have to regret your decision to stay in your own University rather than accept an appointment elsewhere.[42]

Outside the scope of the university system, the institution which made the strongest imprint of a nationalist science with its characteristics assertion on the ethics of 'struggle, renunciation and sacrifice', was the Bose Institute established by Jagadish Chandra Bose in 1917.[43] However, these are not isolated incidents. In his chapter, Suvobrata Sarkar traces the institutional history of electrical engineering in colonial Bengal taking into account the evolution of Bengal Engineering College, Sibpur, and the College of Engineering and Technology, Jadavpur. The arrival of electricity necessitated the introduction of new institutional facilities. With the growth of the technological system, a supportive culture also grew—trained manpower to handle the machines, better educational facilities, new business culture, etc. The CESC, a London-based power company, was instrumental in the generation and supply of electricity in Calcutta. From the beginning, they realized the need to create a pool of personnel (basically Indians) with elementary knowledge on electrical engineering. Thus, the Bengal Engineering College started providing basic instruction on the subject. The erudite Indians identified, on several occasions, the imperfect training of Indian engineers, including electrical. A nationalist initiative, College of Engineering and Technology, from its inception, used to provide advanced training in electrical engineering. Investment in education, especially techno-scientific, was now seen to be of great importance. The electrical power was to be the key to a modern industrial economy excited Bengali *bhadralok*. The chapter is basically on the education of electrical engineers as it had developed in the late years of the Raj, and the interface it had with entrepreneurship and industry in a colonial metropole—Calcutta.

While examining the reception of Freudian psychoanalysis in late nineteenth-century India, Dhruv Raina has shown how the setting up of a discipline in different cultural context opens up discussion on localization of knowledge—whether it involves the production of new curricula, the creation of new organizational structures, or even the production of new knowledge?[44] Oral Health was comparatively an uncharted domain in India in the late eighteenth century but before long dental health was deemed to be an integral part of medical science. The mouth, tongue,

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[42] Asutosh Mukherjee to Meghnad Saha, May 11, 1921; quoted in Uma Dasgupta (ed.), 'Introduction', *Science and Modern India: An Institutional History, c. 1784–1947*, New Delhi: Pearson, 2011, p. liv.

The numerous science institutes established during 1784 and 1945, according to Dasgupta, exemplified how the separate ideologies and functions of colonialism and nationalism, the differences in the traditional and modern systems of knowledge, and an imperial administration following its own logic, all came together in the venture of organizing these science institutes in British India. Ibid, p. lx.

[43] Madhumita Majumdar, *Science and the Nationalist Agenda in Bengal, 1904–1947*, unpublished Ph.D. thesis, University of Calcutta, 2004, p. 120.

[44] Dhruv Raina, 'Travelling Both Ways: The Adaptation of Disciplines, Scientific Textbooks and Institutions', in Feza Gönergun and Dhruv Raina (eds.), *Science between Europe and Asia: Historical Studies on the Transmission, Adoption and Adaptation of Knowledge*, Dordrecht: Springer, 2011, pp. 168–170.

teeth, jaws and its shape, the art of dentistry, diagnosis of disease, and its treatment are an essential part of dental science. Although in common perception dentistry is limited to the teeth, in actuality it incorporates the shape of the mouth, jaws, face, and forehead. Sahara Ahmed traces the origin of the term dontology in the context of colonial India. The shape of the teeth, gradual development, and persistence of abnormalities comprise the crux of the matter of dontology. Similarities in subject matter have prompted the use of the two terms 'oral health' and 'dental health' interchangeably. 'Scientific dentistry' was introduced in India in the nineteenth century by the British and modern dental care and the study of this discipline were initiated a hundred years ago. Dental care was restricted to the extraction of teeth at the hospitals and dispensaries by medical men and assistants. Despite this, for long, dentistry predominantly remained in the hands of the unqualified. The year 1920 is a milestone in the history of dental care and public health with the establishment of the first dental college in Calcutta. Significantly, this perspective found expression in the endeavours of Dr. Rafiuddin Ahmed and the institute he established in Calcutta (1920), eventually came to be known as the R. Ahmed Dental Medical College and Hospital. Dr. Ahmed advocated the American model of dentistry in lieu of his training rather than the British model which honed its thrust on the study of basic medical subjects. The duration of the medical course was two years but through the years, it witnessed many transitions which would comprise the crux of the chapter.

The years between 1947 and 1966, covering the period from independence to the end of the third Five-Year Plan, provided an arena for the most acute debates over the content of industrial development. Essentially these debates centred on the form of ownership and control over the industrial undertakings which were already in operation and those which were to be established. During the period, Nasir Tyabji has anticipated that industrialization in India involved not only the establishment of new enterprises by individual capitalists, or even by the state, but also measures of social engineering by the government. State activity was essential to nurture the development of entrepreneurs with a tangible industrial frame of mind.[45] Dinesh C. Sharma argues that in the late 1960s and 1970s, electronics was an emerging sector of technology development and industrial production. It was seen as a sunrise industry, with potential applications of electronics in varied sectors such as defence, atomic energy, entertainment, communication, and education. All these factors attracted the governments, policy makers, and Indian industry to this field. The government's entry into electronics and computing sectors was driven by the desire to achieve self-reliance, ending multinational monopoly and dependence on imports. In the run-up to the formation of the Department of Electronics and soon afterwards, scientists and technocrats took upon themselves the task of setting up an electronics industry. They started looking for opportunities in R&D, design, production, export, and import. Electronics was considered strategic—at par with space and atomic energy, so they strived for national control over it. This gave rise

[45] Nasir Tyabji, *Forging Capitalism in Nehru's India: Neocolonialism and the State, c. 1940–1970*, New Delhi: Oxford University Press, 2015, pp. xiv–xv.

to the phenomenon of 'government entrepreneurship', whereby scientific departments planned commercial ventures for production of components, computers, and software. Several ventures were conceived at Indian Statistical Institute, Tata Institute of Fundamental Research, Department of Atomic Energy, and Department of Energy under Prasanta Chandra Mahalanobis (1893–1972), Homi Jehangir Bhabha (1909–1966), Vikram Sarabahi (1919–1971), and M. G. K. Menon (1928–2016). Most of them failed for lack of business and market orientation. The ones that took shape helped India develop certain capabilities and manpower in advanced areas of R&D and production. According to the author, this helped create nuclei to human capital and expertise that eventually helped the private sector in seeding the software revolution in the decades that followed.

Metropolitan Methods, Colonial Practices

The encounter between metropolitan sciences of the West triggered numerous projects of cultural redefinition and engagement with European modernity and Indian culture. Western science had to be reinvented in the vocabulary of a modernizing India. This process could be viewed and S. Irfan Habib and Dhruv Raina have argued, either in terms of the proclamation of the new or in terms of a course of cultural appropriation. The expansion of Western science was accelerated by the combined efforts of imperial bureaucrats, their scientific peers, and indigenous traditions. The local elites envisaged this encounter with European sciences as a path to revitalization. This reflective association itself continuously reconstituted modern science.[46] A large number of Indian interlocutors, belonging to different disciplines and walks of life, contributed to the new quest for scientific knowledge. Among those who were the first to take scientific research and teaching as their career were Pramathanath Bose (1855–1934), Jagadish Chandra Bose, and Prafulla Chandra Ray. Bose specialized in geology at the University of London and later joined the Geological Survey of India. In 1886, he wrote a pamphlet on 'Technical and Scientific Education in Bengal' and a decade later published three volumes on *A History of Hindu Civilization during British Rule*. Aggressive nationalism had converted a geologist into a historian. As Deepak Kumar opines from physical mapping, Bose shifted to cultural contours.[47]

V. V. Krishna in his chapter on the emergence of Indian scientific community explores the contribution of leading Indian scientists in laying the foundations for professionalization of science and advancement of scientific knowledge during the

[46] Habib and Raina have further argued that the assimilation of modern science began at the level of pedagogy. This was a complex process where science teachers had to contend with indigenous knowledge systems, and produce translations of modern science into vernaculars. This encounter opened up the gateways for a dialogue that generated interesting experiments both in pedagogy and science and was to enrich both. S. Irfan Habib and Dhruv Raina (eds.), 'Introduction', *Social History of Science in Colonial India*, New Delhi: Oxford University Press, 2007, pp. xiii–xl.

[47] Deepak Kumar, *Science and Society in Modern India*, Cambridge: Cambridge University Press, 2023, p. 78.

1870s and 1940s. He demonstrates leading scientists in this era such as Mahendra Lal Sircar, Prafulla Chandra Ray, Ashutosh Mukherjee, Chandrasekhara Venkata Raman, Meghnad Saha, and Satendyanath Bose, to name some, waged an intellectual struggle against the British colonial gate keepers who resisted local and indigenous initiatives in the professionalization of science. In collaboration with Indian political elite, systematic efforts were directed at laying the foundations for cultivation of science institutions from translation of science into local languages, popularization of science, promotion of science teaching in colleges, and higher institutions of learning to basic scientific research. Between the 1890s and 1940s half a dozen advance research specialist groups emerged in plant physiology, chemistry, physics, mathematics, and astronomy. In a large measure, the genesis of Indian science community had taken roots outside the confines of colonial science enterprises as these institutions were not conducive for the professionalization of science and the advancement of knowledge. Indian scientific intellectual struggle in laying the foundations of basic research during this period had dented the Centre-Periphery relations or dichotomy in science practised by British colonial scientific enterprise. Thus, the chapter challenges the basic assertion of key classical colonial thinkers, such as George Basalla, that independent scientific tradition in the colonial era emerged outside the confines of colonial science enterprises.

The first generation of Indian scientists struggled hard to inaugurate a scientific research system. The professed objective was to draw India closer to the international community of science. Collectively and individually, they had set in motion the efforts to build new institutions to do research at international levels and train new generations of competent scientists who would stay and work in India. Through their international networks, well before 1947 and immediately after that, they articulated new ideas and programmes, and these networks remained so impactful in India that the planning and development of science, as emphasized by Robert Anderson, was a major responsibility that non-specialists had to acknowledge and allow scientists a free hand.[48] On the other hand, while exploring the academic roots of India's nuclear research, Jahnavi Phalkey has pointed out that the leading Indian physicists were convinced of the imperative to create within India the facilities and capabilities required for international participation in nuclear physics research.[49] We need to appreciate how these scientists overcame the many obstacles they faced, to a great extent in the initial phases, and to understand the lessons their lives teach us.

The relationship between 'centres' of science (or scientific metropolises) and the geographical regions lying at the periphery has been a subject of some interest to historians and sociologists of science. The relationship between Britain and India during the heyday of the British Empire was coloured by the complicating fact that India was a colony of Britain. Although Indian scientists were fully aware that some

[48] Anderson argues that there would not have been a sustained atomic energy programme without a continuously evolving relationship between science and politics in South Asia. Robert S. Anderson, *Nucleus and Nation: Scientists, International Networks, and Power in India*, Chicago and London: The University of Chicago Press, 2010, pp. 2–17.

[49] Jahnavi Phalkey, *Atomic State: Big Science in Twentieth-Century India*, Ranikhet: Permanent Black, 2013.

other countries like Germany might have been ahead of Britain in certain branches of science such as physics and chemistry in the early decades of the twentieth century, Arnab Rai Choudhuri highlights in his chapter that there was still a special craving for British honours in India, since such honours would bring additional benefits in the colonial set-up. Many of the leading Indian scientists of that era openly expressed the view that nationalistic feelings drove their science, but they still wanted British recognitions for their research. Since the Knighthood was an official honour bestowed by the British Crown, many Indian scientists had an ambivalent attitude towards it. However, the Fellowship of the Royal Society was viewed as recognition by the scientific peers of Britain, and it was perhaps the most coveted honour for Indian scientists of that era. Rai Choudhuri concludes that it was well known that the FRS election process was not a level playing field for Indian scientists, and a few Indian scientists with high international reputation (such as Prafulla Chandra Ray) were never elected FRS even after being nominated repeatedly by their British peers.

In his pioneering study on the life histories of two Indian scientists during colonial times, Jagadish Chandra Bose and Srinivasa Ramanujan (1887–1920), Ashis Nandy has brilliantly constructed 'a cultural psychology of scientific creativity' through their encounters between individual creativity and social reality. Bose's creativity was influenced by the synthesis of the dominant traditions of Western science and the indigenous ideals of knowledge and enquiry. In doing so, as claimed by Nandy, Bose not only created a personalized Indian perspective of world science, but also tried hard to recover the self-esteem of his subjugated countrymen.[50] The theme, Indian creativity in modern science, attracts considerable attention.[51] However, Deepanwita Dasgupta has raised a few significant questions—Why to study the scientific practices of a small non-Western community on the colonial margins? Being imitations of the dominant practices of Europe and America, what could be the philosophical relevance of Indian science?[52]

In June 1924, Satyendra Nath Bose sent Einstein a short four-page paper containing a new proof of Planck's law. That proof involved two unusual moves—first, a consistent interpretation of blackbody radiation in terms of Einstein's newly proposed light quantum theory, and secondly, the use of a new statistics that counted such light particles as indistinguishable. With Einstein's quick endorsement of those moves, the paper won Bose—until then completely unknown to the international scientific community—a lasting place in quantum theory. Yet, a second paper written shortly thereafter with very similar strategies on the interaction of matter and radiation remained largely ignored, and this is usually taken to be the result of Einstein's adverse comments on the paper. Having thus shown up briefly on the scene of international science, Bose disappeared quickly from the stage of quantum theory, and

[50] Ashis Nandy, *Alternative Sciences: Creativity and Authenticity in Two Indian Scientists*, New Delhi: Oxford University Press, 2nd edition, 1995.

[51] Subrata Dasgupta, 'Jagadis Bose's panvitalism as intellectual history', *Indian Journal of History of Science*, Vol. 57, No. 1, 2022, pp. 26–36.

[52] Deepanwita Dasgupta, *Creativity from the Periphery: Trading Zones of Scientific Exchange in Colonial India*, Pittsburgh: University of Pittsburgh Press, 2021.

for the rest of his life devoted himself primarily to the work of building a scientific community in India, adding new topics of research in crystallography and organic chemistry, in addition to his original domain of theoretical physics. He also carefully nurtured a generation of women students, who became important researchers later in life. Bose's brief track records in quantum theory, and his two papers, taken together, according to Deepanwita Dasgupta, thus offer us a window on to the world of 'peripheral science'—the relatively unexplored region of scientific practice where we often see great creativity among people who were trained by somewhat unconventional methods, bypassing the usual channel of recognized mentors and institutions. If Bose indeed trained himself in such an unconventional manner, how did he do it? And having been able to do it once, why was he not able to replicate his success for a second time? Since many scientific communities in Asia and Latin America had gone through a similar peripheral phase, at least in the beginning, it is important to understand these processes, grasp their difficulties, but also see how such peripheral practices can often become the birthplace for great scientific ideas, ushering in new conceptual changes. The reflections on such processes, Dasgupta further claims in her chapter, can help us design an optimal practice for science in the twenty-first century.

Science and Multiple Modernities

Indians differed widely in their responses to Western science and its proselytizing message of modernity. A handful of Indian elites endorsed the call for transformation and identified enthusiastically with the modernizing project. To accept the Western set of institutions and values in ditto was problematic. As it would turn them into imperfect copies of Western ideals. Thus, according to David Arnold, a need to construct a particularly Indian modernity has been seen as the driving force behind colonial subjects' participation in debates on science and technology.[53] As Partha Chatterjee asked long back how could Indians accept and assimilate Western modernity while at the same time seeking to contest colonial authority.[54] One response is to see, as Gyan Prakash does, that Western science and technology as being reinterpreted in and for the colony usually by Indian erudite and popularizers of science. Indian elites,

[53] Arnold put forward three observations. First, the discussions on modernity are largely discussions of Indian pronouncements on science and technology. Second, the need to construct an Indian modernity is seen to be arisen in 'response' to the perceived modernity of the new knowledge brought by the colonial power. This occurred primarily through a strategy of revivalism, a search for elements of modernity in India's ancient past and its indigenous systems of learning. Third, ideas of modernity are viewed as an integral component of the Indian nationalist movement that arose in the late nineteenth century and came into its own in the twentieth century. David Arnold, *The New Cambridge History of India: Science, Technology and Medicine in Colonial India*, Cambridge: Cambridge University Press, 2000, pp. 15–18.

[54] Partha Chatterjee, *Nationalist Thought and the Colonial World: A Derivative Discourse*, Minneapolis: University of Minnesota Press, 2nd impression, 1993.

in translating Western scientific ideas and technologies into vernacular languages, engaged in a 'renegotiation of knowledge and power', setting themselves up as the champions of an Indian modernity.[55] However, even at the close of the British rule, it remained uncertain how far scientific modernity could facilitate a consensus within India and how far a science conversant by Indian values could gain acceptance from an international audience.

Indian modernity is not a single entity, patented by Britain, but is capable of multiple forms and any number of cultural and political variants. Recently, Kris Manjapra has examined the changing scope and quality of interactions between Garman and South Asian intellectuals during the late years of the British Raj. A particular alignment of international politics enabled new kinds of scholarly and scientific encounters across national and colonial boundaries.[56] In the 1910s and 1920s, Indians considered Germany as the great physics and chemistry laboratory of the world and these two disciplines alone could provide the high road to scientific and industrial development. Collaborations in the sciences, arts, and humanities between German and Indian minds produced some extraordinary results—Meghnad Saha met Albert Einstein, Girindrasekhar Bose (1887–1953) began a correspondence with Sigmund Freud, and Rabindranath Tagore (1861–1941) travelled to Germany to recruit scholars for his newly founded university in Santiniketan. In 1930, Einstein had two highly publicized encounters with Tagore, in which as Manjapra has put it, both thinkers addressed fundamental philosophical questions about epistemology and ethics.[57]

There is no conflict, as recently claimed by a scholar, between Tagore's poetic imagination and scientific perception. On several occasions, his poetic vision of nature around him is not only harmonious with scientific insight but, it appears, directly inspired by it and integrates it. Some of his poems seem to mesh with the physical sciences, astronomy, and cosmology in particular; others with the life sciences, rejoicing the order and energy in the living world of nature.[58] The originality of Tagore's philosophy attracted the leading European scientists (Arnold Sommerfeld, Werner Heisenberg, including Einstein) of his time, combatting with the deep philosophical problems unrestrained by their scientific discoveries. Tagore's most sustained interaction was with the eminent Indian scientists of the day—Jagadish Chandra Bose and Prasanta Chandra Mahalanobis. As a matter of fact, the poet and Bose became great friends and the latter dedicated his book *The Nervous Mechanism of Plants* (1926) to Tagore.[59] Shiv Visvanathan in his chapter looks at Rabindranath Tagore's relationship and interaction with two scientific legends, Patrick Geddes, the

[55] Gyan Prakash, *Another Reason*, op.cit., pp. 83–84.

[56] Kris Manjapra, *Age of Entanglement: German and Indian Intellectuals across Empire*, Cambridge, Massachusetts and London: Harvard University Press, 2014, pp. 2–9.

[57] Ibid, p. 126.

[58] Partha Ghose, 'Rabindranath and Science', in Sukanta Chaudhuri (ed.), *The Cambridge Companion to Rabindranath Tagore*, Cambridge: Cambridge University Press, 2020, p. 349.

[59] The poet responded enthusiastically at this, 'I realized this is where our truth lies, this light, this life—this is India's essence'. Quoted in Partha Ghose, ibid, p. 339.

Scottish biologist, and Jagadish Chandra Bose, and also between him and Mohandas Karamchand Gandhi (1869–1948). Each is an event on its own, but each telescope into the other to give an intriguing picture of a multifaceted man. The letters that Tagore wrote and received from the two scientist-intellectuals are also analysed. Tagore was no ordinary nationalist and went beyond the tired categories of the modern nation state. He wanted India to smell the West, taste it, and understand the differences within it. He realized that imperialism is only one phase of the West, that there were other Wests that one could talk to and conspire with.

Whereas some Indian intellectuals and nationalists envisaged science as both the agency and emblem of their modernity, others (led by non-other than Gandhi) rejected Western modernity with its alien sciences and inappropriate technologies. Gandhi condemned the West precisely for the same reasons for which it had prided itself for so long, that is, science and technology with all its achievements, consequences, and ramifications. He seldom used the terms 'science' or 'technology'. His concern was civilization and mechanization. He believed that it was machinery (and Manchester) that impoverished India![60] Contemporary scholarship has portrayed Gandhi's relationship with industrial civilization and technology as a complex one; as opposed to the more reductionist interpretations of his work suggesting that he was an anti-modernist and Luddite. The chapter, by Dhruv Raina, in three parts returns to a historical moment dating back to the first two decades of the twentieth century to situate Gandhi's reflections on industrialism and the 'West' in the context of a larger social movement that he was instrumental in shaping and that shaped his own thinking. The second part briefly summarizes contemporary meta-reflections within STS on technology, in order to argue that the binary dichotomies that purportedly characterize Gandhi's writings on the subject disappear when Gandhi begins to be seen as a social determinist on the question of industrialization and technology. And finally, the third part takes up a recuperation of Gandhi within the appropriate technology movement in the last quarter of the twentieth century in India to detail the issues wherein Gandhi continues to be relevant for the contemporary practice of science and technology.

The standard narrative of Indo-German academic exchange usually begins with the German Indology and its role in shaping a national consciousness in India. The initial German enthusiasm for India was opposed by a criticism of the 'value' of Indian culture and a reaffirmation of Western philosophical and religious superiority. This divergence meant, according to Angelika Malinar, either an emphasis on the value of India's spiritual and metaphysical traditions, or an appreciation of its rationalistic and scientific achievements.[61] Swami Vivekananda (1863–1902), who

[60] The first clear-cut exposition of Gandhi's views is to be found in *Hind Swaraj* (1909). For a meaningful discussion see, Deepak Kumar, *'Culture' of Science and the Making of Modern India*, New Delhi: Primus, 2023, pp. 290–302.

[61] Angelika Malinar, 'Ideas of Indian Philosophy in Nineteenth-century Germany: Vivekananda, Deussen, and Garbe', in Hans Harder and Dhruv Raina (eds.), *Disciplines and Movements: Conversations between India and the German-speaking World*, Hyderabad: Orient Blackswan, 2022, p. 129.

met German philosopher and Sanskritist Paul Deussen in 1896, while acknowledging their contribution in preserving the integrity of the ancient scriptures, argued that the German philosophers were unable to master the Indian philosophical texts entirely. The interpretations of Indian philosophy by prominent German philosophers of the nineteenth century can be served as a model to understand the progress of the Sanskrit studies and philosophy in the academia.[62] The final chapter in the volume by Nirmalya Narayan Chakraborty claims that with the arrival of colonialism in India, the term 'Comparative Philosophy' gained a new momentum. Comparative philosophy in colonial India acquired a different connotation, different from the comparative philosophy that has been there in practice in classical period.

The complete rupture in the age-old traditional knowledge system has got some interesting consequences for the Indian academic scenario, especially with regard to philosophy. The present chapter is an attempt to focus on how the very concept of philosophy is being debated on by some contemporary Indian philosophers. Chakraborty highlights how in this debate the participants freely use ideas and debates found in European philosophical tradition, but give these a very distinctive traditional Indian colour. Comparative philosophy gives rise to a cosmopolitan philosophy in the sense that different philosophical traditions converge and this convergence could be said to be inclusive in nature. This inclusiveness moves beyond mimicking the other. Internalizing the insights of both the classical Indian and contemporary European philosophical traditions, a novel creative philosophical repertoire has been generated. This post-colonial Indian philosophy defies any geographical labelling.

Coloniality, Modernity, and Decoloniality

'Modernity, of course, is not a decolonial concept, but coloniality is. Coloniality is constitutive, not derivative, of modernity. That is to say, there is no modernity without coloniality…' Thus, convincingly argued by two scholars recently.[63] The spate of discussions and publications on decolonization or decoloniality indicates an enduring and increasing interest in the subject.[64] In Asia, Africa, and Latin America, the varying character, depth, and length of colonial experience set the multiple modalities and spatiotemporal contexts for the efforts of decolonizing knowledge. This situation

[62] Malinga further argues that despite the attempts by Paul Deussen and Richard Garbe to launch Indian philosophy as a subject of study, while it was established as an area of specialization in Indology, it remained a marginal course in the philosophy department of German universities. Ibid, pp. 164–165.

[63] Catherine E. Walsh and Walter D. Mignolo (eds.), 'Introduction', *On Decoloniality: Concepts, Analytics, Praxis*, Durham and London: Duke University Press, 2018, pp. 3–4.

[64] Sekhar Bandopadhyay, *Decolonization in South Asia: Meanings of Freedom in Post-independence West Bengal, 1947–52*, Hyderabad: Orient Blackswan, 2009; also see, Sabyasachi Basu Ray Chaudhury, 'Governance of migration in South Asia: the need for a decolonial approach', in Tamar Mayer and Trinch Tran (eds.), *Displacement, Belonging, and Migrant Agency in the Face of Power*, London and New York: Routledge, 2022, pp. 78–91.

is understandable given the seriousness of the problems that were accompanying with formal colonialism—poverty, inequality, exploitation, and epistemic imperialism, among others. The East-West divide has been given way to the North-South split. Despite the rise to economic prominence of some former colonies, the political and intellectual power globally remained, until the rise of China, largely concentrated in the hands of former colonizers. One consequence of the centrality bestowed to decolonization, is embedded in its long colonial history. With scholars focussing on the enduring impact of colonization, the tendency is to look back into the colonial past for the roots of contemporary problems, and to the even deeper past (ancient?) for the solutions to them.

In an era of (pseudo?) revivalism, Deepak Kumar anticipates, history of science acquires special significance and makes insistence on scientific temper and definitive sources even more important. The study of history of science may provide a better understanding of the historical processes and forces.[65] Can the ethos and function of decolonization or decoloniality be extended to the realm of science and modernity? Is there any pattern or design? David Fairchild, an American scientist, mentioned several Indonesian (Oedam, head gardener at the Bogor Botanical Gardens, for example) who helped him during his visit to the then Dutch East Indies in 1895. One Henry Ogg Forbes, another scientist from Scotland who studied the flora and fauna in the Dutch Indies during 1878 and 1883, had similar observations about the local expertise.[66] Recently, a group of academicians have identified people like Oedam as intermediaries (go-betweens) connecting Western and indigenous knowledge in the eighteenth and nineteenth centuries. They argue that by paying more attention to knowledge collectors, translators, procurers, and others, we can better understand that the modern world emerged not in Europe but in global exchanges.[67] Although the role of intermediaries is important, this group is often missing in the narratives of colonial history. They remain unsung heroes of our knowledge production.[68]

For Fajri Siregar, the movement to decolonize science invites the scientific community to forcefully enter to the field of knowledge production largely dominated by the Global North and to make provision for local knowledge produced by local talents all across the globe. Thus, it talks about moving away from scientific absolutism originated from the dynamics of colonization. The social scientists can

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[65] Deepak Kumar, 'Why HISTEM and how to do it?', Kuruvila Zachariah Memorial Lecture, Presidency University, Kolkata, 7 November 2019.

[66] Irawan Santoso Suryo Basuki, 'Why the role of native Indonesians in developing science is often overlooked during colonialism?' *The Conversation*, 27 July, 2020. https://theconversation.com/why-the-role-of-native-indonesians-in-developing-science-is-often-overlooked-during-colonialism-143263 (Accessed on 15 June, 2023).

[67] Simon Schaffer, Lissa Roberts, Kapil Raj, and James Delbourgo (eds.), *The brokered world: go-betweens and global intelligence, 1770–1820*, Sagamore Beach, MA: Watson Publishing International, 2009.

[68] Several Indians without academic training in engineering and sciences excelled in the field of modern technology. However, they remain absent in the official narratives and can only be found in the contemporary vernacular publications. Suvobrata Sarkar, *Let there be Light: Engineering, Entrepreneurship and Electricity in Colonial Bengal, 1880–1945*, Cambridge: Cambridge University Press, 2020, pp. 203–212.

play a pivotal role in the process, but not many Indonesian social scientists, Siregar laments, have been involved in the decolonizing science, an important discourse.[69] A prominent Indian sociologist, Benoy Kumar Sarkar's (1887–1949) campaign for a materialistic orientation of Indian culture brings us to the last point we wish to emphasize—how did South Asians writing in the twentieth-century envisage terms like science and modernity? Sarkar argued (1918):

> The real and only cause of the parting of ways between the East and the West, nay, between the medieval and the modern, was the discovery of steam, or rather its application to production and transportation. The steam engine effected an industrial revolution during the first three decades of the nineteenth century. It is this revolution which has ushered in the 'modernism' of the modern world in social institutions, science, and philosophy, as well as brought about the supremacy of Eur-America over Asia…[70]

Thus, the volume interrelates a wide range of perspectives from the lived experiences of coloniality and decolonial thought and practices in different local histories from South Asia.

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[69] Fajri Siregar, 'Decolonizing science: it's high time for Indonesia to break free from overreliance on Western theories', *The Conversation*, 24 March 2022. https://theconversation.com/decolonising-science-its-high-time-for-indonesia-to-break-free-from-overreliance-on-western-theories-179474 (Accessed on 15 June 2023).

[70] Benoy Kumar Sarkar, *Hindu Achievements in Exact Sciences: A Study in the History of Scientific Development*, Bombay, Calcutta, and Madras: Longmans, Green and Co., 1918, p. 7.

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