

Like animals, plants also show organ-to-organ signal transmissions between the site of signal perception and the remote target tissues to maintain cellular homeostasis. Choi *et al.* have provided excellent information about the rapid long-range signalling pathways mediated by calcium (Ca<sup>2+</sup>), reactive oxygen species (ROS) and electrical signal in plants subjected to various environmental cues. They have proposed that these signals constitute a signalling cassette, which couples a myriad of signalling networks. The long distance ROS-based signalling network is closely linked with systemic Ca<sup>2+</sup> signalling. The importance of plasma membrane glutamate receptor-like (GLR) channels and the vacuolar two pore channel 1 (TPC1) is highlighted in the context of systemic signalling response.

In the context of biotechnological application, the articles by Yusibov *et al.* on ‘antibody production in plants and green algae’ and Kantar *et al.* on ‘perennial grain and oilseed crops’ have provided additional value to the readers. The cost-effective production of antibodies, including monoclonal antibodies have always been a challenging task. Plants and green algae could be potential sources not only to reduce the cost, but also improve the efficacy of antibodies. The authors have highlighted the positive as well as negative aspects of various post-translation modification(s) on the production of antibodies in plants. Over the decades, plant breeders have put a lot more effort to improve the yield of annual crops. Despite improved crops yield, the equilibrium between growing human population and food security remains a major challenge. The article by Kantar *et al.* starts with a glimpse of food security and importance of perennial crops, and provides the history as well as strategy for development of perennial crops with improved yields. In June 2017, Hu and his colleagues (Yunnan University, China) held an international event to showcase their successful development of several high-yielding perennial rice lines of *indica* and *japonica* for upland and lowland cultivation. With perennial buckwheat, wheat, sorghum, sunflower and legumes under development in USA, China and elsewhere, it seems that we will soon witness the contribution of perennial crops towards sustainable agriculture. They save labour, tillage, sowing, transplantation, soil car-

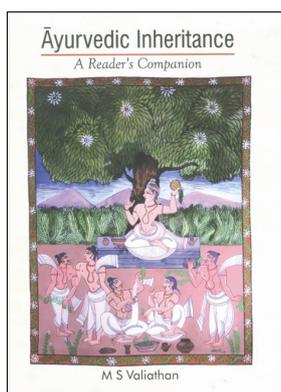
bon, greenhouse gas emissions from the soil and much more. Unfortunately, there is no research programme in India on perennial crops and it seems that we are not even thinking seriously in that direction, as monoculture and urea continue to dominate our policies and research activities. Unless we act swiftly, the era of globalization will not allow us to ‘catch up’ as we could do in the years of the Green Revolution.

In conclusion, *ARPB* 2016 has once again lived up to its reputation of providing timely reviews on topics of contemporary interest that are comprehensive, yet concise and easy-to-read, catering to the needs of students and scientists alike in the frontiers areas of plant biology.

1. Chakraborty, N. *et al.*, *Plant Mol. Biol.*, 2015, **89**(6), 559–576; doi: 10.1007/s11103-015-0374-2.
2. Chakraborty, N. *et al.*, *PLoS ONE*, 2015, **10**(2), e0117819; doi: 10.1371/journal.pone.0117819.
3. Urano, D. *et al.*, *Nature Cell Biol.*, 2012, **14**(10), 1079–1088; doi:10.1038/ncb2568.

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**Ayurvedic Inheritance: A Reader's Companion.** M. S. Valiathan. Manipal University Press (MUP), Behind Post Office, Manipal 576 104. 2017. 244 pages. Price: Rs 650. ISBN: 978-93-82460-58-9.

This book is indeed an engaging and deeply insightful reader's companion. Discerning students of history of medi-

cine, particularly those interested in India's medical heritage can get a broad sweep of the evolution of Ayurveda from Vedic times to the 21st century. It will be a glimpse only because a single book can hardly be expected to provide the reader access to the various dimensions of Ayurveda elaborated in an estimated 20,000 medical manuscripts. This book would definitely be of value and interest to healthcare professionals who wish to develop a general appreciation of Ayurveda; they can certainly anticipate insights in an uncommonly refreshing and contemporary perspective. Such appreciation by medical professionals is perhaps important in the emerging scenario of complementary medicine, integrative healthcare and medical pluralism that is already evident in the health-seeking behaviour of citizens all over the world. The recently released National Health Policy has adopted medical pluralism as one of its governing principles.

The first chapter on the ‘Roots of Ayurveda’, traces the origins of this system of medicine. The author conveys the understanding explicit in Ayurvedic texts that the roots of Ayurveda lie in the observations of nature. The observations acknowledged in Ayurvedic literature have three sources. First, Caraka exhorts his students to learn from the health practices of communities living close to nature, viz. the forest dwellers and shepherds. Unfortunately today, the symbiotic relationship between the codified and folk traditions is deeply eroded. The second source is the behaviour of birds and insects like kites and bees, mammals and reptiles like pigs, mongoose and snakes, who heal themselves. References to such behaviour are mentioned in the hymns of the *Atharveda*. The third source is from the direct observations of thoughtful and intuitive persons, the rishis and munis who in meditative states of mind were perhaps ‘one with nature’. Ayurveda thus did not emerge out of nothing. It emerged, as does all knowledge, from communion with life and nature. The book informs us that the first account of medicine is found in Vedic literature, particularly the *Atharveda*. This is followed by specific foundational texts which were regarded as upaangas or upavedas like *Susruta Samhita* and *Caraka Samhita*. Today only redacted versions of the original texts are available. The redacted version on *Susruta Samhita* was written by Nagarjuna in

4 CE and on Caraka in 1 CE. Hence the period of their original exposition can only be inferred. After the *Samhitas* there were a series of Buddhist works on Ayurveda and also reportedly Jain contributions about which the author is silent.

The second chapter on Ayurveda practice in Buddhist India 5 BCE to 1 CE, is one of the highlights of the book because in conventional Indian accounts of history of medicine, the contribution of Buddhist scholars and physicians is generally ignored. Valiathan points to the marked emphasis on public health in Buddhist India. He refers to the detailed information on design, construction and maintenance of toilets and bathrooms, the punishment for pollution of water bodies and dispels the impression that the Buddhist period discouraged the study of anatomy and practice of surgery. For a deeper understanding of the Ayurveda knowledge system, one may need to read Valiathan's own earlier translations of the three Ayurvedic *Samhitas* which are the foundational texts of Ayurveda or the five volumes of Meulenbeld on the *History of Indian Medical Literature* (Groningen, 1999), which reviews its long literary history.

The 18 chapters of the book sketch the Vedic origins, the Buddhist and post-Buddhist history and pre-colonial, colonial and post-independence evolution of Ayurveda, till the present date. There are chapters that outline the basic philosophy of Ayurveda, its concept of health and disease, food and drinks, medical ethics,



Caraka

principles of clinical medicine and surgery, drugs of plant, animal and metal and mineral origin and Ayurvedic pharmacology. Chapter 4 focuses on philosophical ideas in Ayurveda. It gives the reader insight into the world view, logic, methods of discourse and bioethics of Ayurveda. The 16th and 17th chapters of the book literally fly the reader from the past to the 21st century scenario. Valiathan introduces the reader to his own pioneering science initiative which has generated a new emerging trans-discipline called Ayurveda-biology. This chapter begins with a narrative of the Portuguese, Dutch and Indian scientific documentation and investigations into medicinal plants starting with taxonomic studies, drug development of natural products, clinical trials and culminating in the emerging and deeply collaborative, trans-disciplinary research on Ayurveda-biology which interfaces with molecular biology and immunology.

The book is full of interesting, intelligent and critical insights which one may hardly expect to find in a conventional publication dealing with the history and evolution of Ayurveda. Valiathan narrates insights into aracheo-epidemiology based on the work of Yamashita (Kyoto University, Japan). The analysis of frequency of references to disease entities in *Charak Samhita* (1 CE) suggests that it was more for infectious diseases (883) than non-infectious conditions (581). It also reports on a comparative study of Ayurveda practice across five centuries or more between the time of *Charak Samhita* (redacted in 1 CE) and *Vagbhata* (6 CE). This study concluded that in the 6 CE Ayurveda had become of a practical art with lesser emphasis on philosophy and perhaps a decline in the Gurukula tradition. The author informs that according to the observations of the Chinese Pilgrim Hiuen Tsiang in the 6 CE, the legacy of surgery of Susruta had declined and was practised around the 6th century, not by professional surgeons but by the artisan class of people in the fringes of society. This trend continues up to the 19 CE, wherein British observers report how low-caste persons (potters) performed skilled operations such as plastic reconstruction of the nose and couching for cataract in Coimbatore. Valiathan rejects the view that surgery

which had its genesis in India, declined in the Buddhist period on account of cultural acceptance of non-violence. He cites sources to show that Jivaka, who was the physician to Buddha and King Bimbisara, was an extraordinary surgeon. He also infers that Susruta must have practised in Banaras much earlier than 5 BCE, because Jivaka is reported to have performed a trephining operation which is not described in *Susruta Samhita*.

The 17th chapter on musings on Ayurveda appears to be the author's own reflections on the essence of Ayurveda philosophy and its outlook on nature. He reflects on a number of foundational premises of Ayurveda like providence, effect of time in different contexts, chance, fate and destiny, ethical goals of life, self-awareness and compassion. An interesting observation narrated by Valiathan is about the effect of moral and social behaviour on community health. Ayurvedic texts suggest that just as there are psychosomatic diseases that have a psychological origin, so also it is speculated that epidemics can be attributed to breakdown in the moral fibre of society.

The last chapter (18th) is a selection of verses from Ayurveda classical literature in order to give the reader a first-hand flavour of authentic Ayurvedic thought directly from the Sanskrit verses in the classics.

The Ayurvedic inheritance is perhaps worthy of appreciation not only for Indians, but for citizens of the world. Ayurveda is a macro-perspective (panchamahabhuta sidhanth) of nature, its systemic principles, key biological functions and the management of changes that constantly occur in life forms. Indians have discovered the working of nature viewed from a particular perspective. They are also custodians of the knowledge. The ownership, however, rests with life itself.

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