feely available to all users over the globe. Various aspects of ground stations, data dissemination and rush mode for emergency operations are all covered in the article. Excellent overview of applications is also provided. EUMETSAT Polar System which is part of the Global Operational Observing System under the auspices of the World Meteorological Organisation, is a cooperative programme of NOAA and the French Space Agency CNES. Details of the same are provided in section 1.07.

The next four sections (1.08 to 1.11) provide an account of how earth observation programmes have evolved over the years in China, Japan, India and Korea. China launched its first meteorological satellite in 1988 and since then has progressed considerably to have its own series of satellites devoted to observations over land, ocean and atmosphere. It also had successful collaboration with Brazil in launching China–Brazil Earth Resource Satellites (CBERS). China has developed many advanced sensors such as hyperspectral sensor, SAR, scatterometer, altimeter, etc. In addition to earth observation satellites, China has embarked upon development of a constellation of navigation satellites called BEIDOU. Geostationary Meteorological Satellite GMS-1, Himawari was the first satellite launched by Japan in 1977 for meteorological observations. Since then, Japan has launched a number of advanced remote sensing satellites, e.g. ALOS, PRISM, ADEOS-1 and 2, PALSAR and GOSAT. Japan collaborated with ESA in EARTH CARE programme. ASTER provided data in thermal channels. Indian earth observation programme began with the launch of an experimental remote sensing satellite Bhaskara-1 in 1979; it is applications driven. A number of satellites devoted to observations over land, ocean and atmosphere have been successfully launched over the years. The article provides the rationale for choice of sensors and their specifications flown on-board and also indicates the likely future missions. The Korean programme began with the launch of KITSAT-1 in 1992. Korea has come up with a long-term space development plan.

Detailed description of sensors operating in different parts of the electromagnetic spectrum is provided in the next few sections (1.12 to 1.16). Advances in ultraviolet remote sensing are dealt with in section 1.12. Some of the challenges associated with ultraviolet remote sensing like high level of Rayleigh scattering and presence of strong Fraunhofer lines are highlighted. Generally, this topic is not covered in textbooks on remote sensing, and hence this article may be particularly useful to some of the readers. Detailed aspects of design considerations, choice of specifications, and trade-off analysis in case of visible and infrared sensors are covered in the next section. Thermal sensors are quite distinct from the VNIR systems. Details of detectors used in thermal sensors, methods of cooling, optical systems required and the calibration techniques to be adopted are all described in another section. Description of a Fourier transform spectrometer is also provided. LIDAR systems find detailed description in section 1.15. Some of the advantages of laser-based sensors in remote sensing, such as high temporal and spatial resolutions have been highlighted. How laser systems are used to obtain very fine topographic information, tree structures, atmospheric compositions, wind profiles, fluorescence in oceanic waters, and investigations of planetary surfaces is described. Engineering details of the sensors, data processing tools and technology trends are well covered. Spacecraft systems carrying laser sensors such as ICESAT/GLAS are also described. Microwave sensors are a class apart. There are passive microwave sensors like the sounders, synthetic and real aperture radiometers which sense the emitted microwave radiation. The active sensors have their own source of radiation, which when incident on the object/surface gets reflected/scattered and is detected by the sensor. Some of the active microwave sensors are the scatterometer, altimeter and SAR. Basic physics, engineering details, signal processing and data processing issues are described in great detail in this section. How retrieval of physical parameters is carried out using signals is also discussed.

Vicarious calibration and validation is an important section (1.17) of this volume. While calibration defines quantitative response of the instrument to the known controlled input signal, validation refers to comparing the derived physical variables with the *in situ* physical observations. Vicarious calibration refers to calibration methods without the use of systems directly mounted on-board the satellite. Various vicarious calibration methods used in characterizing remote sensors are described in this section. Mathematical basis of active coherence in radar missions is provided in the last section (1.18).

Overall, the volume is quite comprehensive in providing up-to-date information on remote sensing sensors and platforms, and how they have evolved in the last 40 years or so. It also provides description of remote sensing programmes of different countries and major international programmes. Physical basis to the design of sensors is also provided. Absence of information related to the remote sensing programmes of well-known players such as Russia and France is surprising. In the last few years, smaller platforms such as CubeSats are becoming important in space-based remote sensing. Planet Labs is one such example. This volume does not mention these developments. Notwithstanding these shortcomings, this book is an excellent source for every remote sensing professional. Every library should have this volume on its racks.

RANGANATH R. NAVALGUND

Indian Space Research Organisation,
Antariksh Bhavan,
New BEL Road,
Bengaluru 560 094, India
e-mail: navalrr@gmail.com

Annual Review of Physiology, 2018. David Julius and Mark T. Nelson (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California, 94303-0139, USA. Vol. 80. vi + 429 pages. Price: US$ 112.00.

One of the articles that immediately caught my eye in this volume of the *Annual Review of Physiology* was that by Rucker *et al.* entitled 'Salt, hypertension and immunity'. Hypertension, a major health problem, affecting about 13% (1 billion) of the total population of the world is a major risk factor for a host of diseases, including stroke, myocardial infarction, kidney failure and heart failure, among others. Medical students who have read Guyton's classic *Textbook of Medical Physiology* will be familiar with

his lucid chapter on the regulation of blood pressure via the 'pressure-natriuresis' pathway, and his elaboration on salt sensitivity. The link between salt sensitivity and blood pressure is not new and has been established repeatedly, initially in relation to black Americans and their increased propensity for high blood pressure. What is different in the article is the detailed review of immune mechanisms that mediate hypertension and salt hypersensitivity. Thus, increased salt affects myeloid cell differentiation such that it increases proinflammatory monocytes, which through their release of inflammatory cytokines and reactive oxygen species could impact the function of the kidneys and the vasculature. Sympathetic nervous activation and oxidative stress in the central nervous system enhance antigen-dependent T-cell activation in the kidneys and the vasculature, and the release of cytokines and ROS at these sites impairs renal sodium excretion. Much of the evidence presented comes from *in vitro* and animal studies, and an important extension of this work will be to evaluate the role of immunity in human hypertension and assess the extent to which hypertension accrues from immune mechanisms.

In their article on 'Chemoreceptors in the gut', Steensels and Depoortere discuss the mechanisms of chemosensory signalling in the gut in health and disease. This is important because gastrointestinal epithelium constitutes the largest interface between the body and the external environment and needs to sense not only nutrients but also non-nutrients, some of which may be particularly harmful to the body. The sensory information processed in the gut can affect a host of bodily responses, including gut motility, appetite, immune responses and hormonal release, among others. The chemoreceptive function is not restricted to enterocytes alone, but is also a function of enteroendocrine cells, tuft cells, and goblet and Paneth cells, among others. Resetting of the chemoreceptive function of the gut has been implicated in many disorders, including obesity and diabetes. It has also been implicated in immune disorders affecting the gut, such as Crohn's disease and ulcerative colitis. The holy grail, as always, is to identify new therapeutic targets that utilize chemosensing pathways in the gut.

Neuromuscular transmission has seen some important advances in the past. In 1936, Otto Loewi shared the Nobel Prize with Henry Dale for his work on acetylcholine, a neurotransmitter at multiple locations, including at the neuromuscular junction (NMJ). In 1957, Daniel Bovet won the Nobel Prize for his work on the neuromuscular blocking effects of succinylcholine, an analogue of acetylcholine. This paved the way for the use of neuromuscular blocking agents during the induction of anaesthesia. Later in 1970, Bernard Katz shared the Nobel Prize for his work on the quantal release of acetylcholine and the development of the endplate potential. This volume carries an interesting article on neuromuscular junction formation and development, and its potential role in ageing and other disorders. Neuromuscular junction formation requires a close interaction between the motoneurons, muscles and the Schwann cells. The article by Li *et al.* highlights the role of AGRIN-Lrp4-MuSK signalling in inducing acetylcholine receptor clusters and also details various intracellular and extracellular mechanisms linked to this signalling process. A notable neuromuscular disease is myasthenia gravis, an autoimmune disorder in which antibodies are directed against the acteylcholine receptors (AChR) in the neuromuscular junction. However, as the authors point out, 10–15% of patients with myasthenia gravis are negative for antibodies against AChR but positive for antibodies against agrin and its receptor Lrp4, suggesting an important role for agrin in NMJ maintenance. Ageing is associated with NMJ fragmentation and an important question is whether this contributes, and to what extent, to sarcopenia (loss of muscle mass) associated with ageing. The ultimate goal would be to prevent sarcopenia and thus mitigate some of its deleterious effects including, among others, decreased physical activity, leading to a higher prevalence of insulin resistance, type-2 diabetes mellitus, dyslipidemia and hypertension.

The spinal cord is an important relay station for nerve impulses being transmitted to and from the brain. It is also an important site for the processing of various spinal reflexes. Koch *et al.* in their article on 'Spinal circuits for touch, pain and itch', outline recent research in mice which attempts to map the spinal cord circuits that process the cutaneous somatosensory modalities of touch, pain and itch. These circuits contain excitatory nerve populations that are important for transmission of impulses as well as inhibitory neurons responsible for 'gating' – the phenomenon where sensory information is blocked or inhibited from onward transmission. Three years ago marked the 50th anniversary of the landmark *Science* publication 'Pain mechanisms: a new theory' by Ronald Melzack and Patrick D. Wall (1965, **150**, 971–979), in which the authors introduced the gate control theory of pain. The theory had a profound influence on approaches to managing pain, including the simple use of counterirritants in pain 'balms', to newer techniques for intractable pain such as transcutaneous electrical nerve stimulation. Koch *et al.* highlight the complexity of the spinal circuits and extend our understanding of how sensory information is encoded and transformed within the spinal cord, including the fact that different sensory modalities are processed by distinct molecularly defined interneuron cell types.

An article of particular public health importance is that of Humphreys – 'Mechanisms of renal fibrosis'. Kidney fibrosis is the development of scar tissue in the parenchyma. The typical pathway is injury, inflammation, myofibroblast activation and migration, matrix deposition and remodelling. Fibrosis represents the final pathway of almost all chronic kidney disease (CKD), regardless of cause. CKD affects between 5% and 13% of the general population depending on country, and a significant number of people in the later stages of CKD will require dialysis or kidney transplantation. Given this, an important aim of future therapies, although no targeted therapy currently exists, would be to slow renal fibrosis. This article discusses the various cells and molecular mechanisms and pathways that underlie renal fibrosis, including the role of paracrine signals following renal injury. The author suggests that targeting the signalling pathways that mediate tubulointerstitial crosstalk might be a promising therapeutic strategy.

The special topic in this volume is 'Mechanobiology', with Julio M. Fernandez as the special topic editor. It consists of four articles. The first article by Eckels *et al.* focuses on 'The work of titin protein folding as a major driver in muscle contraction'. Despite being the largest protein in the human body, the role of titin in muscle contraction is rather poorly understood. The sliding filament

hypothesis of muscle contraction was initially explained in terms of myosin and actin interactions alone. In this article, an attempt is made to integrate the role of titin with actin and myosin interactions. For instance, the sarcomere length-active tension relationship attributed inadequately to the extent of actin–myosin cross-bridge interaction is shown to be associated with titin folding. The authors also demonstrate that there is synchronization of titin folding with actomyosin contraction. The article is a necessary read for those who are involved with researching and understanding skeletal muscle function, but as the authors indicate 'we are undoubtedly only in the early stages of understanding the physiological functions of titin'. This article is supplemented by another on the titin gene and its function in active and passive muscle by Wolfgang Linge. In a separate article, which I found particularly intriguing, Vogel discusses the 'Mechanobiology of the extracellular matrix'. Cells are anchored to the extracellular matrix (ECM) and there is now a growing understanding that mechanical forces regulate protein, cell and tissue function. For instance, stretching of ECM fibres can affect embryogenesis, tissue homeostasis, regenerative process, cancer and fibrotic disorders, and have implications for the development of drugs that exploit stretched proteins as targets, and tissue engineering.

There were many articles in this volume that I found riveting. There comes a time when you begin to read a lot about very little. In this respect, the *Annual Review of Physiology* reminds us of the vast and exciting advances in fields beyond those of our own specialized interest. I continue to miss the first prefatory chapter that used to blend the science and art of experimentation around the life of a prominent scientist, and I look forward to its return in the future volumes.

MARIO VAZ

Department of Physiology,
St. John's Medical College,
Bengaluru 560 034, India
e-mail: mariovaz@sjri.res.in