

order of square of (v/c) , where v is the velocity of the object and c is the velocity of light. But the author applies this term to photons by taking v to be equal to c ! So the additional term cannot be viewed as a small correction.

There are detailed calculations of predictions in a few cases for which observations are available. The areas where this term has been applied include cosmological redshift, gravitational redshift of light emitted by the sun and white dwarfs, redshift of photons grazing the sun, secular retardation of planets and satellites, transfer of angular momentum from centre to periphery due to differential drag, and matter distribution in spiral galaxies. Some of the applications are qualitative and in some cases, there are just hand-waving arguments given. One glaring omission is the application to bending of light by the sun, where Newtonian theory predicts half the value observed while general relativity predicts the correct value.

The first application is to the photon. The drag on it leads to a formula for cosmological redshift. It is concluded that expansion of the universe is not needed and we are in a static universe. The cosmic background radiation is attributed to cosmic rays and other vague ideas. The derived redshift increases (exponentially) faster than the distance. This does not agree with the recent observations using supernovae, which seem to indicate the opposite; it is distance which is increasing faster than redshift.

The corrections are significant for the sun and galaxies, but get smaller for objects smaller than the sun or larger than the galaxies. This is because the velocity term falls-off like the square of the distance. So the redshift due to drag is not a small correction for the sun, it is an addition of about two-thirds of the Einstein value. The observation of the gravitational redshift of the sun is complicated due to Doppler shift caused by motion of gases at high temperatures. The author claims a good fit to the data for his predicted value. Whereas J. M. Beckers (*Astrophys. J.*, 1977, **213**, 900) found that at dark spots in the sun, where the temperature is low, making convective effects of gases negligible, the exact Einstein value is obtained. A result which leaves no room for the effect of drag. The other predictions made in the book are also not completely convincing,

and are masked by other competing effects.

The book is written in a clear and lucid style, and the author's enthusiasm for the discovery is quite evident. I find it difficult to get excited or even convinced by the idea. The book may be of interest to persons with a liking for unconventional ideas in science, but will have only a limited appeal to others.

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Annual Review of Biomedical Engineering, 2001. M. L. Yarmush *et al.* (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, USA. 2001. vol. 3, 483 pp.

Biomedical engineering, an interdisciplinary field, has emerged as one of the major contributors to health care. It has received inputs from various branches of science, engineering and medicine. It is in this context that the *Annual Review of Biomedical Engineering, 2001* with its 16 reviews gains its relevance by providing a comprehensive review of significant developments.

To honour the memory of Thomas McMahon, a pioneer in the field of cardiac-assist devices and orthopaedic biomechanics, a prefatory chapter is added, which is followed by reviews related to his speciality. The cardiac-vascular development involves a dynamic interaction of genetic and environmental factors. The various features of development of chick-embryo heart are explained based on modelling of growth and microstructural adaptation. The moulding (morphogenesis) of tissues, as controlled by micromechanical and chemical signals, contributes to the growth of the inner and outer walls. The radial growth of the blood vessels depends on shear stress due to blood flow. According to Taber, remodelling of the cardiovascular tissues takes place in diseases. The review by Grotberg on respiratory fluid mechanics and transport process presents the contributions from pulmonary and

critical-care medicine, surgery, physiology, environmental health sciences and engineering. Through modelling and experimental studies the changes in air flow, starting from nasal area to alveoli are presented. The various processes such as transport of non-respiratory gases, aerosol transport, airway stability, etc. associated with health and disease conditions are well elaborated.

In order to understand the occurrence of increasing number of injuries, especially related to abdomen, pelvis and lower extremities due to car accidents, the fundamentals of impact biomechanics are presented. Based on large data, King has reviewed the prevention aspects of these injuries. Osteoporosis could dramatically reduce failure load, which occurs after tolerance limit is exceeded. The micro- and nanomechanics of outer hair cells associated with electromobility is crucial for amplification, sharp frequency selectivity and nonlinearities of mammalian cochlea. The review by Maynard explains the features to achieve narrower mechanical tuning through electromobility modelling, based on phenomenological description, molecular level modelling and membrane bending. The review on trabecular bone by Keaveny *et al.* presents the theoretical and micro-level imaging developments in this field. A unique tool for analysis of multi-axial loading, time-dependent failure and damage accumulation of this spongy bone, the micro-structural class of 'high resolution' finite element method is discussed. Through this the relation between bone anisotropy and underlying architecture with reference to aging, disease and drug treatment is analysed. The interaction of nervous and muscle systems to produce coordinated movements of body parts, by computer modelling and simulation procedures, are analysed. This review by Pandey also includes schematics of the coordination activities of various systems applied to analyse jumping, pedalling and walking of human subjects. The data on the networks of biochemical, genetic and biophysical processes of cellular behaviour and their failure, consisting of hundreds to thousands of interacting chemical species and structures, as analysed by forward engineering and modelling, are reviewed.

The development of vascular tissues considering endothelial cells as base material, is reviewed by Nerem and

Seliktar. The most general configuration contains an adventia-like layer of collagen and fibroblast, a media-like layer of smooth muscle cells followed by monolayer of endothelial cells and Dacron. The requirements of long-term potency and immune response are the prime parameters for their acceptance. Tissue engineering and cellular therapies based on stem cells are important for future developments in medicine. The review by Zandstra and Nagy outlines the biological properties of stem-cell population and highlights the challenges in the development of stem-cell technologies for therapeutic cloning and gene therapies.

The technological development reviews include the image-guided procedures (IGP), high-intensity focused ultrasound (HIFU) and functional vision restoration system (FVRS). The IGP is used to increase the information available to physicians for surgery and other forms of directed therapy. Its fundamentals are well reviewed by Galloway and specific applications to intracranial resection/ablation, function neurosurgery and stimulator placement, orthopaedics, etc. with promising results are discussed. Vaezy *et al.* have reviewed the therapeutic aspects of HIFU of intensity 1000–10,000 W/cm² and changes in tissues which are primarily attributed to its thermal and mechanical effects. For determining the target location and changes induced by HIFU, imaging techniques are used. Acoustic therapy with low-intensity ultrasound is further applied in physical therapy, tumour treatment and biomedical applications. The review by Maynard on FVRS points out that the electrical stimulation of the visual pathways can be used to produce visual sensation in blind individuals. Other issues such as biocompatibility of implant, and emotional and economic reasons of recipients are discussed.

Jafri *et al.* have reviewed the regulation of energy metabolism through ATP synthesis. Details of the micromechanisms involved in this process are well explained through the development of mathematical and computational analysis of various sub-cellular processes. Another molecule, nitrogen monoxide or nitric oxide (NO), chosen in December 1992 as 'molecule of the year' by *Science*, is a rapidly diffusing, free-radical gas with one unpaired electron exhibiting a surprisingly diverse range of biological

activity, including potentially harmful effects. The review by Buerk highlights numerous biochemical reactions or sinks for NO biotransport in the lungs and brain under normal physiological conditions. On the other hand, its excessive production contributes to numerous cardiovascular and neurological diseases.

The human genome and genetic sequencing projects have contributed in the development of sequencing technology. Marziali and Akeson have reviewed various developments in sequencing DNA. The techniques are based on electrophoretic and non-electrophoretic methods. Whitesides *et al.* reviewed soft lithography techniques applied in biology and biochemistry. These are based on printing and moulding using elastomeric stamps with the patterns of microstructure for biological research. The change of surface properties such as hydrophilic or hydrophobic contribute into transferring the pattern of molecular species. These reviews further stress upon the need of molecular biology to explain the micro- and nanomechanics associated with biological processes.

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Geology of Bihar and Jharkhand. T. M. Mahadevan. Geological Society of India, P.B. 1922, Gavipuram P.O., Bangalore 560 019. 2002. 563 pp. Price: Rs 500/US\$ 50.

This is the latest publication in the textbook series on Geology and Mineral Resources of different states of India, being published by the Geological Society of India. The present volume deals with the Geology of Bihar and Jharkhand. The author, T. M. Mahadevan, brings his scholarship and rich experience with the Geological Survey of India and Atomic Minerals Division into the book. The state of Jharkhand was 'carved' out of Bihar while the book was in the printing stage. The author has shown the state of Jharkhand in a map (Figure 1.3), but it was not possible to

incorporate geographical changes in the text. This will cause some difficulty to the reader unfamiliar with the local geography.

The author discusses the geology of Bihar and Jharkhand in 22 chapters running to 558 pages. Singhbhum region of Jharkhand is one of the best-studied Precambrian terrains of India. The author rightly devotes a chapter to the seminal contribution by the earlier workers. Chapter 3 deals with the geological history of Bihar and Jharkhand in 24 pages. This is really a summary of what follows in the book. Readers unfamiliar with the geology of the region will find it out of place. Chapter 4 deals with geomorphology of the states in relation to the geological set-up. It takes up 70 pages which I consider a wee bit lengthy, but is a welcome synthesis. Some of the figures in this chapter (Figures 4.4, 4.8, 4.11) suffer from lack of clarity.

Intensive structural, stratigraphic, petrologic and geochemical studies during the last century have generated comprehensive data on the region, particularly on the Singhbhum area. The author has justifiably devoted 12 chapters covering 251 pages on these aspects. There are classical treatises on the regional geology by earlier workers and critical appraisal of the observations and opinions of recent researchers. The *Crustal Evolution of Singhbhum – North Orissa, Eastern India* by A. K. Saha was published by the Geological Society of India as a Memoir (No. 27) incorporating published data up to 1992, while the volume under review includes publication up to 2000. Mahadevan's overall comprehension of the region as a greenstone–granite terrain exposing several generations of volcano-sedimentary sequences and intrusive granitoids, cutting across the temporal boundary of the Archaean and Proterozoic, is in tune with the present-day understanding. The views on multiple BIF sequences, and the crustal evolutionary models suggested by different researchers have been critically discussed. However, inclusion of recent data on the petrochemistry of the volcano-plutonic assemblages, sedimentological aspects and gravity-magnetic models published in the extended abstracts of Geological Survey of India in the areas around Pala–Lahara, Gorumahisani–Badampahar, Champua, etc., would have enriched the volume further. Mahadevan is, of course, con-