

Annual Review of Biomedical Engineering, 2005. Martin L. Yarmush *et al.* (eds). Annual Reviews Inc. 4139 El Camino Way, Palo Alto, California, USA.

Annual reviews are of great importance in bringing together the expertise and thoughts of eminent scientists and various groups of researchers working in allied areas in a comprehensive way. Such volumes provide glimpses of current happenings and also present the future directions. The volume under review is one such review which contains 12 reviews covering topics like DNA mechanics, nanocrystals, cell bio-chemistry and mechanics, neuronal development, infarct mechanics, molecular imaging in animals using PET, magnetic resonance spectroscopic applications in the study of cancer, functional studies in neuromuscular applications and on retinal prosthesis.

The first article is on the life and work of Warner Goldsmith (1924–2003), a pioneer and an authority on mechanics of impact and biomechanics of head and neck injuries. This article sketches Goldsmith's six decades of contributions in the area of mechanics, dynamics and biomechanics. The biographical sketch is presented including details of his professional career. His interests in biomechanics with particular interest in head and neck injuries and his achievements are given lucidly. It is reported that the development of several physical and mathematical models for head and neck injuries is one of his important contributions. It also describes how his studies helped in understanding the causes and nature of injury in vehicular collisions. Goldsmith has to his credit an encyclopaedia on studies of the biomechanics of head injury. Part 1 is on 'The State of Head Injury Biomechanics: Past, Present and Future' and was published in *Critical Reviews in Biomedical Engineering* in 2001. Part 2 was incomplete at the time of his passing but now being finished by Ken Morson. The article also discusses his various other contributions like in bioengineering education and to the profession at large. Details of his achievements, awards and honours are also provided. W. Goldsmith died peacefully at home in Oakland, California, on 23 August 2003 at the age of 79 after a short, courageous battle with leukaemia.

In the second article, Benham and Mielke review the DNA mechanics. The description and evaluation of several meth-

ods for the analysis of structures of super helical DNA molecules are presented. The review begins with the history of DNA, its structure and energetics. Details of three main approaches used for studying the energetics are presented. The first is on the mechanical equilibrium method that computes minimum energy conformations of topologically constrained molecules. The second is on the description of the statistical mechanical methods, wherein the Boltzmann distribution of equilibrium conformations in a finite temperature environment is computed. The third is on the details of dynamic methods, which are used to compute the deterministic time-dependent trajectories of the helix by solving either numerical or analytical integration of the equations of motion. The article raises some open questions like the agreement between the predicted structures and that obtained experimentally does not in itself provide evidence for the correctness or completeness of any given model of DNA mechanics, since all the models developed make large simplifications like excluding self-contacts, etc.

The third review (Alivisatos *et al.*) deals with the applications of semiconductor nanocrystals (quantum dots, QDs) as a new class of fluorescent labels. The article outlines the recent reports in this area that provides better understanding of the surface chemistry, biocompatibility and target specificity. Studies showing the potential of using QDs as new probes for *in vitro* and *in vivo* applications are presented. The review describes the development of QD as a tool from physical chemistry to biological applications. The details of synthesis, optical properties, biocompatibility, toxicity and specificity aspects are presented. It also summarizes the recent results of QDs usage at the cellular level, including immunolabelling (molecular localization and signalling pathways), cell tracking, *in situ* hybridization, fluorescence resonance energy transfer (FRET), and other related technologies. Several examples of QDs as *in vivo* probes and its potential for cancer studies, drug delivery and non-invasive whole body imaging are illustrated. QDs usefulness in the study of microorganisms has also been reviewed. The article concludes outlining the numerous unexplored possibilities to expand the repertoire of QDs labelling in the future.

Toner and Irimia discuss the method of manipulating blood cells at the micro-

scale. Accurate and fast analysis of the cellular component of blood is of prime importance in medicine and research and the review presents the lacunae in the normal sample preparation procedures for blood analysis that are prone to artefacts. The article describes the need for skilled technicians and well-equipped, expensive laboratories for such analysis. It also presents the recent progress in the area of microfluidics and lab-on-a-chip-type devices. Details of the precise control required for cell microenvironment during separation procedures and the analysis involving small volumes of blood are outlined. The principles of manipulating the blood cells at microscale with high-throughput approaches to blood cell separation using microdevices are also discussed. The review presents several examples of specific single-purpose devices together with integration strategies for blood cell separation and analysis modules.

The biochemistry and biomechanics of cell motility are reviewed by Li *et al.* It is known that cell motility or migration is an essential cellular process for a variety of biological events. The process of cell migration requires the integration and coordination of complex biochemical and biomechanical signals. The review describes the cell protrusion involving a polymerization and extension of the cytoskeleton underneath the cell membrane. Details of the force generation controlled by multiple signalling cascades are presented. Various studies reporting the involvement of the cross-link between the microtubules and the actin filaments are described. The role of cell adhesions in cell motility and the release of adhesions in signalling mediated by integrins and other adhesion receptors are given. The review also describes how the traction force generated by the cell on the extracellular matrix (ECM) regulates cell-ECM adhesions, and the counter force exerted by ECM on the cell drives the migration. The effect of external chemical and mechanical factors, like chemo-attractants and the mechanical forces on the migration of cells and the regulation of cell mobility by ECM are described. The review also presents the future directions and challenges especially in relation to the level of complexity to determine and understand the dynamics of various protein complexes in migrating cells and cell and tissue engineering.

Simon and Green review the biology, biomechanics and dynamics of leukocyte

human polymorphonuclear leukocytes (PMNs) and endothelial cells during inflammations. The review discusses the growing interest in the cell mechanic and receptor dynamics that lead from transient tethering via selectins to affinity shifts and adhesion strengthening through integrins. Optical tools that enable real-time imaging of leukocyte rolling and arrest in parallel plate flow channels (PPFCs) are described. Details of the detection of single-molecule force spectroscopy that provide an inner view of the intercellular adhesive contact region are also presented. The article illustrates that leukocyte recruitment during acute inflammation is triggered by ligation of G protein-coupled chemotactic receptors (GPCRs) and clustering of selectins. This in turn, activates β_2 -integrin (CD18), which facilitates cell capture and arrest in shear flow. The conceptual views of these molecular and biophysical events that contribute to leukocyte recruitment during inflammation are nicely presented.

Studies of axons during development and after injury are reviewed by Maskery and Shinbrot. They first present briefly the molecular biology of regulation of migration of the growth cone and branching of axonal arbors. The growth cone is the terminal structure at the end of a growing axon and the article outlines the fundamental considerations that are important to the modelling of the phenomenology of these guidance effects and their underlying internal mechanisms. The authors also discuss and provide some thoughts on the future of biomedical modelling.

Holmes *et al.* describe the structure and mechanics of healing myocardial infarcts. In general, therapies for myocardial infarction have been developed by trial and error, rather than from an understanding of the structure and function of the healing infarct. The review describes the different mechanisms by which the presence of the myocardial infarct may impair ventricular function. The consequences of myocardial infarction including rupture, infarct expansion, ventricular remodelling, hypertrophy, heart failure, etc. are discussed. The exciting new bioengineering therapies for myocardial infarction are reviewed. The discussion on the time course of the structural and mechanical changes of healing infarct and on the key structural determinants of mechanics during several stages of healing are also presented. In addition, the review presents the results of a number of studies

carried out on temporal correlation, the mechanics during acute ischemia, edema during the subsequent necrotic phase, large collagen fibre structure during the fibrotic phase, and on the cross-linking of collagen during long-term remodelling phase. Further research required on infarct mechanics, particularly studies that integrate material testing, *in vivo* mechanics, and quantitative structural analyses are also outlined.

The development of noninvasive imaging techniques and the use of genetically engineered animal studies to model human diseases and normal development has paved the way for recent advances in biological sciences. Tai and Laforest present the fundamental and technical challenges of small animal positron emission tomography (PET) imaging, with a particular focus on the latest developments and future directions on methodology and system design. Noninvasive imaging techniques like PET, which permit longitudinal studies of the same animals, are very attractive. Such studies reduce the number of animals used, reduce inter-subject variability and improve the accuracy of biological models. The quantitative PET measurements on the spatiotemporal distribution of radiotracers and its role in molecular imaging to study biology, to monitor disease intervention, and to establish pharmacokinetics for new drugs are nicely illustrated. The details of animal PET scanners to study transgenic mice and the fundamental challenges of PET imaging are also discussed. In addition, the current development of PET technology, detector design and system design details are nicely documented.

In vivo magnetic resonance spectroscopy (MRS) for more than two decades is used to investigate the metabolic distributions of living cells and tissues. The application of this new emerging technique for cancer is reviewed by Gilles and Morse. Various techniques that were developed to acquire spectra from single and multiple voxels have been presented. With the current methodology, individual volume element of less than 1 μl of tissue (i.e. $1 \times 1 \times 1 \text{ mm}^3$) can be achieved. The various applications of ^1H , ^{31}P , and ^{23}Na *in vivo* MRS have been well reviewed. In addition, the use of ^{19}F , ^{13}C , or ^{17}O MRS investigations of cardiac and skeletal muscle energetics, neurobiology, and cancer have also been presented. The main focus of this review has been on the applications of MRS, with special refer-

ence to the measurement of tissue choline, which has proven to be a tumour biomarker that is significantly affected by anticancer therapies.

The next review is on the physiological and technological principles and applications of electrical stimulation applied to neuromuscular systems by Peckham and Knutson. It is known that paralysed or paretic muscles can be made to contract by applying electrical currents to the intact peripheral motor nerves innervating them. When electrically elicited muscle contractions are coordinated in a manner that provides function, the technique is termed functional electrical stimulation (FES), the details of this methodology are discussed in this review. The authors also present methods for modulating the strength of electrically induced muscle contractions. The application of FES for restoring function in the upper extremity, lower extremity, bladder and bowel, and respiratory system are nicely illustrated with examples. Technological developments and status of new systems that have no external components, which are used in multiple applications, are highlighted. Finally, the future directions and developments of FES technology and control methods are presented.

The last review is on retinal prostheses by Weiland *et al.* The use of retinal prostheses for individuals with incurable and blinding diseases of outer retina is known. Other visual gross prosthesis such as cortical and optic nerve, is discussed briefly. A discussion on normal eye anatomy, the physical constraint on the implantable devices and a review of retinal diseases are presented. The basis of the electrical activation of nerves, the prototype retinal prostheses tested in blind humans and their capability to elicit the sensation of light and the ability to detect motion are discussed. The review contains a number of examples from animal and human studies. Highlights of improvement of the visual function in implant recipients and a survey of studies that define the output requirements for individual electrodes are described. Finally, the retinal prosthesis subsystems available are reviewed including the future progress and the hurdles that remain.

Overall the volume is not just a collection, but a meticulous selection of articles reflecting the current trends in the area of biomedical engineering. The contents of the volume are exhaustive and useful. It is well structured with nice illus-

trations. The efforts of the editors and those of the authors of the review deserve appreciation. This volume will be an asset as a reference book for libraries and for those who want to know more about biomedical engineering.

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Administrative Reforms: Towards Sustainable Practices. Amita Singh (ed.). Sage Publications India Pvt Ltd, B-42, Panchsheel Enclave, New Delhi 110 017. 2003. 319 pp. Price: Rs 380.

Achieving the multi-faceted goals of sustainable development through more efficient utilization of resources poses formidable challenges while providing great opportunities in India. Major economic reforms gained momentum in India in early nineties, but it failed to deliver effectively due to the lack of appropriate implementation measures that were required to ensure sustainability. Highlighting the tenets of sustainable development, Reddy (*Curr. Sci.*, 2004, **87**, 889–898) has emphasized the need for strategies with ‘equity, economic efficiency, environmental soundness, long-term viability, self-reliance and peace’ for regional and nation’s sustainable development.

In a rapidly urbanizing economy with fast technological changes, there is a need for governments to quickly and continuously ‘adapt’ to these changes ensuring a that smooth and sustained workflow through interactions with the government and the people. Thus, the governance is the exercise of economic, political and administrative authority to manage a country’s affairs at all levels. It consists of the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences. Poor governance generates and reinforces poverty and subverts efforts to reduce it. Good governance would ensure that developmental schemes reach all sections of the society and aid in enhancing the quality of life.

Strengthening governance is an essential ingredient for eradicating poverty while promoting sustainable development.

Democracy empowers citizens through decentralization of power, effective people’s participation through state and non-state mechanisms, greater synergy and consolidation among various agencies and programmes of government, civil service reforms, transparency, rationalization of governmental schemes and mode of financial assistance to states, improved access to formal justice system to enforce rights, reforms and strengthening of land administration and harnessing the power of technology for governance. In contrary, policy-making takes place at the centre (macro-level), and the actual implementations at the end-user (micro-level), by the bureaucrats/administrators are mostly different than what was originally conceptualized or intended for, as implementation practices are embedded with colonial structures, bureaucratic autonomy and opaque systems leading to economic inefficiency, ineffectiveness and inappropriateness of some of these set-ups.

With the onset of economic reforms, emergence of technology-driven society (socio-technical systems) and markets, it is imperative for the governments to reinvent, realign and adapt to remain or sustain the external pressures from different stakeholders, especially with pressures of globalization and calls for decentralization for overall development of India’s 700 million plus strong rural population. The necessity to achieve ‘sustainability’ by the administration with local governance or in public sector organisations or any reforms has become a cornerstone. A key issue on achieving sustainability and sustainable development is through administrative reforms. The book under review, a compilation of ‘good practices’, comes in at a time when the helm of affairs on governance and administrative practices is up for a thorough introspection. This book is a collection of papers presented at the ‘International Conference on Administrative Reforms, Good Practices and their Sustainability’ on 24–25th April 2003 at New Delhi.

The introductory chapter by Amita Singh dwells on the ‘best practices’ and ‘innovations’ in the administrative sectors that has taken place at grass-root levels of administrative hierarchy based on exhaustive literature review. This chapter starts with a general overview of administrative reforms, its role and experiments

worldwide. Subsequently, the chapter addresses the early attempts to reform administration in India from post-independence to recent reforms driven by globalization and influence of information and communication technologies (ICT) in administration (e-governance). It is noted that the emergence of New Public Management (NPM) and the need for economic efficiency in governance (through privatisation) although has spearheaded administrative reforms, it is the innovations and best practices either initiated by the local administration (decentralization) or the civic society that has made these successful. Identifying the successful innovations and best practices while addressing the issues of sustainability and replicating these in different instances are difficult since most of these practices and innovations are context specific. However, in the wake of decentralization and greater autonomy at the local/grass-root levels complimented by public participation can be a successful one as evinced from the different case studies.

The first chapter by Mohit Bhattacharya presents the decentralizing experiment in the Kolkata Municipal Corporation through borough and ward committees. The decentralized system headed by a Mayor of the council has come in place of a central command, paving the way to a more participatory approach. In spite of these, the exercises have not been fully successful due to lesser autonomous and executive powers at the ward or borough levels, and limited financial independence. However, it is noted that this experiment can become a role model for many other large municipal corporations by providing greater autonomy at the ward level with scope for revenue mobilization and thereby reducing the dependency on funds from the central agency.

The second chapter by Jennifer Jalal presents the comparison of good practices in public sector reforms that have taken place in Bangalore and Kolkata due to administrative reforms through participation of private sector, non-governmental organizations and public. In the case of Bangalore, the state had mooted the Bangalore Agenda Task Force, which acted as an interface for synergizing the efforts undertaken by different stakeholders involving the different state-run service organizations, the public and the private enterprises. Contrary to this, Kolkata continued the centralized administration without significant reforms while adopting