Oxidative Stress in Skeletal Muscle. A. Z. Reznick, L. Packer, C. K. Sen, J. O. Holloszy and M. J. Jackson (eds). Birkhauser Verlag AG, P.O. Box 133, CH-4010 Basel, Switzerland. 1998. 346 pp. Price: SFr 178/DM 198.

Free radicals and antioxidants are buzzwords these days. Atoms or molecules that have one or more unpaired electrons are designated free radicals. Two important examples of free radicals produced in the human body are superoxide, a one-electron reduction product of oxygen, which mediates the destruction of infectious organisms by phagocytes, and nitric oxide, which is now recognized to have several physiological functions. It is estimated that approximately 1.72 kg of superoxide is made in the body per year! Excess of free radicals is toxic to the cells and antioxidant defenses in tissues either minimize the production or remove excess of free radicals.

Oxygen radicals are implicated in the pathogenesis of a wide variety of human disorders that include age-related diseases such as Parkinson's disease and cataract. During the last decade, the study of the role of oxidative stress in causing damage to tissues gained momentum thanks to the availability of several techniques to measure various components of the oxidant–antioxidant system in the body.

This multiauthored book is a testimony to the expansion of knowledge with respect to mechanisms associated with oxidative stress in muscle. The text is one of the series titled 'Molecular and Cell Biology Updates' edited by Angelo Azzi and Lester Packer. All the authors are eminent in their fields; most of them are from the USA and the UK.

There are 22 articles in this volume. The first two reviews introduce the readers to the role of oxidative damage in human diseases and oxidative metabolism in skeletal muscle. The third one discusses the various approaches and methodologies currently available to detect and measure in biological systems, the levels of oxidants, antioxidants and oxidantly modified DNA, proteins, enzymes and fatty acids. In this article, Reznick *et al.* draw attention to the considerable complexity in the assessment of oxidative parameters because of the number of enzymatic pathways involved and the limitless number of reactions of oxygen and its derivatives.

Skeletal muscle comprises about 35% of our body weight. Muscles consume substantial amounts of oxygen during contraction and exercise. During these times, the excessive use of oxygen also results in generation of large amounts of reactive oxygen species. Excessive physical exercise can however result in damage to muscle fibers. M. J. Jackson details the mechanisms of muscle damage during exercise. During exhaustive aerobic exercise, oxygen radicals generated by secondary inflammation are responsible for the delayed onset of muscle damage.

J. Komulainen and V. Vihko describe the structural changes in muscle injured during exercise. The early lesions are disruptions in the cytoskeleton, banding pattern of myofibrils and of sarcolemma and swelling of mitochondria. Later, degradation of fibers by macrophages and signs of muscle cell regeneration can be seen. The extent of muscle damage is best estimated by the use of specific immunohistochemical staining for structural proteins or by measuring the activities of enzymes such as glucose 6-phosphate dehydrogenase and beta glucuronidase. The exact mechanism that triggers muscle cell damage during exercise is unknown. A higher amount of water in muscle fibers and swelling of the fibers are the most common phenomena in various injuries. Surprisingly, only a few studies have addressed the rate of water accumulation in muscle injury.

A prime target of both endogenous and exogenous free radicals is muscle protein. Oxidation of proteins alters its susceptibility to proteolytic degradation. Many physiological and pathological processes are associated with oxidation of amino acid residues such as histidine and arginine. Radical-induced oxidation of peptide side chains generates reactive carbonyl derivatives (RCDs). Aging, rheumatoid arthritis, Alzheimer's disease, smoking, muscle dystrophy and reperfusion after ischemia are all associated with accumulation of RCDs in skeletal muscle and cardiac muscle. Z. Radak and S. Goto narrate the effects of exercise and aging on protein oxidation and DNA damage in skeletal muscle.

J. W. Haycock, G. Falkhouse and D. Mantle provide evidence that purified muscle proteins *in vitro* have differential susceptibility to free radical-induced oxidative damage. Their findings suggest that oxidative susceptibility of proteins is determined by the secondary or tertiary structure of proteins. They demonstrate that in dystrophin, there are different regions with resistant and susceptible sites to oxidative damage. They remark that intracellular protein turnover *in vivo* may be mediated by the effects of free radicals on both the protein substrate as well as substrate-specific proteolytic enzymes.

It is interesting to note that training of muscles induces protection against muscle damage. The mechanisms are not clear. The protection would disappear after a certain period if exercise were discontinued. Regular exercise and caloric restriction are believed to decrease accumulation of oxidized proteins in muscle and hence might help to delay the age-related increase in oxidation of proteins.

Superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx) are the primary enzymes that are involved in the antioxidant defense against reactive oxygen species (ROS). Molecular structure, catalytic mechanisms, kinetics, cellular distribution, gene regulation and function as well as the therapeutic use of these enzymes are discussed by L. C. Ji. We now have a better understanding of the role of these enzymes in antioxidant defence. Gene regulation in skeletal muscle is however still largely unknown.

Skeletal muscle handles the oxidants with enzymes of the glutathione system. Skeletal muscle has a high activity of glutathione-dependent enzymes and an unusual ability to synthesize glutathione. Reduced glutathione has several biological functions, which include defence against reactive species and detoxification of xenobiotics. Several diseases of muscle including myopathies are linked to decreased content of glutathione in muscle. C. K. Sen in his article presents current understanding of glutathione metabolism in skeletal muscle.

Another potent and widely prevalent antioxidant in the human body is vitamin E. Dietary intake or supplementation can influence vitamin E levels in tissues. Vitamin E deficiency, though rare, can lead to muscle fiber degradation and deposition of lipid granules in muscle cells. Exercise can reduce vitamin E content of skeletal muscle and individuals who regularly exercise may require vitamin E supplementation. M. Meydani and co-authors examine the role of vitamin E in exercise performance and the relationship of the vitamin to

other antioxidant defence systems. They indicate that long-term supplementation of the vitamin lowers oxidative stress and associated risk for many diseases. Studies, however, do not provide evidence that vitamin E supplementation reduces oxidative stress associated with physical activity, increases training capacity or improves performance in trained individuals.

The book also contains articles pertaining to other exciting areas of research. These include oxidative stress and calcium transport in sarcoplasmic reticulum of cardiac and skeletal muscles, the role of ROS in ischemia-reperfusion damage of skeletal muscle and the part of redox status in the regulation of diaphragmatic function in health and disease.

E. Livne *et al.* provide the results of investigations on the effects of L-tryptophan restricted diet on lipid peroxidation and protein oxidation in skeletal muscle of rats. L-tryptophan induces inflammatory processes and tissue fibrosis in skeletal muscle, which appears to be enhanced via the kyneurinine pathway. The increase in levels of lipid peroxides in skeletal muscle of rats after L-tryptophan consumption appears to be a secondary phenomenon and not the cause for pathological changes.

Clinical studies of patients implicate free radical-mediated reactions in the pathogenesis of alcoholic myopathy. V. R. Preedy *et al.*'s data from alcohol feeding studies in rats indicate that ROS are not directly responsible for alcohol-induced myopathy. Obviously, further investigations are warranted to find the factors that mediate muscle damage by ethanol.

There is a comprehensive review on drug-induced muscle damage. The list of drugs or substances of abuse, reported to cause muscle damage is long. The list includes lipid lowering agents, steroids, vincristine, chloroquine and zidovudine (AZT), medicines that are widely prescribed. Drug-induced muscular syndromes are categorized into eight distinct types, and eight possible mechanisms are suggested for muscle damage. The mechanisms range from sarcolemmal membrane disruption to oxidative stress. The most extensively studied drugs are lipid-lowering agents and the studies indicate that the risk for muscle toxicity is higher for the more lipophilic reductases.

The concluding article will not hearten the supporters of antioxidant therapy. It is a short critical appraisal of therapeutic trials of antioxidants in three different types of muscular dystrophy. In Duchenne, Becker and myotonic muscle dystrophies-free radicals have been shown to be definitely involved in muscle degeneration. The results of the trials in these primary muscle diseases, however, do not provide clear evidence for a beneficial effect of antioxidants in the treatment of these conditions.

In summary, the book has substantial information on oxidative metabolism in skeletal muscle, evidences for involvement of oxidative stress in muscle damage in primary muscle diseases, during exercise and drug toxicity, and views on the role of antioxidants in reducing muscle damage in muscle diseases. The hardback text is beautifully produced on acid free paper. All the contributions are well referenced up to the year 1996 and adequately indexed. Medical scientists interested in muscle pathophysiology as well as biologists and chemists working on free radical biology would find the volume immensely valuable. I must, however, confess that reading it was tedious.

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Lipids in Photosynthesis – Structure Function and Genetics. Paul Andre Siegenthaler and Norio Murata (eds). Kluwer Academic Publishers, Vol. 6. The Netherlands. 1998. ISBN 0-7923-5173-8. 320 pp.

Topics on lipids are briefly touched upon in graduate courses in plant and crop physiology and biochemistry; only structure, biosynthesis and breakdown of lipids are discussed. In photosynthesis, functional roles of lipids are hardly elucidated. This is chiefly because there are not many good textbooks that focus on structure–function correlations of thylakoid lipids in photosynthetic electron transport and energy transduction processes or genetics. The volume 6 of Govindjee's series 'Advances in Photosynthesis', *Lipid in Photosynthesis – Structure, Function and Genetics* edited by Paul Andre Siegenthaler and Norio Murata fills the void. Fifteen chapters in the book cover comprehensively, the structure distributions and biosynthesis of glycerolipids in cyanobacteria, algae and higher plant chloroplasts and in anoxygenic photosynthetic bacteria. These chapters not only review the current literature but provide new insights into the developments and directions for research. Besides, some of the chapters have critical assessment of methodology. The molecular organization of acyl lipids in thylakoid membranes, particularly their asymmetric transmembrane distributions, give insights not only into lipid heterogeneity but also to the modulation of thylakoid membrane fluidity and consequent regulation of functions. Researchers interested in any aspect of photosynthesis, would find this volume useful. Chapters dealing with chloroplast – protein import, chloroplast development and differentiation contain wealth of new materials on experimental strategies and analysis of methodologies and these aspects would help researchers to widen their scope of research. The roles of lipid in many physiological processes have now been well recognized. Lipid research is perhaps a bit sticky and thus in India we have almost no research efforts on the roles of lipid on biology of chloroplasts or algae. The mutational studies with specific alterations in lipid contents and composition using *Arabidopsis* have provided interesting data on the regulatory function of glycerolipids in plant-adaptive processes, particularly on low temperature and chilling stress. The chapter by P. Vijayan *et al.* very comprehensively discusses the state of the art in this field. Similarly, genetic engineering of unsaturation of membrane glycerolipids using cyanobacteria has yielded definitive evidence on the roles of fatty acid unsaturation in photoinhibition of photosynthesis and in low temperature and heat tolerance of plants. Besides, the genetic manipulation of glycerolipids, unsaturation in cyanobacteria, bioengineering of phosphatidyl glycerol in tobacco give the current state of research in this fascinating field. These genetic studies provide definitive understanding of the regulation of photo-