QCD and the electroweak theory. I particularly appreciated inclusion of an explicit treatment of loop calculations in a spontaneously broken gauge theory, and also the detailed discussion of the Kobayashi-Maskawa matrix, CP violation and neutrino masses. All in all the book contains a lot of goodies, including grand unification and nonperturbative aspects of gauge theories; but, again, one probably needs some experience to appreciate them, for often an historical approach is followed which hinders the logical development of the subject. For example, a detailed discussion of the role of light-cone singularities in the Bjorken scaling region precedes the more modern and more physical momentum space Feynman graph analysis. Also there are no set problems to guide the reader. Ideally, then, Cheng and Li's book should be read after one (or both!) of the more introductory texts discussed above.

The fourth book, by Becher, Böhm and Joos, is a translation of the German edition

which first appeared in 1981. It is different in character to the others, delving deeper into the theory of the renormalization of the gauge field theory. This is more in the nature of an advanced text or review for an experienced theoretician and contains extensive discussions, without full details of intermediate steps, of perturbative and nonperturbative aspects of QCD. The account of the electroweak theory, on the other hand, is briefer but more straightforward with a nice discussion of the high energy behaviour of Yang-Mills gauge theories.

Although the four texts reviewed here have as a general theme the gauge theories of the fundamental interactions, they vary widely in their demands on the reader. To a large extent they complement one another, and together represent a substantial improvement in the literature surveying modern particle physics. □

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Pastures of muscle physiology

D.R. Wilkie

Muscles, Reflexes, and Locomotion.

By Thomas A. McMahon.

Princeton University Press: 1984. Pp.331.

Hbk \$50, £50; pbk \$15, £12.50.

THIS is a brilliant book. Dr McMahon's original training as an engineer is an excellent one for a physiologist; in both branches of science we are concerned with machines that must function in an optimal way. Here we are provided with a clear and accurate summary of many of the mathematical aspects of muscular function that otherwise demand a laborious appraisal of a large number of original papers. Our understanding (and diligence) are repeatedly challenged by the examples and questions to be found at the end of every chapter.

McMahon's wide and scholarly approach to his subject, and his limpid and often witty style of writing, enable him to illuminate a whole range of topics ranging in physical scale (though not necessarily in complexity!) from the mode of operation of the individual cross-bridges thought to generate mechanical power at the molecular level, to the problems inherent in designing an elephant and in building a "tuned" running track on which athletes have consistently produced improved performances.

Naturally I do not agree with every word in the book. For example, McMahon writes (p.35) "The discovery of a process which apparently absorbs heat, like the mechanism of a refrigerator, provided a great deal of entertainment in the muscle

literature for years". Alas he does not make it nearly clear enough for my liking that the "entertainment" resulted in deep confusion which lasts to this day. There are no circumstances in which a muscle acts as a refrigerator, which is a machine that moves heat from a lower to a higher temperature by the continued application of mechanical or electrical power. Nor can I see how a "unifying principle" (p.79) is provided by the non-uniformity of sarcomere lengths. The question of the instability of stretched muscle fibres, whose tension-length curve has a negative slope, has been discussed for many years yet remains controversial. In whole anatomical muscles (rather than in isolated single fibres) an important role, probably a stabilizing one, may well be played by the connective tissue between the fibres which is plentiful and unlikely to be arranged at random. Microanatomical studies are much needed; until they have been carried out, comparison between isolated muscle fibres and intact anatomical muscle demands great caution.

The biochemical aspects of muscular function are touched on only lightly (nobody should expect everything!) but McMahon is careful to differentiate between the chemical processes and the physical energy — heat and work — that results from them. A widespread failure to make this distinction is at the root of the continuing confusion about a topic introduced on page 211, that of positive and negative work. In movements of a whole animal, the function of muscles as brakes absorbing mechanical work is almost as important as their function as motors producing mechanical work. Unlike mechanical brakes, however, the muscles consume fuel in performing their braking action and even in sustaining a static load. To pursue the mechanical analogy further,

a motor car can stop indefinitely on a hill by applying the brake and stopping the engine. A muscle must rev the engine and slip the clutch. The definition of "efficiency" given in Eqn 8.3 is ambiguous concerning positive and negative signs, though they can be inferred from the left-hand lines in Fig. 8.21 which do indicate negative values of "efficiency". This is formally correct though perhaps not very helpful. I hope that this section will make the topic as clear to the uninitiated as I know it to be to the author himself.

The last chapter, "Effects of Scale", is a delight to read and may well come as a surprise to biologists who work on subjects other than muscular contraction. Experimentally, we find in animals of different size a large number of functions that depend in a highly regular way on body weight, but in hardly a single case is there a satisfactory physical or biochemical explanation for the dependence. McMahon explores various possibilities in a way that is both instructive and entertaining. The relationship between metabolic rate and body weight is the best-established of such laws and is referred to briefly on page 279. It is known to apply to living creatures over a weight range of 10^{18} , a respectable number even by astronomical standards, yet it totally lacks an adequate explanation. This seeming vacuum is a constant source of irritation to all biologists who concern themselves with such issues. Presumably because of their recent publication dates, no references are given to the fuller analyses of the problems of scale given in the beautifully-illustrated books by McMahon and John Tyler Bonner (*On Size and Life*; W.H. Freeman, 1983) and by Knut Schmidt-Nielsen (*Scaling: Why is Animal Size so Important?*; Cambridge University Press, 1984).

Students of muscle physiology at all levels will benefit from reading *Muscles, Reflexes, and Locomotion*. Not only is it a compact source of information, but a novel, comprehensive and readable book which tempts one to browse in the wider pastures opened up by Dr McMahon. □

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