

## Obituary

### PROFESSOR KOSCAK MARUYAMA (1930–2003)

Professor Koscak Maruyama made many important contributions to muscle research in a career spanning 50 years. He was born in Tokyo in 1930 and studied zoology at Tokyo University, graduating first in 1953 and gaining his PhD in 1958. His early work examined the ATPase properties of acto-myosin from a wide range of organisms. He showed that the 'clearing response' of acto-myosin, which is an *in vitro* model of muscle relaxation, is due to the dissociation of the complex and requires magnesium ions. Studies of actin filaments and their gelling properties led him to discover the Z-disc protein  $\beta$ -actinin (later called CapZ) and he collaborated with Setsuro Ebashi on the properties of  $\alpha$ -actinin.

In 1976 he published a paper in *Nature* with Natori and Nonomura based upon the properties of the 'stroma' that remains after the exhaustive extraction of muscle. A new protein was identified in this residue, which was suggested to be elastic; it was later called connectin and this was to be his main preoccupation in succeeding years. In 1979, Wang, working in Texas, identified two exceptionally large proteins in SDS gels of muscle, which were given the names of titin and nebulin. Connectin and titin were subsequently shown to be the same and both names remain in use. For several years it was not clear what the molecular weight of titin was, but Maruyama's estimate of ca. 3 MDa proved to be correct. This remains the largest polypeptide yet found in nature.

Work prior to the discovery of connectin/titin had indicated that there were elastic connections between the ends of the thick filaments and the Z line in insect muscles; however few people thought the connecting filament were present in vertebrate muscles. It was studies of connectin/titin that showed that these and

related proteins form the connecting filaments, which are now believed to be present in all striated muscle. This family of proteins now numbers about 20 and other members are found in different parts of the sarcomere. It includes twitchin, C-protein, M-protein, projectin and kettin. The members are string-like molecules that consist primarily of concatenated immunoglobulin (I-set) and fibronectin type III domains, which are otherwise found in many extracellular proteins.

Maruyama made many studies in this now large field, especially in the purification and properties of connectin. The connecting filaments are the main determinant of the axial elasticity of the relaxed sarcomere, and they also maintain the central location of the filaments, which results in the development of balanced forces between both halves of the thick filaments during contraction. Connectin filaments are thus a fundamental modification of the two filament model of the sarcomere whose 50th anniversary was celebrated earlier this year.

Maruyama's first chair appointment was in Kyoto, but in 1977 he moved to Chiba University, where he was head of the Biology Department and was later President of the University. He also worked in the USA and for two periods in John Pringle's laboratory in Oxford. From 1999 he was head of the university entrance exam authority in Japan. The group that he set up continues muscle research at Chiba under the leadership of his long-time collaborator, Kimura. He was also interested in the history of biochemistry and wrote about the founders of the subject and on the discovery of ATP. He continued to work until a few days before he died on 19 November 2003 from oesophageal cancer.

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