A UNIFIED APPROACH TO MODELLING OF SUSTAINED MUSCLE PERFORMANCE UNDER STATIC AND DYNAMIC LOADS

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CERTIFICATE

This is to certify that the thesis entitled "A UNIFIED APPROACH TO MODELLING OF SUSTAINED MUSCLE PERFORMANCE UNDER STATIC AND DYNAMIC LOADS" by Kamal Prasad Kothiyal is a record of original bonafied research carried out under my supervision and has not been submitted elsewhere for a degree.

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ABSTRACT

A unified approach to understanding the causes of fatigue in muscles both in static and dynamic work is the subject matter of this thesis. Fatigue in muscles is a complex phenomenon and has eluded a definite solution so far.

The relationship between fatigue and the physiological correlates like oxygen uptake, depletion of energy yielding substances, blood flow, accumulation of lactic acid and other by products of metabolism etc. were studied rather extensively in the luterature. By a systematic analysis, we have shown that all the above physiological correlates are influenced by fatigue and that they themselves do not cause fatigue. We had been able to establish that the processes at the level of the muscle cell are possibly responsible for inducing fatigue.

Analysis of the processes at the muscle cell level reveals the critical role played by the calcium ion in force generation by muscle fibres. As fatigue is decrease in the capacity of muscle to produce work, it is necessary to model the mechanism of force generation before one can model the mechanism of fatigue in skeletal muscles.

Many models of force generation are reported in the literature. All the models reported so far can be classified either as cross-bridge models or as electrostatic models. While the cross-bridge models are not stable, the electrostatic models do not explain all the experimental evidence. A model that is described in CHAPTER III of this thesis incorporates the relevant features of both types of models identified so far and is capable of explaining all the experimental evidences while being stable. A study of the model developed in the thesis shows that the force developed by a muscle fibre is directly proportional to the amount of calcium taken up by the actin filaments.

From the model of force generation developed in CHAPTER III we can infer that the analysis of the transport of calcium ion between the different intracellular compartments of a muscle fibre will lead to an understanding of the phenomenon of fatigue. A model of static fatigue developed in CHAPTER IV of the thesis successfully simulates a twitch, tetanus and long term static work. The fundamental mechanism causing static fatigue has been identified as the formation of complexes between ADP and /or P_i and calcium ion.

The model developed to simulate static fatigue can be used to simulate dynamic fatigue as well. It is found that the accumulation of calcium by mitochondria is the basic process inducing dynamic fatigue in CHAPTER V.

From the insight gained in modelling the mechanisms of force generation, static fatigue and dynamic fatigue, we conclude that both static fatigue and dynamic fatigue are present in the muscular system by design and not by accident. Arguments to support the preceding statement are given in CHAPTER VI alongwith possible future work in the area of muscular fatigue.

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