REVERSAL OF ENZYMATIC PROFILES AND CAPILLARY SUPPLY OF MUSCLE FIBERS
IN FAST AND SLOW MUSCLES AFTER CROSS INNERVATION

Flaviu C.A. Romanul
Neurological Unit, Boston City Hospital, and Department of Neurology, Harvard Medical School, Boston, U.S.A.

During the past decade histochemical studies have contributed much to our understanding of skeletal muscle. As a result of these investigations it has become possible to bring together in a meaningful way some very basic observations from anatomy, physiology, and biochemistry. It is well known by now that the mammalian skeletal muscles are composed of a number of fiber types which differ in enzymatic activity. In every type of fiber the activities of the enzymes of glycolysis are inversely proportional to the activities of the enzymes of oxidative and lipid metabolism\(^1\). These differences indicate that some muscle fibers derive their energy of contraction mostly by anaerobic glycolysis while others obtain it chiefly by oxidative breakdown of lipids and other compounds.

There are several histochemical aspects of muscle which should be reviewed in this meeting on muscle metabolism during exercise. With regard to the number and nomenclature of the different histochemical types of fibers existing in skeletal muscle, some workers distinguished two, naming them I and II\(^1\). Other investigators described three, designating them as A, B, C\(^5\). We found a larger number of fiber types but did not label them\(^2\). For ease of reference we prefer to divide them into two groups and call them "glycolytic" or "oxidative" depending upon their predominant enzymatic activity.

Histochemical studies are most advantageously carried out on serial cross sections of "sandwich blocks" composed of red and white skeletal muscles and a fragment of heart (Figure 1). After incubating the sections for different enzymes one can study the enzymatic profiles of individual fibers, as well as the population of fibers in each muscle. A red muscle such as the soleus, known to contract
Fig. 1 Serial cross sections of a "sandwich block" consisting of gastrocnemius (G), plantaris (P), soleus (S), and heart (H) muscles incubated for cytochrome oxidase (A), succinic dehydrogenase (B), mitochondrial alpha-glycerophosphate dehydrogenase (C), and beta-hydroxybutyric dehydrogenase (D).

The white muscles, like the plantaris and gastrocnemius, have fast contraction characteristics and consist of a majority of glycolytic fibers. It is important to note that in the white muscles the oxidative fibers are not evenly scattered but are more concentrated in the axial portions of the muscle heads near the tendons of insertion. The existence of such an arrangement indicates a special physiological role of the oxidative fibers in white muscles. From the practical standpoint one can envisage the serious errors which may be made when taking muscle biopsies for chemical analysis. Different values may be obtained by sampling various parts of the same muscle, and even if the biopsies are confined to a single muscle head, the results will depend upon the depth of sampling.

 Concerning the blood supply of the muscle fibers it has been known since the time of Ranvier that the white muscles have fewer capillaries than the red muscles, but it has always been stated or assumed that every fiber comes in contact with an equal number of capillaries. Recent investigations have shown that the number of capillaries around each muscle fiber is directly proportional to the oxidative metabolism of the fiber.