LOCALIZED FATIGUE AND RECOVERY.*

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Efficiency, its estimation and measurement, are problems which have received a great deal of consideration for many years. Efficiency in business is sought for in commercial and industrial phases of life, but the forms that are to receive our attention are twofold, namely, physical efficiency and organic efficiency.

Organic efficiency involves an estimation of the degree of fitness of the vital organs, the reaction of the cardiovascular and respiratory systems to a measured amount of work which is thrown upon them. Physical efficiency tests are based on accomplishment and involve factors of speed, skill, and endurance in an estimation of ability, which can be compared with what is considered normal for an individual of any given age or development. The effect of practice or training has an influence in each type of test, but the important fundamental factor, which modifies the results in each case, is the condition, the adaptability, or the efficiency of the heart and lungs. The efficiency of these organs in responding to the expressed demand of the higher mental centers for a certain amount of physical activity, and the ability of the tissues to carry it out, determine the capability of the individual. The factors which limit this capability, that is, the amount of work that the machine can perform, are spoken of as fatigue.

Fatigue[1] may normally be considered a lowered capacity for work, resulting directly from the accumulation of the products of activity and varying with the duration, rate, and intensity of the performance and the initial strength or capacity of the physical system involved. Howell[2] defines it as "a more or less complete loss of irritability and contractility brought on by functional activity."

The object of this study was not, however, to consider the problem of general systemic fatigue, nor was it to study the capacity of the body, nor any part of it, for the maximum amount of work it could perform. The problem was to consider how certain groups of muscles could recover most advantageously from the condition of absolute fatigue.

Recent studies in the physiological laboratory have thrown much light on the problems involved in the capacity for and the means by which the muscle performs work.

Tissue Metabolism.

According to Hill,[3] when a muscle is stimulated a certain amount of lactic acid is liberated within it. This, by some physical or chemical process still uncertain, causes a development of force and contraction. The acid is then rapidly neutralized, its effect passes off and the muscle relaxes. This process can be repeated again and again until the available supply of alkali for neutralizing the acid has been used up, when the rapidly increasing acidity of the muscle stops its further activity. This is complete fatigue, and the amount of work that the muscle can perform depends on the degree to which it can tolerate acid before this stage is reached. The lactic acid formation is the chief chemical reaction on which the whole of voluntary muscular activity depends, and is not, as was formerly thought, merely the end result of the combustion which causes contraction. Hill's[4] contention is that the stimulus or shock changes the permeability of some membrane which normally restrains chemical bodies, energy is released through the escape of these bodies, the reaction is the result, which ends in the formation of lactic acid and in the mechanical response.

The intramolecular oxygen theory has been totally discredited,[5] and the work of Fletcher and Hopkins with the further investigations and findings of Winterstein and Meyerhof have shown conclusively that the excess of oxygen used in the recovery period is equivalent to the oxygen usage which was omitted during the anaërobic phase. It has also been

*Reprinted from the AMERICAN PHYSICAL EDUCATION REVIEW, November, 1926.