

## Recent Ideas on Muscle Training

Dr. E. A. Muller, Max-Planck-Institute, Dortmund.

Muscle strength can be defined as the maximum strength of an isometric contraction, acting voluntarily against an unsurpassable resistance. The average strength of a muscle in repeated measurements shows a standard deviation of  $\pm 4$  to 5%. Training a muscle with one daily maximum contraction lasting 1 sec. increases its strength less and less from week to week and leads finally to a constant strength-level, called the "limiting strength". If the initial strength is expressed as a percentage of the limiting strength ("relative strength"), one obtains a quantitative measure for the relative state of training (or atrophy) for a given muscle. Muscles cannot be compared in their inherent individual strength and reaction upon training except by relation to their limiting strength. The lower the relative muscle strength, the steeper the weekly increase in strength. On the other hand the muscles of sports-students are usually near the limiting strength, which can be attained by 1 daily maximum contraction of 1 sec. Thus no increase in strength, or an insignificant one, is to be expected. The variable success of different authors using this training stimulus is therefore understandable. There is no difference in the trainability, expressed as increase in strength as a percentage of the limiting strength per week, due to age, sex or muscle group. Muscles trained at a shorter resting-length show a higher increase in strength per week than if trained at a greater length. The limiting strength of a muscle reached with 1 daily maximum contraction is further increased by 5 to 6 daily maximum contractions lasting 5 to 6 sec. The limiting strength seems to be constant in adults, but increases in youngsters with growth.

In order to explain these findings, taken from experiments with W. ROHMERT, the following theory is given. It is assumed that a muscle which has a lower strength than its limiting strength is overstretched in its elastic elements by a maximum contraction. As long as this overstretched state remains (about a week), a trophic stimulus is exerted upon the muscle tissues. The elasticity of the muscle elements falls with increasing strength. Overstretching is increased by lengthening the duration of a maximum contraction, and by contracting the muscle at a reduced resting length.