Chapter 35

Endurance of Muscle

Three factors are essential for the contraction of skeletal muscle:

1. Strength of the muscle
2. Power of the muscle
3. Endurance of the muscle.

Strength and power of the muscle are the two factors which determine the endurance of the muscle. Power of the muscle is developed by strength of the muscle

STRENGTH OF THE MUSCLE

Maximum force that can be developed during contraction is known as strength of the muscle. It is defined as the maximal contractile force produced per square centimeter of the cross-sectional area of a skeletal muscle. The normal force produced by a muscle is about 3 to 4 kg/cm^2 area of muscle. If the size of the muscle is more, the strength developed also will be more.

The size of the muscle can be increased either by exercise or by some hormones like androgens. For example, weight lifters will have the quadriceps muscle with cross-sectional area of about 150 cm^2. So, the total strength of the quadriceps muscles is between 500 and 550 kg/cm^2.

TYPES OF MUSCLE STRENGTH

Strength of the muscle is of two types:

1. Contractile strength
2. Holding strength.

1. *Contractile Strength*

Contractile strength is the strength of the muscle during the actual contraction or shortening of muscle fibers. For example, while jumping, when a person takes his body off the ground, there is contraction of the leg muscles. This is called the contractile strength.

2. *Holding Strength*

Holding strength is the force produced while stretching the contracted muscles. For example, while landing after jumping, the leg muscles are stretched. The force developed by the muscles at that time is called the holding strength. The holding strength is greater than the contractile strength.

POWER OF THE MUSCLE

Amount of work done by the muscle in a given unit of time is called the power. Power of the muscle depends upon three factors. Muscle power is directly proportional to these factors:

1. Strength of the muscle.
2. Force of contraction.
3. Frequency of contraction.

Muscle power is generally expressed in kilogram-meter per min (kg-m/min), i.e. the weight lifted by a muscle to a height of 1 meter for one minute. The maximum power achieved by all the muscles in the body of a highly trained athlete, with all the muscles working together is approximately,

First 8 to 10 seconds	:	7,000 kg-m/min
Next 1 minute	:	4,000 kg-m/min
Next 30 minute	:	1,700 kg-m/min

This shows that the maximum power is developed only for a short period of time.

ENDURANCE OF THE MUSCLE

Capacity of the muscle to withstand the power produced during activity is called endurance. It depends mostly on the supply of nutrition to the muscle.

Most important nutritive substance for the muscle is glycogen. This is actually stored in the muscle before the beginning of the activity. More amount of glycogen can be stored in the muscles if a person takes diet containing more carbohydrates than the diet containing fat or a mixed diet. Following is the amount of glycogen stored in the muscle in persons taking different diets.

High carbohydrate diet	:	40 gm/kg muscle
Mixed diet	:	20 gm/kg muscle
High fat diet	:	6 gm/kg muscle.