



**MUSCLE PERFORMANCE
ENHANCEMENT ON
TRAINING
BY**

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OBJECTIVES:-

AT THE END OF THIS LECTURE THE STUDENT SHOULD BE ABLE TO:-

1- KNOW EFFECT OF TRAINING ON HEALTH AND MUSCULOSKELETAL SYSTEM

2- IDENTIFY TYPES OF HYPERTROPHY

2- KNOW EFFECTS OF STRENGTH TRAINING

3- UNDERSTAND PROTEIN SYNTHESIS IN MUSCLE BY TRAINING

4- APPRECIATE ANAEROBIC AND AEROBIC TRAINING

6- KNOW FACTORS AFFECTING HYPERTROPHY

○ Exercise and Training:-

- - Exercise often recommended as a mean of improving motor skills. Exercise has several effects upon muscles, connective tissue, and the nerves that stimulate the muscles.
- -When properly performed, strength training can provide significant functional benefits and improvement in overall health and well-being, including :-
 - -**increased bone density,
 - ** increased muscle, tendon and ligament strength and toughness, (صلابة)
 - **improved joint function
 - **reduced potential for injury
 - **a temporary increase in metabolism,
 - **improved cardiac function,
 - **and elevated HDL (good) cholesterol.



- **** Intense workouts elevate metabolism for several hours following the workout, which also promotes fat loss**
- ****The body's basal metabolic rate increases with increases in muscle mass^lwhich promotes long-term fat loss and helps dieters avoid yo-yo dieting.^l**
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- ****Weight training also provides functional benefits. As stronger muscles improve posture, provide better support for joints, and reduce the risk of injury from everyday activities.**
- **Older people who take up weight training can prevent some of the loss of muscle tissue that normally accompanies aging—and even regain some functional strength—and by doing so become less frail(هش) .They may be able to avoid some types of physical disability.**
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- ****Weight-bearing exercise also helps to prevent osteoporosis**
The ability of the body to resist the stresses that can result from an injury can be increased by obtaining a greater amount of strength. That is true in the athletic world and it has its advantages in performing everyday activities, such as lifting or carrying objects.



- For many people in rehabilitation (اعادة تاهيل) or with an acquired disability such as following stroke or orthopaedic surgery, strength training for weak muscles is a key factor to optimise recovery
- Though weight training (anaerobic) can stimulate the cardiovascular system, aerobics training of maximal oxygen uptake is a better cardiovascular stimulus.
- -One side-effect of any intense exercise is increased levels of neurotransmitters as dopamine, serotonin and norepinephrine, but they can help to improve mood and counter feelings of depression



-MUSCLE HYPERTROPHY INDUCED BY TRAINING

- Athletes show extensive muscular hypertrophy.
- Muscle hypertrophy is the increase of the size of muscle cells.
- It differs from muscle hyperplasia which is the formation of new muscle cells(increased number of cells).



○ Types of hypertrophy

○ There are two different types of muscular hypertrophy:

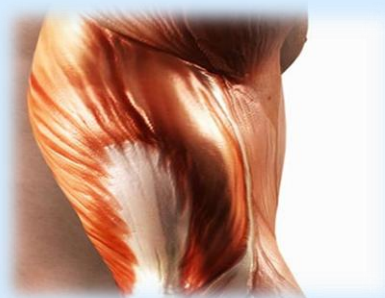
○ **1-sarcoplasmic**

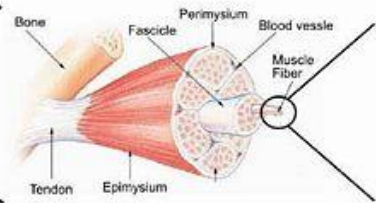
○ **2- myofibrillar.**

○ - During **sarcoplasmic hypertrophy**, the volume of sarcoplasmic fluid in the muscle cell increases with **NO** accompanying increase **in muscular strength**.

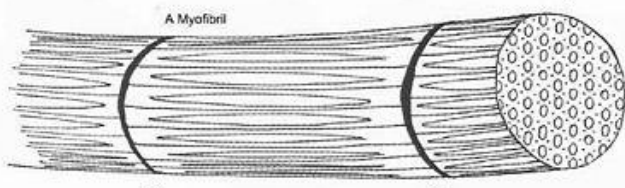
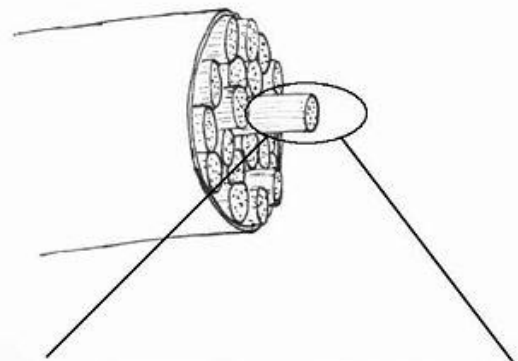
○ -- Sarcoplasmic hypertrophy is characteristic of the muscles of **bodybuilders** .

○ -Several repetitions (generally 12 or more) against a sub-maximal load facilitates mainly sarcoplasmic hypertrophy (professional bodybuilders and endurance (تحمل)athletes).

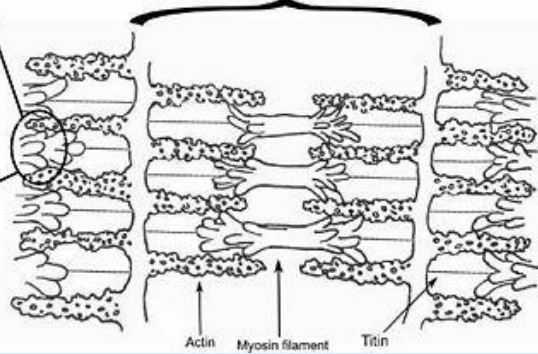
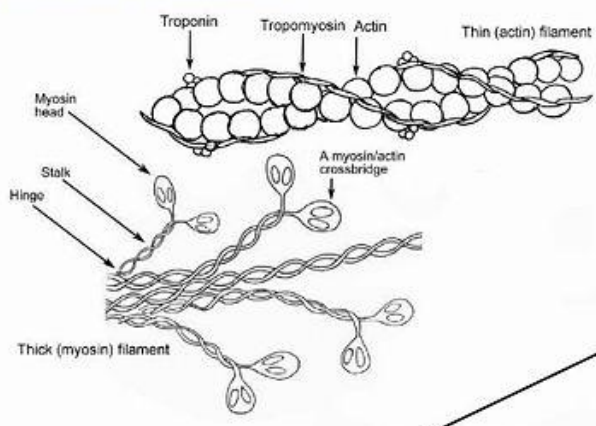




Muscle Fiber (single cell, multi-nuclear)

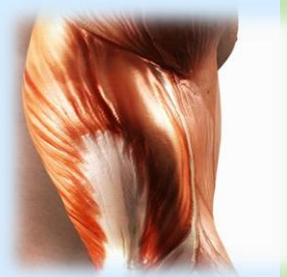


One sarcomere



- - During Myofibrillar Hypertrophy,:-
- - actin and myosin contractile proteins increase in number
- - They add to muscular strength
- - as well as a small increase in the size of the muscle.
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- Myofibrillar hypertrophy is characteristic of weightlifters because contraction against
- Maximum load for 2-6 repetitions causes myofibrillated hypertrophy to dominate





- -**Progressive overload** is considered the most important principle behind hypertrophy.
- - **Progressive** increase in the weight or repetitions (reps) will all have a positive impact on growth.
- 1 -The first measurable effect is an increase in the **neural drive** stimulating muscle contraction.
- 2-As the muscle continues to receive increased demands, the protein synthetic machinery is **upregulated**.
- -this upregulation of protein synthesis appears to begin with the second messenger system (including **phospholipases**, **protein kinase C**, **tyrosine kinase**, and others).



Muscle hypertrophy & Protein synthesis

-EXERCISE hypertrophy is due to increase in contractile protein (number of actin & myosin filaments in each muscle fibre = muscle cell).

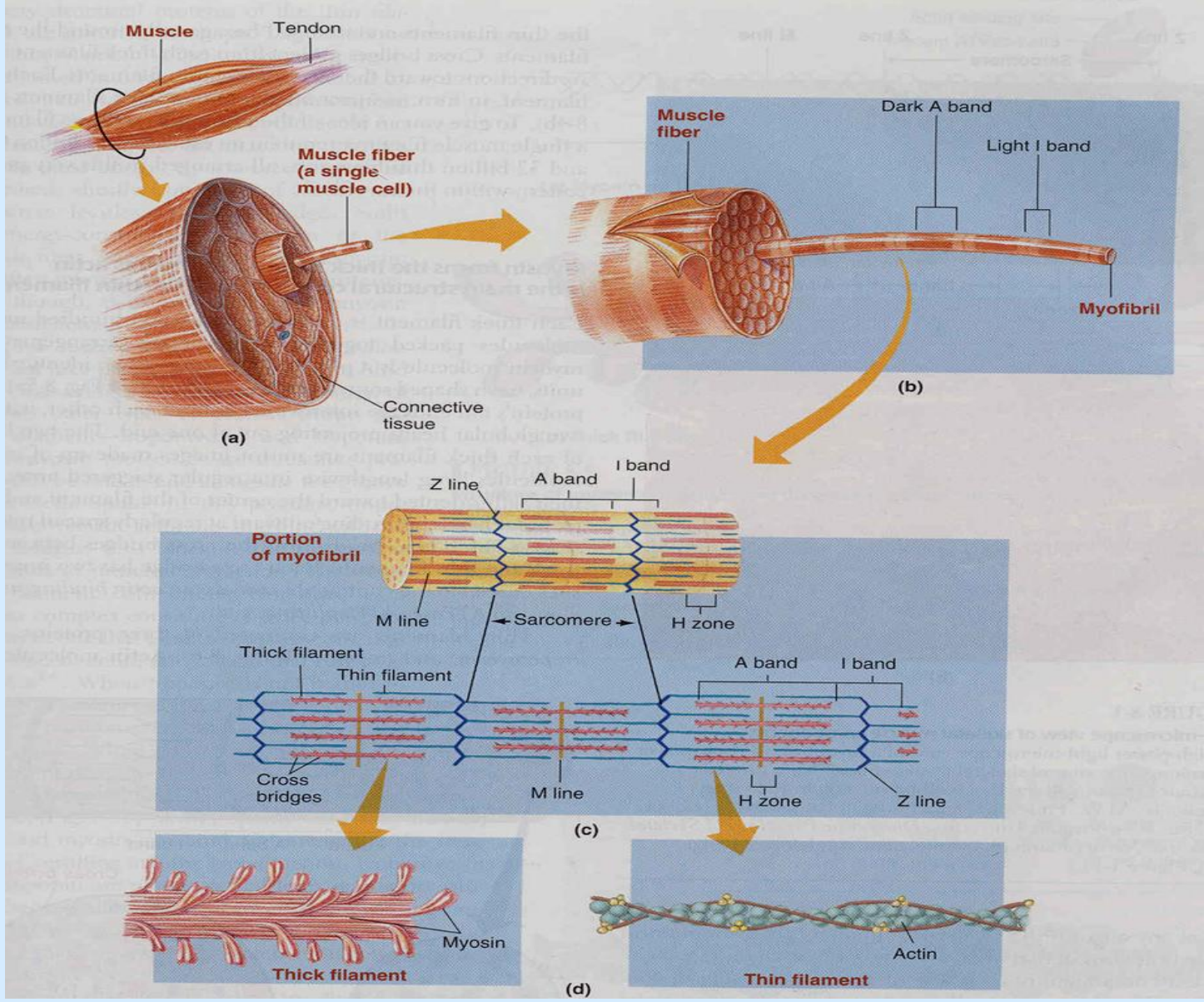
-When number of contractile proteins increases sufficiently, myofibrils split within each muscle fibre to form new myofibrils, so it is mainly great increase in the number of additional myofibrils that causes muscle fiber to hypertrophy.

-The additional contractile proteins appear to be incorporated into existing myofibrils (the chains of sarcomeres within a muscle fiber).

-There appears to be some limit to how large a myofibril can become.

-That is, hypertrophy results primarily from the growth of each muscle cell, rather than an increase in the number of cells.





- **EFFECT OF HORMONES:-**

- **-Cortisol** decreases amino acid uptake by muscle tissue, and inhibits protein synthesis
- **- Testosterone** increases amino acid uptake by muscle tissue, and increases protein synthesis
- men find hypertrophy much easier to achieve than women.
- - Taking additional testosterone, as in athletes taking anabolic steroids, this will increase results.
- - It is also considered a performance-enhancing drug

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- **Microtrauma during training**
- **Microtrauma** which is tiny damage to the fibers, may play a significant role in hypertrophy
- When microtrauma occurs (from weight training or other strenuous activities), the body responds by overcompensating, replacing the damaged tissue and adding more,
- -So that the risk of repeated damage is reduced
- - progressive overload is essential for continued improvement, as the body adapts and becomes more resistant to stress

○ (No pain No gain)



○ Other factors affecting hypertrophy

- Several biological factors such as **age** and **nutrition** can affect muscle hypertrophy.
- - During puberty in males, hypertrophy occurs at an increased rate.
- - Natural hypertrophy normally stops at full growth in the late teens.
- **Nutrition:** An adequate supply of **amino acids** is essential to produce muscle hypertrophy.



- - Muscular hypertrophy can be increased through :-
 - 1-strength training
 - 2-short duration, high intensity anaerobic exercises

- -Lower intensity, longer duration aerobic exercise generally does not result in very effective tissue hypertrophy



- Each muscle is composed of combination of 2 types of muscle fibers but one is usually dominant
- 1-Anaerobic ("fast-twitch")
 - White muscle fibers(deficient in myoglobin)
 - larger in size for strong & **powerful contraction**
 - have extensive sarcoplasmic reticulum for rapid release of calcium
 - have a lot of glycolytic enzymes for rapid release of energy
 - lower capillarity & few mitochondria because oxidative metabolism is of secondary importance
- 2-Aerobic ("slow-twitch")
 - Red muscle fibers because its high content of myoglobin
 - Smaller & innervated with small nerve fibers & they are adapted for **prolonged** muscle activity
 - have extensive sarcoplasmic reticulum for rapid release of calcium
 - have a lot of glycolytic enzymes for rapid release of energy
 - Higher capillarity & large number of mitochondria to support high level of oxidative metabolism



○ Anaerobic & aerobic training

- it was generally considered that consistent anaerobic strength training will produce hypertrophy over the long term, in addition to its effects on muscular strength and endurance.
- -Weight training is commonly perceived as anaerobic exercise, because one of the more common goals is to increase strength by lifting heavy weights.
- - At higher loads, the muscle will recruit all muscle fibers possible, both anaerobic ("fast-twitch") and aerobic ("slow-twitch"), in order to generate the most force.
- -However, at maximum load, the anaerobic fibers contract so forcefully that the aerobic fibers are completely shut out, and all work is done by the anaerobic processes.
- -In the anaerobic muscle fibre uses its fuel faster than the blood and intracellular restorative cycles can resupply it& the muscle fail fast
- -In the aerobic regime, the blood and intracellular processes can maintain a supply of fuel and oxygen, and continual repetition of the motion will not cause the muscle to fail
- - Other goals such as weight loss or body shaping often use low weights, adding aerobic character to the exercise.



○ Nutrition during training:-

- It is widely accepted that muscular training must be matched by changes in diet in order to be effective.
- -Adequate proteins generally believed to be required for building skeletal muscle .Weight trainers consume a high-protein diet with from 1.4 to 3.3 g of protein per kg of body weight per day .
- \downarrow Protein that is neither needed for cell growth and repair nor consumed for energy is converted by the liver into fat , which is then stored in the body.
- -Some people believe that a high-protein diet entails risk of kidney damage, but studies have shown that kidney problems only occur in people with previous kidney disease
- - The deamination of proteins process creates urea, which places low, but consistent, strain on the nephrons
- -An adequate supply of carbohydrates (5-7g per kg) is also needed as a source of energy and for the body to restore glycogen levels in muscles.



- -A light, balanced meal **prior** to the workout (usually one to two hours beforehand) ensures that adequate energy and amino acids are available for the intense bout of exercise.
- -The **type of nutrients consumed** and **nutrient timing** affects the response of the body.
- -**Water** is consumed throughout the course of the workout to prevent poor performance due to **dehydration**
- **Protein and carbohydrates** are consumed **prior to and after** workout has a beneficial impact on muscle growth
- 1-A **protein shake** is often consumed immediately **following** the workout, because both protein uptake and protein usage are increased at this time.
- 2--**Glucose (or another simple sugar)** is often consumed following workout since this quickly replenishes any glycogen lost during the exercise period.
- -To maximize muscle protein anabolism, recovery drink should contain glucose (dextrose), protein (usually **whey**) (ماء اللبن) hydrolysate containing mainly dipeptides and tripeptides, and leucine

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