PES 241 – EXERCISE PHYSIOLOGY
WEEK 3
SKELETAL MUSCLE
STRUCTURE AND FUNCTION

The study of muscle is termed MYOLOGY and it is basic to an understanding of how the body responds to a single bout of exercise and adapts to physical training.

- Muscle contraction.
- Muscle exertion & extent of muscle fatigue.
- Muscle consumption of O_2 and the requirement of most of the body blood during exercise.

The main framework of the skeleton of the body is covered by muscles and are responsible for 50% of our body weight.

FUNCTIONS

Movement: Most obviously, muscles enable us to move from place to place; to move and position individual body parts. Muscle contractions also move body contents in the course of breathing, circulation, digestion, urination, defecation and childbirth.

Communication: Muscle contractions enable us to communicate by means of writing, speech, and body language such as facial expressions.

Stability: Muscles maintain posture by resisting the pull of gravity. They hold articulation bones in place by maintaining tension on the tendons of joints.

Control of body openings: Circular muscles called SPHINCTERS close the eyes, mouth and other orifices; regulate the passage of stomach contents, bile, urine, and faeces; and regulate the diameter of the pupil.

Heat production: As much as 85% of our body heat is, produced by contraction of the skeletal muscles. This heat is vital to the proper functioning of enzymes and therefore to all our metabolism.

TYPES OF MUSCLES

Smooth / Involuntary: Muscles of the internal organs like those involved in the movement of the heart, respiration, digestion, etc. Their innervation is autonomic i.e. their contraction is independent of conscious control. They have slender and smooth types of cells without cross stripes and have one nucleus.

Skeletal / Voluntary: These are muscles attached to the skeleton. These are muscles used in walking, writing, etc. Their innervation is somatic i.e. their

contraction is under conscious control. Physically, they are long, cylindrical and multinucleated. They are cross-banded i.e. striped and striated.

Cardiac: A section of the heart muscle tissue shows that whilst it is involuntary, it has characteristics which bear superficial resemblance to voluntary muscle tissue. The contraction is rhythmical and automatic.

STRUCTURE OF A MUSCLE

Skeletal muscles have bundles of long, thin cells called muscles fibres. That is the unit cell of a skeletal muscle is called muscle cell of fibre. They are multinucleated. The life of a muscle depends on the nucleus. Within the muscle fibres are the thread-like fibres called the MYOFIBRIS found beneath the SACROLEMMA (the cell membrane that surrounds muscles fibres) are SACROPLASM/ CYTOPLASM. These are protein – like structures made up of the enzymes MYOSIN and ACTIN. These are also striated. The myosin and actin bring about contraction. The mucles has three connecting tissues namely;

(1) Epimysium – the outer layer that surrounds the entire muscle.
(2) Perimysium – the layer that surrounds individual bundles of muscle fibres. These bundles of individual muscle fibres are called FASCICLES.
(3) Endomysium – Each muscle fibre within the fascicules is also surrounded by a connective tissue called the endomysium.

Skeletal muscles have two points of attachment; the point of origin where the bone of attachment does not move and the point of insertion where the bone of attachment that causes movement e.g. the biceps of the arm has its point of origin at the shoulder end of the arm and point of insertion as the radius of the lower arm.

TYPES OF THE MUSCLES FIBRES

There are basically two fibres types found in human beings and these are: (1) fast-twitch and slow-twitch. The percentage of a respective type contained in skeletal muscles can be influenced by genetics, blood levels of hormones, and the exercise habits of the individual.

CHARACTERISTICS OF THE FIBRES

SLOW TWITCH – TYPE I

- Large numbers of oxidative enzymes (high mitochondrial volume that produces large amounts of energy).
- High concentration of myoglobin (muscle protein)
- Large number of capillaries.

These characteristics make them lend themselves to large capacity of aerobic metabolism and resistance to fatigue.

- Contractile process is slow.
- Have VO_2 max
- Produces a lower specific tension

- More efficient

* Use sprint training to improve the speed of athletes of predominantly slow twitch fibres.

FAST TWITCH (TYPE II)

- Sometimes called fast-twitch fibres or fast-glycolytic fibres.
- Small number of mitochondria.
- Limited capacity for aerobic metabolism.
- Less resistance to fatigue.
- Rich in glycolytic enzymes providing them with large anaerobic capacity.
- Greater specific tension.
- Highest VO_2 max (ATP production).

INTERMEDIATE FIBRES IIA

- Sometimes called fast-oxidative glycolytic fibres.
- Fatigue characteristics between type I and type IIb.

*Endurance training to improve their endurance.

	% ST type I	% FT II & II a
Dist Runner	70 - 80	20 – 30
Sprinters	20 - 30	70 – 75
Non-athletes	47 - 53	47 – 53

MUSCLE CONTRACTION

Movement is caused by muscle pulling on a bone. Muscles can only pull, they cannot push. This is why most of our muscles are arranged in opposing pairs. When one muscle tenses and contracts, its partner relaxes and stretches to allow movement. The prime mover at any given time is known as AGONIST and the one that holds it in check is termed ANTAGONIST. This means that skeletal muscles are not completely at rest. They are normally in a condition of slight tension or contraction called MUSCULAR TONE. Muscles work like engines by burning fuel to produce movement. They are energy converters. The muscle fibres contract in order to exert a force. The greater the force you need to produce, the more fibres you use. Muscular contraction produces the force called "STRENGTH". Muscular strength is defined operationally as the greatest amount of force that muscles can produce in a single maximal effort.

TYPES OF MUSCLE CONTRACTION

DYNAMIC CONTRACTIONS

When a contraction results in a change in muscle length and movement at a joint or joints this is called a dynamic contraction.

When the contraction force is greater than the load to be lifted, the dynamic contraction results in a shortening of the muscle. This is known as CONCENTRIC contraction.

When the contraction force is slightly less than the load to be lifted. Then the dynamic contraction results in a lengthening of the muscle. This is termed ECCENTRIC contraction.

STATIC CONTRACTION

This type of contraction is more commonly known as isometric contraction. When a muscle contracts somatically it develops tension, but there is no lengthening or shortening of the muscle and no movement. Such contraction is very common and can be observed when an attempt is made to move an immovable object.

The ability of a muscle or a group of muscles to exert force repeatedly is known as muscular endurance; (the capacity of a muscle or a muscle to sustain a contractile state over a period of time).

Muscular strength & endurance are specific to each muscle or muscle group. Different muscles in the body can have different levels of strength and endurance. Muscles used more frequently are stronger than muscles used less frequently. When muscles are not used. Strength and endurance decreases (atrophy).

Muscular strength and endurance are important for good health. They contribute to the maintenance of proper posture and the improvement of personal appearance.

Strong muscles provide better protection for body joints, the risk of joint injuries is decreased.

High levels of muscular strength and endurance are important for athletes. Strength training for sports must be specifically related to the particular characteristics required for performance of the sport. E.g. sprinter / shot putter.

NEUROMUSCULAR JUNCTION

Each skeletal muscle cell is connected to a nerve fibre branch from a nerve cell. These nerve cells are called MOTOR NEURONS and external outward from the spinal cord. The motor neurons and all the muscular fibres it innervates is called a MOTOR UNIT. Contraction of muscles is stimulated from motor neurons. The site where the motor neuron meets with muscle cell is called the NEUROMUSCULAR JUNCTION. At this junction the sarcolemma forms a pocket that is called the MOTOR END PLATE.