VCE Physical Education

Unit 1 – AOS 1: Bodies in Motion
What are the major body systems that allow movement to happen?

✓ Muscular  }  Musculoskeletal System
✓ Skeletal  
✓ Cardiovascular  }  Cardiorespiratory System
✓ Respiratory
Skeletal System

✓ What do you know about it?
✓ Can you name any?
✓ How many bones are there?
✓ Have you broken any bones?
Skeletal System

- There are 206 bones in the body!

- 5 major function
  - Support
  - Protection
  - Movement
  - Storage
  - Blood cell production
## Functions

<table>
<thead>
<tr>
<th>FUNCTIONS</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Support</td>
<td>Framework for body shape</td>
</tr>
<tr>
<td>Protection</td>
<td>Protects vital organs; heart, brain, lungs</td>
</tr>
<tr>
<td>Movement</td>
<td>With muscles create movement</td>
</tr>
<tr>
<td>Storage</td>
<td>Stores &amp; releases minerals; collagen</td>
</tr>
<tr>
<td>Blood cell production</td>
<td>Produces and releases red blood cells into the blood stream.</td>
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What's in a bone?

- **Periosteum**
  - tough membrane around the bones.
- **Marrow**
  - produces blood cells (white, red and platelets)
- **Spongy Bone**
  - holey and filled with bone marrow
- **Compact bone**
  - dense and heavy, provides strength
- **Blood vessels**
Developing bones

- As a baby, bones are more flexible. They contain cartilage which gradually becomes harder & turns into bone.

- You can find cartilage in your nose.

- Have you ever wondered how a baby’s head can fit through as a slow opening?
Dietary intake

- Which foods do you know help to make bones strong?
  - Vitamin A
  - Vitamin C
  - Vitamin D
  - Calcium
Exercise and Bones

✓ You can eat all of those things but you MUST combine it with weight-bearing exercise. Eg. running, jumping, weights

✓ Consequences of inadequate dietary intake and lack of exercise can lead to serious health conditions such as Osteoporosis.

✓ Osteoporosis literally means ‘bones with holes’. It is where the bones become weak and fragile. It is more common in elderly females

✓ Weight training and a diet high in calcium and vitamin D are effective in preventing the onset of osteoporosis.
Identifying the bones in your body

✓ Label the bones in your body in the workbook provided.
✓ Axial Skeleton
  ✓ Provides the main support for the body and includes the skull, vertebral column and rib cage
✓ Appendicular Skeleton
  ✓ Made up of the limb bones and their ‘girdles’ that connect onto the axial skeleton
Bone Classifications

- There are 4 types of bones, distinguished by their shape.
  - Short bones
  - Long bones
  - Flat bones
  - Irregular bones
Vertebral Column

- There are 3 curves:
  - Cervical Curve (7)
  - Thoracic Curve (12)
  - Lumbar Curve (5)

- Protects the Spinal Cord!
Muscular System

✓ Do you know how many muscles there are in the body?
  ✓ Over 600

✓ Without muscles our hearts would not beat, we could not breathe, digest food, walk, talk or reproduce.
Functions of Muscles

- Movement
  - Pulls on bones.

- Posture
  - Keeps body balanced and aligned correctly.

- Body Heat
  - Contractions produces heat for the body.
Types of Muscles

- **Skeletal Muscle**
  - “BIG muscles”
  - Attached to bones
  - Voluntary movements
  - Striated appearance (striped)
Types of Muscle

- Smooth Muscle
  - Found in blood vessels & the walls of intestine and stomach.
  - Involuntary movement. Eg. food passing through our digestive system.
Types of Muscle

✓ Cardiac Muscle
  ✓ Walls of the heart
  ✓ Involuntary movement
Muscles

✓ All of these muscles work together to perform a wide variety of tasks; however each individual muscle is actually only capable of only two movements - contraction & relaxation.
Connective Tissue

✓ Cartilage:
  ✓ Cushions bones. Eg. between ribs and sternum, b/n vertebrae.

✓ Tendons:
  ✓ Attaches muscle to bones. Eg. Achilles Tendon.

✓ Ligaments:
  ✓ Joins bone to bone. Eg. ACL, PCL.
Origins & Insertions

✓ Skeletal muscle attaches to bones via tendons.

✓ The one proximal (closest) to the body is called the origin, the one distal (further away) from the body is called the insertion.
Muscles of the Body

- Refer to page 11

- Note there are 4 Quadriceps Muscles & the 3 Hamstrings muscles
Identifying the muscles in your body

✓ Label the muscles in your body in the workbook provided.
Anatomical Positions

Anterior (front)           Posterior (back)
Anatomical Positions

✓ Medial (middle)
✓ Lateral (outside)
Anatomical Positions

✓ Proximal - closest to attachment to body.

✓ Distal - further away from attachment to body.
Planes of the body

Frontal

Sagittal

Transverse
Types of Joints

- There are 3 main types:
  - **Fibrous Joints** (Immoveable) Eg. Skull, Sacrum, coccyx.
  - **Cartilaginous Joints** (partially moveable) Eg. Vertebrae
  - **Synovial Joints** (freely moveable) Eg. Knee, Shoulder, Hip
Synovial Joints

- Cartilage covers the ends of bones.
- Ligaments stabilise joint.
- Synovial membrane contains synovial fluid to allow easy movement.
- Joint capsule encases the joint.
Synovial Joint

Generalised structure

- Synovial cavity
- Fibrocartilage disc (meniscus)
- Surrounding fibrous capsule/supporting ligament
- Synovial membrane producing synovial fluid
- Hyaline articular cartilage
- Bone
Hinge Joint

- 1 Axis
- Allows only flexion & extension.
- Eg. Knee, elbow, toes, fingers.
Pivot Joint

- 1 axis
- Only allows rotation.
- Eg. Skull on spine, elbow (2 lower bones).
Gliding Joint

✓ Allows side, back and forwards movement.

✓ Eg. Wrist, ankle.
Ball & Socket Joint

- Able to move in all directions.
- Eg. Shoulder, Hip
Saddle Joints

✓ Allows sideways, backwards and forwards movement.

✓ Eg. Wrist
Condyloid Joint

- Allows sideways, backwards, & forwards movements.

- Eg. Wrist
Body movements

- Muscles can only pull. To make a joint move in two directions, you need two muscles that can pull in opposite directions.

- Antagonistic muscles are pairs of muscles that work against each other. One muscle contracts (agonist, or prime mover) while the other one relaxes (antagonist) and vice versa.

- Stabilisers are also involved in contractions. These provide stability to the origin e.g. the trapezius during elbow flexion.

- Reciprocal Inhibition is the term used to explain how muscles work in ‘teams’. It essentially describes how one muscle contracts and its opposite relaxes to allow ease of movement and reduce muscle tears.
Body Movements

✔ Flexion
  ✔ Angle of the joint is DECREASED.

✔ Extension
  ✔ Angle of the joint is INCREASED.
Body Movements

- ✓ Abduction
  - ✓ Body part is moved away from the midline.

- ✓ Adduction
  - ✓ Body part is moved towards the midline.
Body Movements

✓ Medial Rotation

✓ Body part is moved inwards on an axis
Body Movements

- **Lateral Rotation**
- Body part is moved outwards on an axis
Body Movements

✓ Circumduction

✓ Body part is moves in a cone shape
Body Movements

- Supination
  - Rotation of the forearm, palm faces up!

- Pronation
  - Rotation of the forearm, palm faces down!
Body Movements

- Eversion
  - Rotation of the sole of the foot outwards.

- Inversion
  - Rotation of the sole of the foot inwards.
Body Movements

- **Dorsiflexion**
  - Foot points towards the head.

- **Plantarflexion**
  - Foot points away from the head.
Muscle Fibres

- There are two types:
  - Slow Twitch Fibres
  - Fast Twitch Fibres

- We all have a combination of both. The percentage of each type varies depending on genetic inheritance and training undertaken.

- They can influence the type of activity an athlete is best suited to and can be determined through a biopsy.

- https://www.youtube.com/watch?v=Uxwh2Ilg_Z0
Type I - Slow Twitch Fibres

- Red colour
- Contract slowly over a period of time
- Aerobic & endurance sports
- Exert less force for long periods

Athletes that have a high proportion of slow twitch fibres include: triathletes, marathon runners and rowers
Type II - Fast Twitch Fibres

- White colour
- Best suited to short duration, high intensity anaerobic work
- Provide high bursts of power and speed
- Easily fatigue due to build up of by-products

- Athletes that have a high proportion of fast twitch fibres include: sprinters, weight lifters and throwers
% of Fast Twitch Fibres in Various Athletes
% of Slow Twitch Fibres in Various Athletes

- Marathoners
- Swimmers
- Distance runners
- Speed skaters
- Orienteers
- Cross-country skiers
- Alpine skiers
- Ice-hockey players
- Race walkers
- Canoeists
- Cyclists
- Javelin throwers
- Downhill skiers
- Weightlifters
- Shot-putters/discus throwers
- Sprinters/jumpers
Force Generation of FT & ST Muscle fibres

Graph showing the time required for FT & ST fibres to generate maximal force (tension)
Further classification of Type II fibres

- **Type IIa**
  - Partially aerobic
  - Also known as intermediate fast-twitch fibres

- **Type IIb**
  - Purely anaerobic
  - Highest rate of contraction for explosive bursts of energy
Gender & Age differences

- How do you think they could vary?
- Until puberty there isn’t much difference.
- Testosterone enables males to develop a larger muscles to produce greater power.

- Muscles are strongest between 20 - 30.
Microscopic Muscle Structure

✓ Muscle is made up of thousands of muscle fibres.

✓ These fibres contain many myofibrils.

✓ Myofibrils then contain sarcomeres placed end to end.
Sarcomeres

- Myofibrils consist of contractile units called sarcomeres and are placed end to end along the muscle.
- Contains 2 protein filaments:
  - Actin (thin)
  - Myosin (thick)
- These filaments overlap allowing the sarcomeres to shorten and lengthen.
Parts of the sarcomere…

- Many sarcomere units run the length of a myofibril. Z lines are used to indicated where one sarcomere begins & ends.

- Action & myosin occupy different parts along the length of the sarcomere.

- The lighter section contains only the thin actin filaments. This section is known as the I Band.
The dark sections occur when actin & myosin overlap. This is known as the A Band.

The H zone is a very small section in the middle of the A band. This section contains only myosin filaments.
Sliding Filament Theory

- Explains how muscular contraction occurs.
- The myosin filaments (thick) have tiny protein projections that extend towards the actin filaments and grab onto them to shorten the sarcomere, and contract the muscle. These are called cross bridges & are very important in muscle contraction.
- The greater the stimulation, the greater the shortening (contraction).
What occurs in a Sarcomere during Muscular Contraction

1. H zone disappears because actin filaments slide over myosin filaments.

2. I Band shortens the actin filaments attached to the Z lines on either side of the sarcomere are pulled toward the centre.

3. The A Band does not change in length.

4. Neither the actin nor the myosin filaments change in length, because of the sliding mechanism.

5. https://www.youtube.com/watch?v=Cjx3vSm54N8
Nervous control of muscular contractions

- Nervous impulses are sent by nerve cells called neurons.
- There are two main types of neurons:
  - **Sensory neurons**, which pass information about stimuli such as light, heat or chemicals from sensory organs and receptors to your central nervous system.
  - **Motor neurons**, which pass instructions from your central nervous system to other parts of your body, such as muscles and glands.
Structure of Neurons

✓ Neurons are made up of three main parts:
✓ The **cell body** which directs the activities of the neuron
✓ The **dendrites** which are receptors that pick up the nervous impulse from other neurons
✓ The **axon** which transmits the impulse away from the cell body
Structure of Neurons

- The junction between the dendrite of one neuron and the end of the axon of another is referred to as a **synaptic cleft** or **synapse**.
- The junction between an axon and a muscle is called a **neuromuscular synapse** or **junction**.
The Neuromuscular Synapse

✓ The neuromuscular synapse is a specialized excitatory synapse that allows motor neurons to communicate with muscle fibres.
✓ It is a chemical synapse using \textit{acetylcholine (ACh)} as the neurotransmitter.
✓ As a nerve impulse reaches the end of the axon, it triggers the release of ACh which is stored within the nerve ending.
✓ This transmitter substance travels across the synaptic cleft and stimulates an electrical impulse (\textit{action potential}) in the muscle fibre, which in turn brings about a muscular contraction.
The Neuromuscular Synapse
Motor Units

✓ One motor neuron does not stimulate a whole muscle, but only a number of fibres within that muscle.
✓ The motor neuron plus the muscle fibres it innervates (stimulates) is called a **motor unit**.
✓ The number of muscle fibres within each motor unit varies according to the precision of movement required.
Any muscle will have a number of motor units stimulating different sections of its fibres.

The number of muscle fibres stimulated by a single motor unit varies according to the precision of the movement required.
“ALL OR NOTHING” PRINCIPLE

- Once the nerve impulse reaches threshold level,
- All of the fibres in a given motor unit will contract fully.
- If the impulse is insufficient no fibres will contract.
The types of muscular contraction

- There are 3 types of contractions:
  - Isotonic
  - Isometric
  - Isokinetic
Isotonic Contraction

- Most common
- Occurs when muscle length changes while creating force.
  - Eg. person picks up a shot put.

- There are two types:
  - Isotonic concentric - muscle shortens/contracts
  - Isotonic eccentric - muscle lengthens/extends
  - Eg. Bicep Curl (Up & Down phase)
Isometric contraction
Muscle contracts but does not shorten

Concentric contraction
No movement

Eccentric contraction
Movement

(a)

(b)

(c)
Isometric Contraction

✓ When the muscle creates force but the muscle length does not change.
  ✓ Eg. Rugby scrum, pushing a car, resting position in rock climbing.

✓ Creates most force.
✓ Tires the athlete.
Isokinetic Contraction

- Muscle produces maximal force throughout range of motion.
- Need specific gym equipment to match the force applied by the muscles.
- Power lifting.
Lab

- Sit-up
- Planks
- Push-ups
- Push against the wall
Nervous Control

- Brain is responsible for initiating all actions.
- Messages travel down spinal cord then along motor neurons to the muscles.