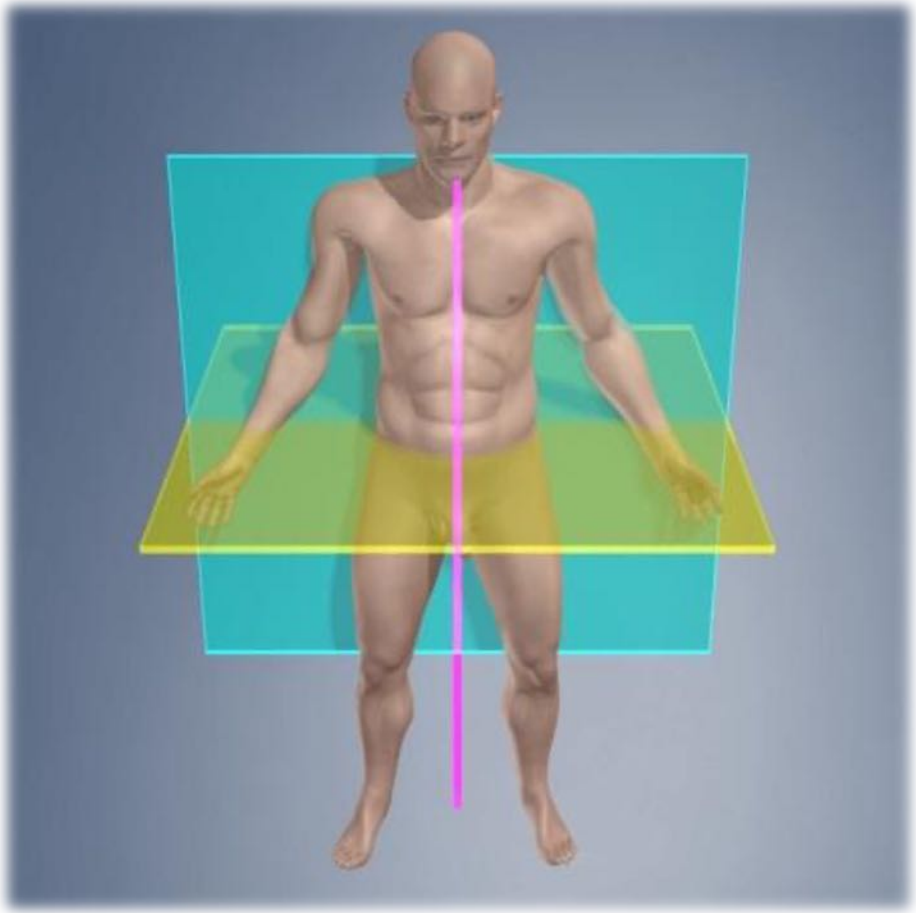
A&P
Slide Deck

Anatomical Planes



Anatomical Planes - Frontal

- Divides the body into front and back sections (anterior and posterior)

- Joint actions
  - Abduction and adduction
  - Elevation and depression

Anatomical Planes - Sagittal

- Divides the body into left and right sections (can be uneven)

- Joint actions
  - Flexion and extension
  - Plantar and dorsi flexion

Anatomical Planes - Transverse

- Divides the body into upper and lower parts

- Joint actions
  - Rotation
  - Pronation and supination
  - Protraction and retraction
  - Inversion and eversion

Joints

Level 3 Anatomy and Physiology
for Exercise and Health

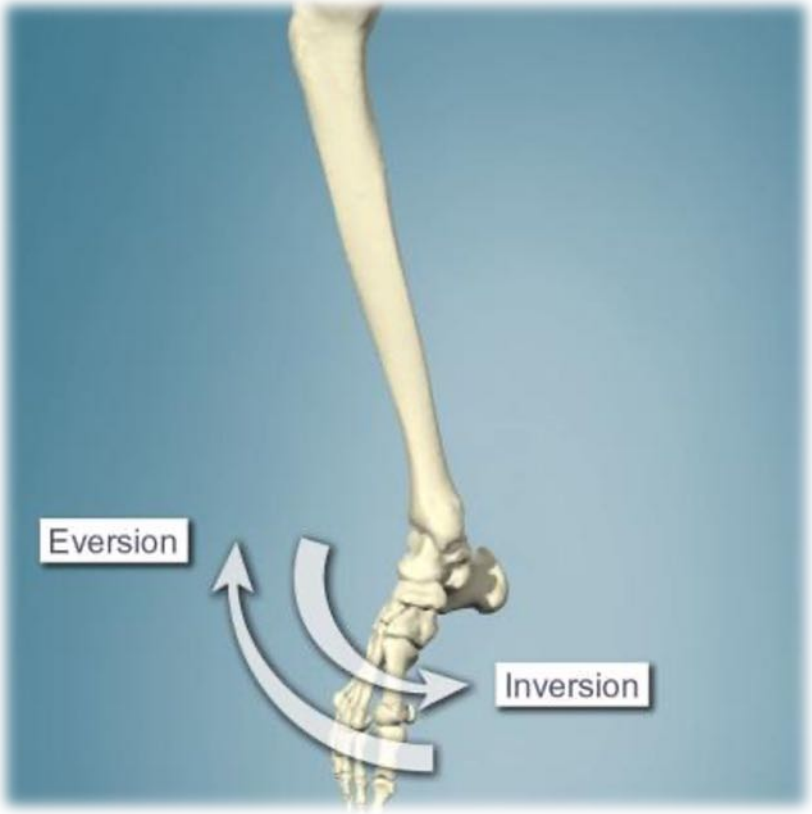
Learning Outcomes

- By the end of this session you will be able to:
  - Describe joints / joint structure with regard to range of movement and injury risk
  - Describe the structure of the pelvic girdle and the associated muscles and ligaments

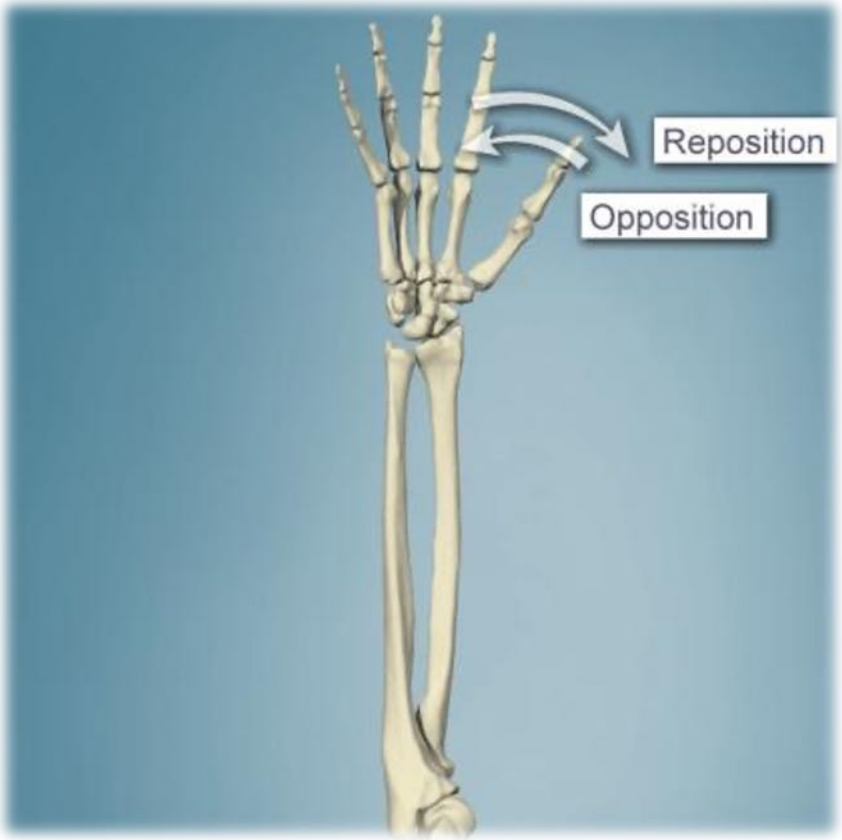
Joint Actions

- Revise joint actions from level 2
- Inversion
  - Movement and the sub talar joint
  - Sole of the foot turns inwards
- Eversion
  - Sole of the foot turns outwards
- Opposition
  - Touching the thumb to the fingers

Joint Actions
Inversion and Eversion



Joint Actions - Opposition



The Shoulder Girdle

Scapula

Shoulder Girdle

AC Joint

The Shoulder

The Elbow

The Wrist

The Hip

The Pelvic Girdle

Male

Female

The Knee

The Ankle

The Foot

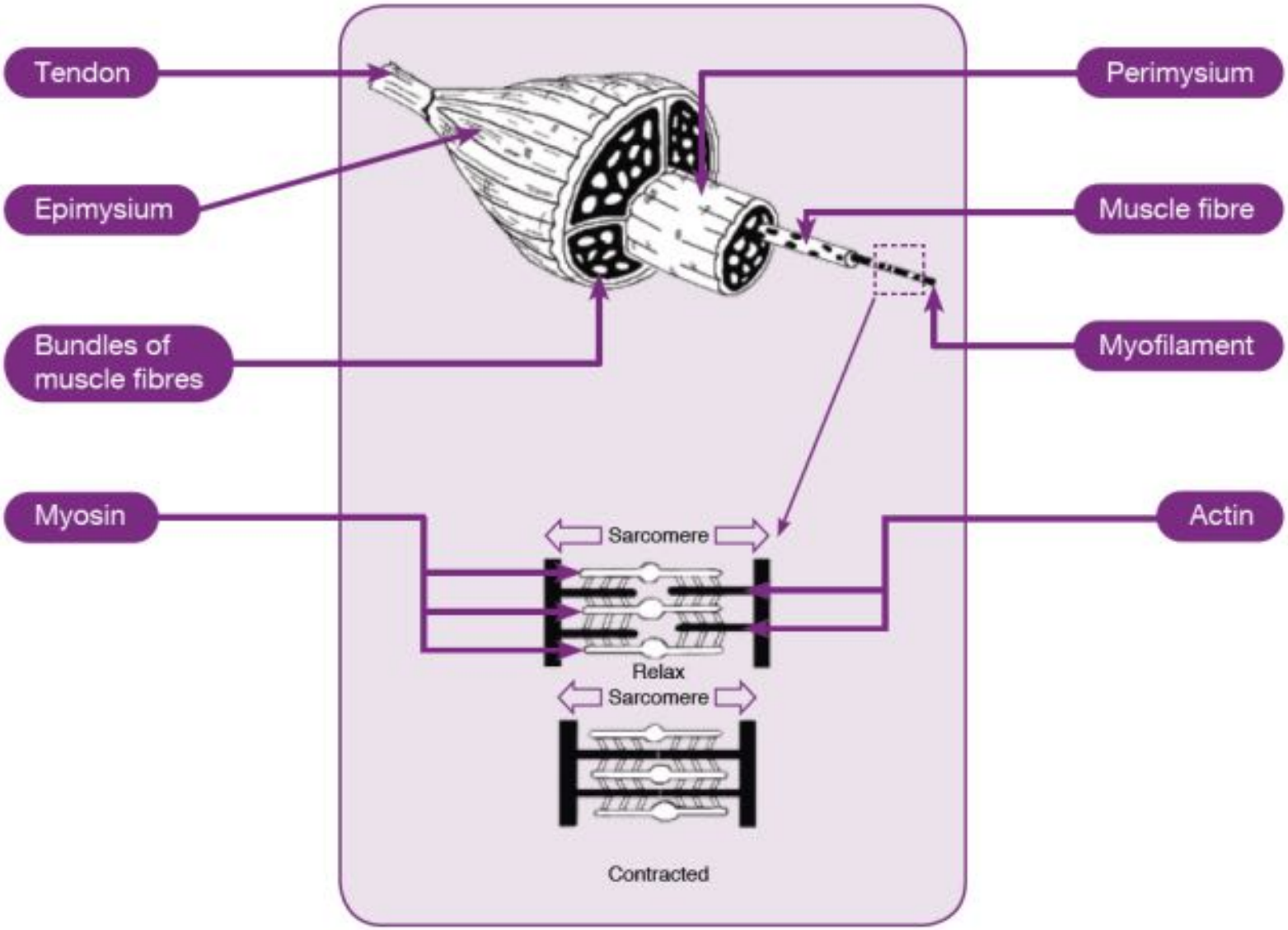
Muscle Structure and Function

Level 3 Anatomy and Physiology
for Exercise and Health

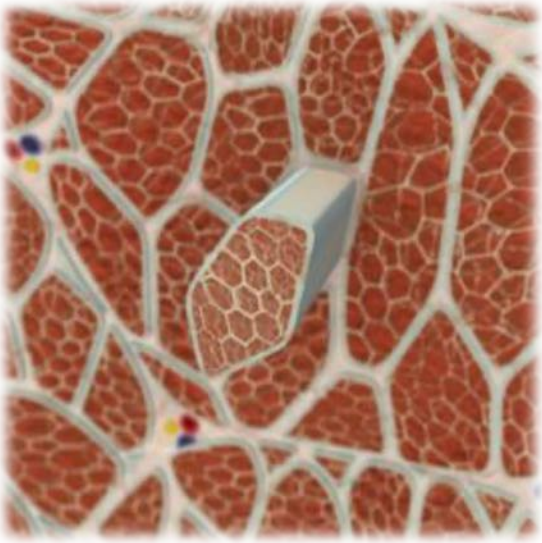
Learning Outcomes

- By the end of this session you will be able to:
  - Explain the cellular structure of muscle fibres
  - Describe sliding filament theory
  - Explain the effects of different types of exercise on muscle fibre types
  - Describe the ability of muscle fibres to adapt to training

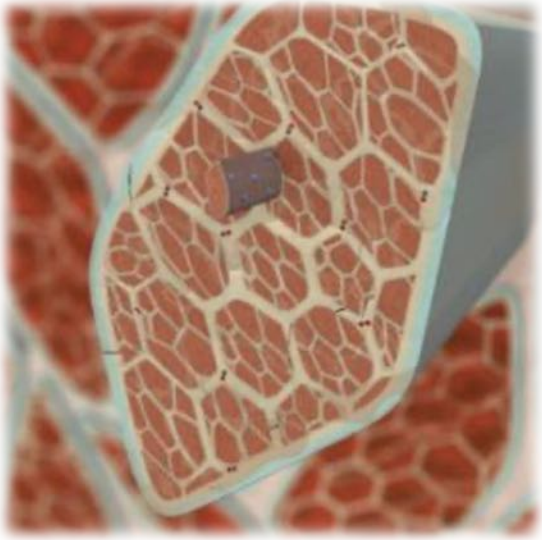
Muscle Structure and Function



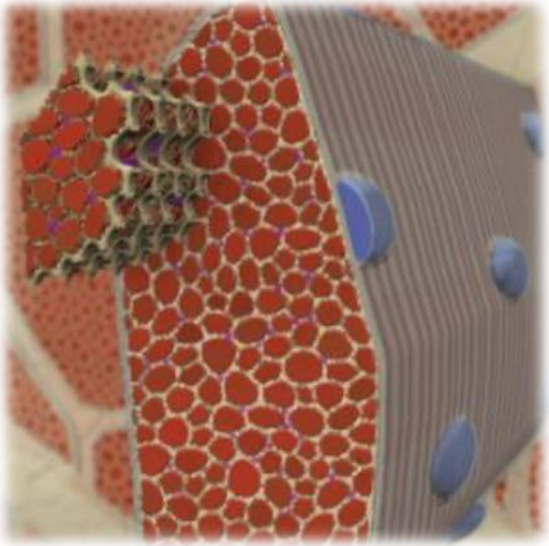
Muscle Structure



Muscle fibre



Myofibril

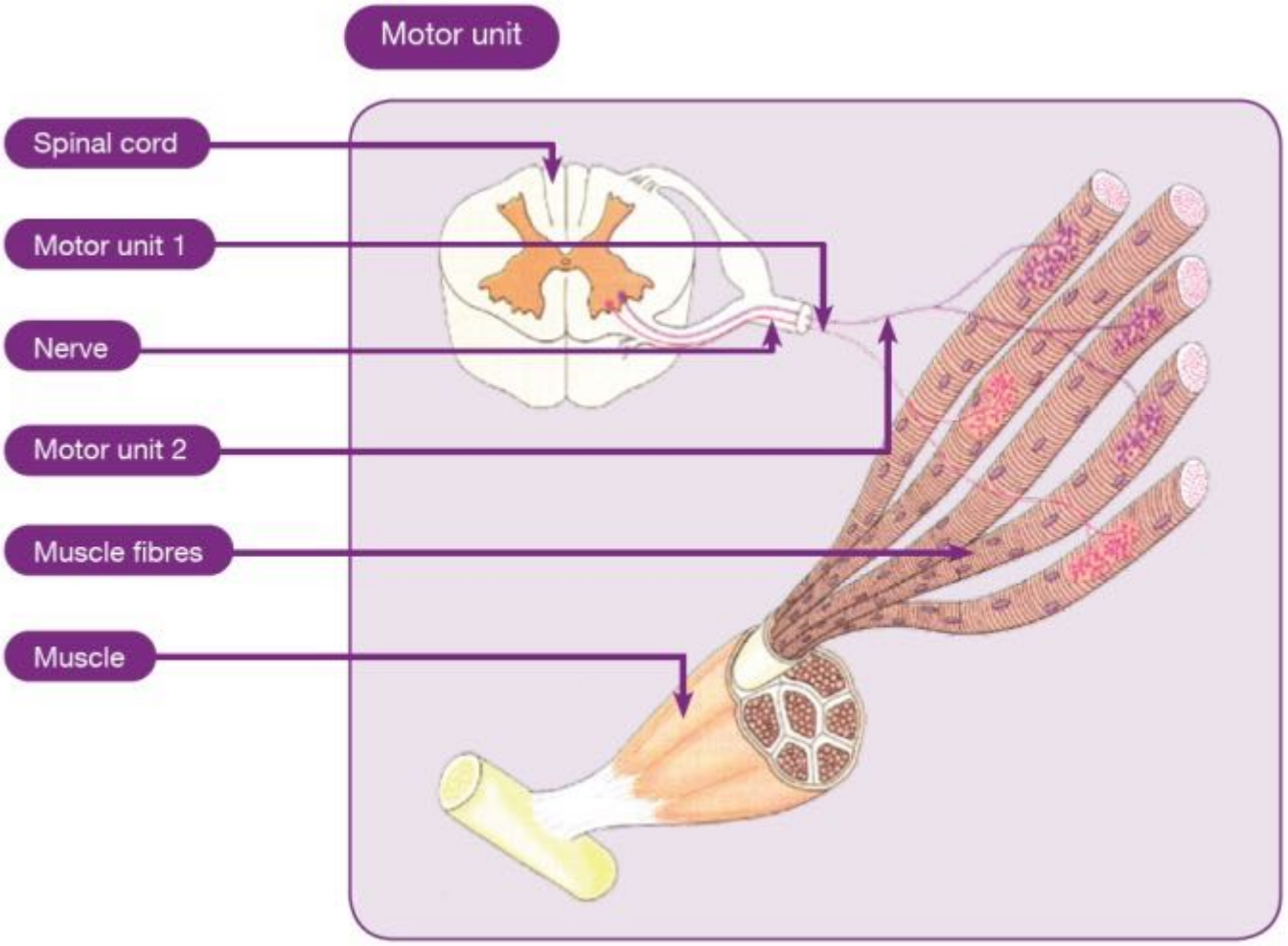


Myofilament

Sliding Filament Theory

- Occurs within the sarcomere
  - The ‘unit’ of muscular contraction
- Requires calcium and ATP
  - Nervous stimulus causes the myosin heads to attach to the actin forming cross bridges
  - Myosin heads pivot and pull actin towards the centre of the sarcomere
  - Process is repeated and myosin attaches further along the actin

Motor Units and Recruitment



Motor Units and Recruitment

- The strength of a muscular contraction will be affected by:
  - The frequency of nerve impulses coming into the muscle cell
  - The number of motor units activated

Muscle Fibre Types

Slow twitch fibres	**Fast twitch fibres**
Type 1	Type 2
Slow oxidative fibres	Fast glycolytic fibres
Red in colour	White in colour
Contain large numbers of mitochondria	Contain low numbers of mitochondria
Endurance type activities	Strength / anaerobic type activities

Muscle Fibre Types

- Type 2 fibres subdivide:
  - Type 2a – Fast oxidative glycolytic (FOG)
  - Type 2b – Fast glycolytic (FG)

Muscles of the Body

Level 3 Anatomy and Physiology
for Exercise and Health

Learning Outcomes

- Name, locate and explain the function of muscles and their attachment sites

Muscles of the Upper Limb

Level 3 Anatomy and Physiology
for Exercise and Health

Muscles of the Shoulder Girdle

Level 3 Anatomy and Physiology for Exercise and Health

Trapezius

Origin

- Back of skull: C7, all thoracic vertebrae

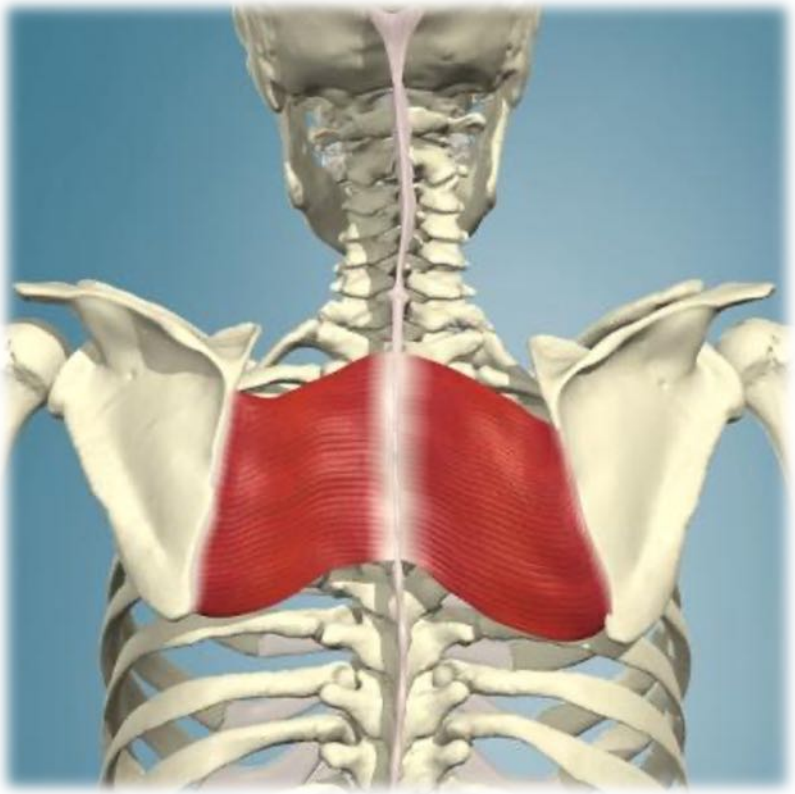
Insertion

- Spine of scapula and lateral edge of clavicle
- Joint crossed
- Shoulder girdle (moves scapula relative to rib cage)

Joint actions

- Upper fibres elevate the shoulder girdle
- Middle fibres retract shoulder girdle
- Lower fibres depress shoulder girdle
- Whole muscle upwardly rotates scapula (works as a synergist with serratus anterior)

Rhomboids



Origin

- Spinous processes of cervical and thoracic vertebrae (C7 and T1–T5)

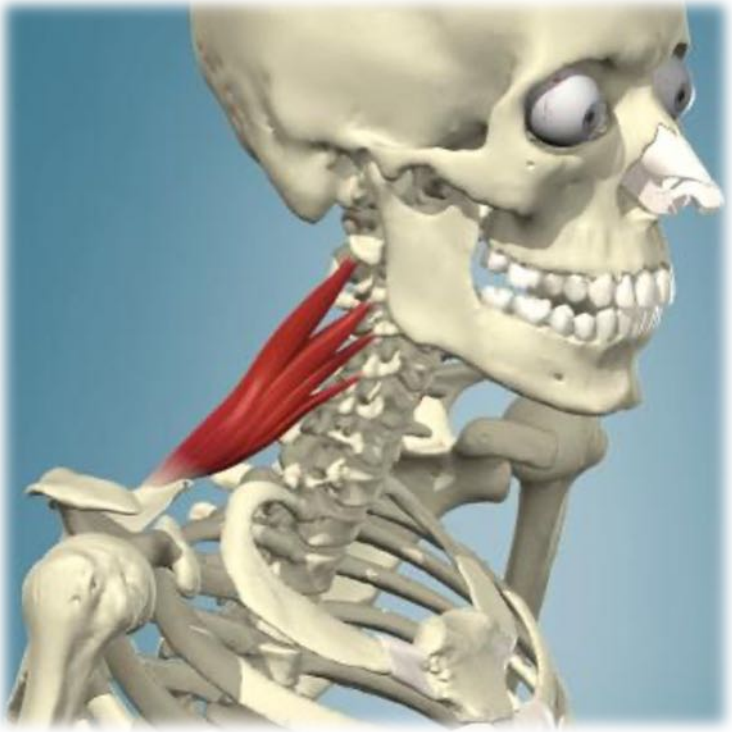
Insertion

- Medial border of scapula
- Joint crossed
- Shoulder girdle (moves scapula relative to rib cage)

Joint actions

- Retracts scapula
- Downwardly rotates scapula (works as a synergist with pectoralis minor)

Levator scapulae



Origin

- Transverse processes of cervical vertebrae (C1–C4)

Insertion

- Medial border of scapula, between superior angle and root of the spine of the scapula

Joint crossed

- Shoulder girdle (moves scapula relative to rib cage)

Joint action

- Origin fixed: elevates the scapula. Assists in downwards rotation of scapula
- Insertion fixed: laterally flexes the neck

Serratus anterior

Origin

- Front of ribs 1–8

Insertion

- Anterior surface of medial border of scapula

Joint crossed

- Shoulder girdle (moves scapula relative to rib cage)

Joint action

- Protracts the scapula
- Upwardly rotates scapula (works as a synergist with trapezius)

Pectoralis minor

Origin

- Front of ribs 3–5

Insertion

- Coracoid process of scapula

Joint crossed

- Shoulder girdle (moves scapula relative to rib cage)

Joint action

- Origin fixed: Protracts the scapula. Downwardly rotates scapula (works as a synergist with rhomboids)
- Insertion fixed: Elevates rib cage during breathing

Muscles of the Shoulder Joint

Level 3 Anatomy and Physiology
for Exercise and Health

Deltoid

Origin

- Clavicle (anterior head), acromion (medial head) and spine of scapula (posterior head)

Insertion

- Lateral surface of humerus (nearly half way down)

Joint crossed

- Shoulder (glenohumeral joint)

Joint action

- Anterior fibres flex the shoulder and assist in horizontal flexion and medial rotation.
- All fibres abduct the shoulder (emphasis on medial fibres)
- Posterior fibres extend the shoulder and assist in lateral rotation

Pectoralis major

Origin

- Clavicle, sternum and cartilages of ribs 1–6

Insertion

- Top of the humerus

Joint crossed

- Shoulder (glenohumeral) joint

Joint action

- Shoulder horizontal flexion
- Shoulder adduction
- Shoulder medial rotation

Latissimus dorsi

Origin

- Via thoracolumbar fascia (TLF) from spinous processes of T6–T12, lumbar and sacral vertebrae and iliac crest. Also lower 3–4 ribs and bottom (inferior) edge of scapula

Insertion

- Top of the humerus (anterior)

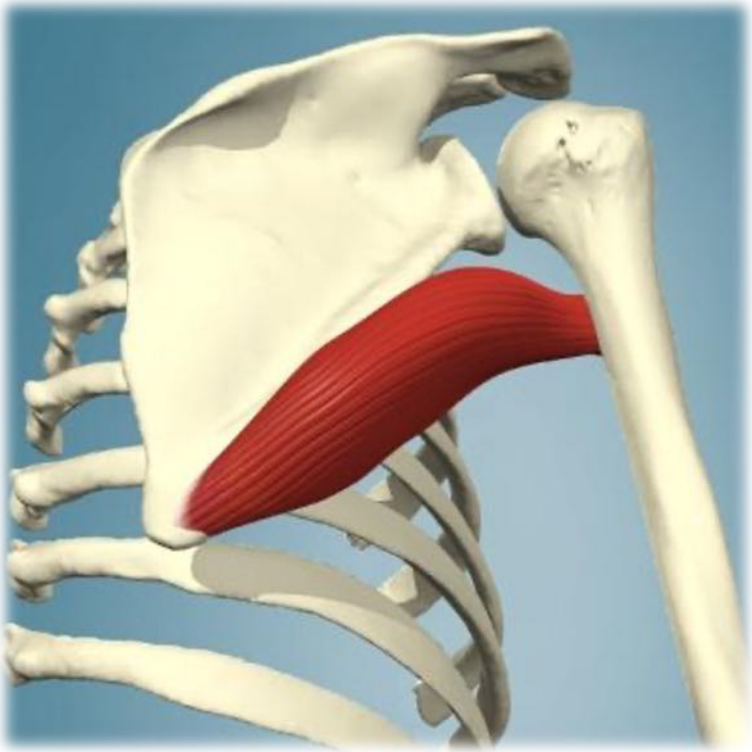
Joint crossed

- Shoulder (glenohumeral) joint

Joint action

- Origin fixed: adducts and extends arm. Assists in medial rotation of the arm. Depresses the shoulder girdle via the insertion on the humerus
- Insertion fixed: tilts the pelvis forwards

Teres Major



Origin

- Lateral border of the scapula near the inferior angle

Insertion

- Humerus (proximal, anterior)

Joint crossed

- Shoulder joint

Joint action

- Medial rotation, adduction and extension of the shoulder joint

Muscles of the Shoulder Joint
Rotator Cuff

Level 3 Anatomy and Physiology
for Exercise and Health

Supraspinatus

Origin

- Superior to spine of scapula

Insertion

- Superiorly on the head of the humerus

Joint crossed

- Shoulder

Joint action

- Assists deltoid in abduction of the arm. Weak lateral rotator
- All four muscles together hold the head of the humerus in the correct position relative to glenoid cavity

Infraspinatus

Origin

- Inferior to spine of scapula

Insertion

- Laterally on the head of the humerus

Joint crossed

- Shoulder

Joint action

- Rotates arm laterally
- All four muscles together hold the head of the humerus in the correct position relative to glenoid cavity

Subscapularis

Origin

- Anterior surface of scapula

Insertion

- Anteriorly on the head of the humerus

Joint crossed

- Shoulder

Joint action

- Subscapularis: Rotates arm medially
- All four muscles together hold the head of the humerus in the correct position relative to glenoid cavity

Teres Minor

Origin

- Lateral border of scapula near the inferior angle

Insertion

- Teres minor: Laterally on the head of the humerus

Joint crossed

- Shoulder

Joint action

- Teres minor: Rotates arm laterally
- All four muscles together hold the head of the humerus in the correct position relative to glenoid cavity

Muscles of the Elbow

Level 3 Anatomy and Physiology
for Exercise and Health

Biceps brachii

Origin

- Scapula

Insertion

- Top of radius, and bicipital aponeurosis to medial part of forearm

Joints crossed

- Shoulder and elbow

Joint action

- Flexes elbow
- Supinates forearm
- Assists in flexion of the shoulder joint

Brachialis

Origin

- Humerus

Insertion

- Ulna

Joint crossed

- Elbow

Joint action

- Flexes elbow

Brachioradialis

Origin

- Laterally at the distal end of humerus

Insertion

- Laterally at the distal end of the radius

Joint crossed

- Elbow

Joint action

- Flexion when the forearm is semi pronated (as in a drinking action). Assists other flexors

Triceps brachii

Origin

- Long head on scapula just above shoulder joint
- Other two heads on the posterior of the humerus

Insertion

- Olecranon of ulna

Joints crossed

- Elbow and shoulder

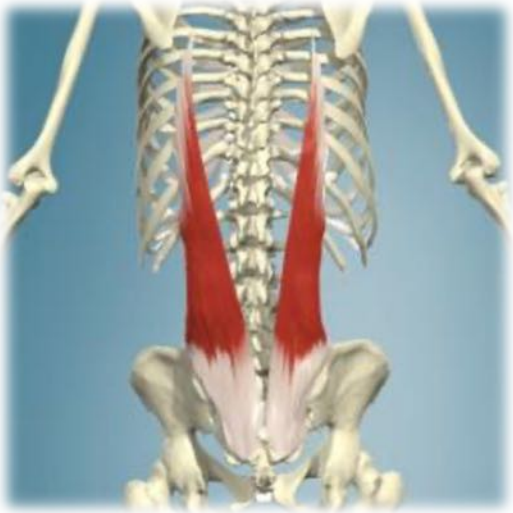
Joint action

- Extension of elbow
- Assists in shoulder extension and adduction (long head only)

Muscles of the Vertebral Column

Level 3 Anatomy and Physiology for Exercise and Health

Iliocostalis



Origin

- Ribs and iliac crest

Insertion

- Transverse processes of cervical vertebrae and ribs superior to origin

Joint crossed

- Vertebrae

Joint action

- Extends the spine

Longissimus

Origin

- Transverse Processes of cervical, thoracic and lumbar vertebrae

Insertion

- Transverse Processes of superior vertebrae to origin

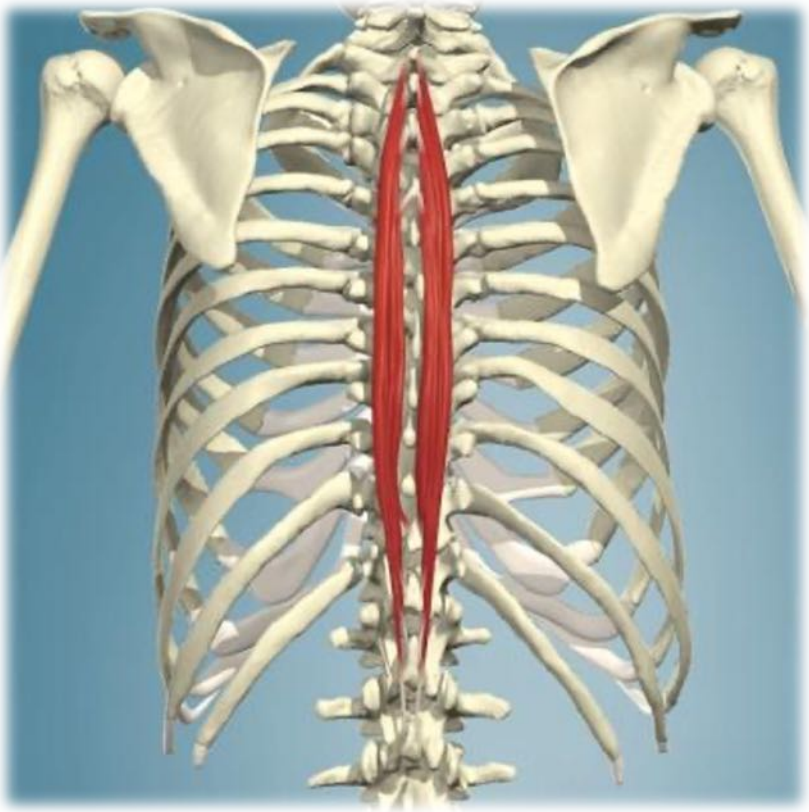
Joint crossed

- Vertebrae

Joint action

- Extends head and rotates it to same side, extends the spine

Spinalis



Origin

- Spinous processes of cervical, thoracic and lumbar vertebrae

Insertion

- Spinous processes of superior vertebrae to origin

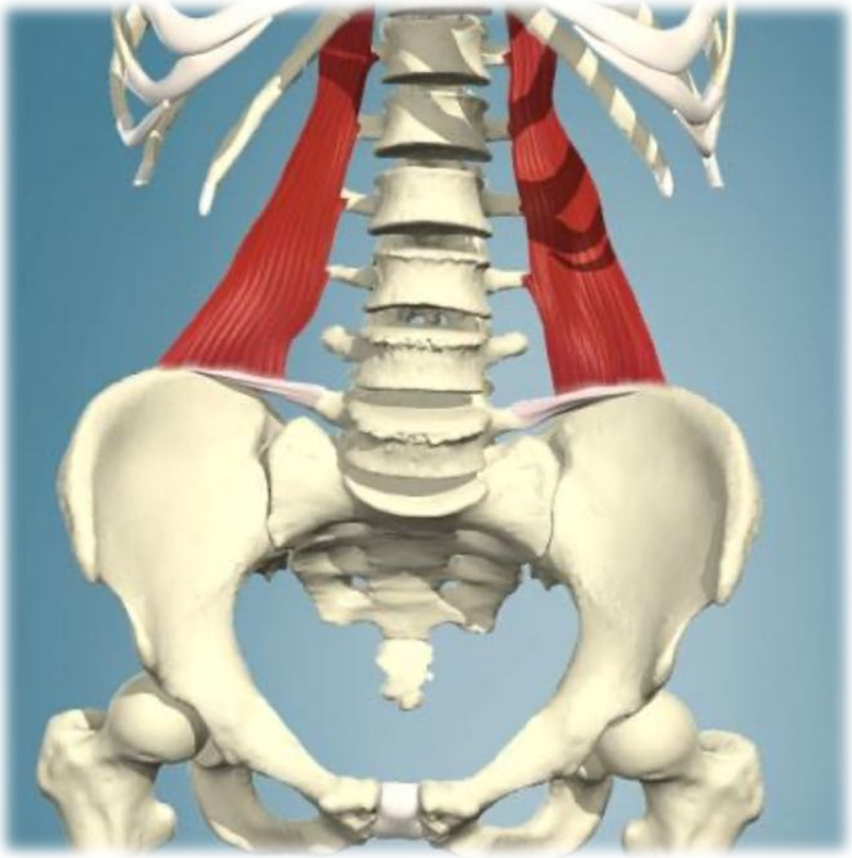
Joint crossed

- Vertebrae

Joint action

- Extends the spine

Quadratus Lumborum



Origin

- Iliac crest and Iliolumbar fascia.

Insertion

- Upper 4 lumbar vertebrae and lower margin of 12th rib.

Joint crossed

- Intervertebral joints of lumbar vertebrae.

Joint action

- Unilateral concentric contraction: lateral flexion of lumbar spine.
- Unilateral isometric contraction: prevents lateral flexion of lumbar spine (e.g. when carrying a heavy suitcase in one hand).
- Bilateral eccentric contraction: assists in preventing hyperflexion of lumbar spine.

Multifidus

Origin

- Sacrum, and transverse processes of vertebrae.

Insertion

- Spinous processes 2-4 vertebrae superior to origin.

Joint crossed

- Intervertebral joints of vertebral column.

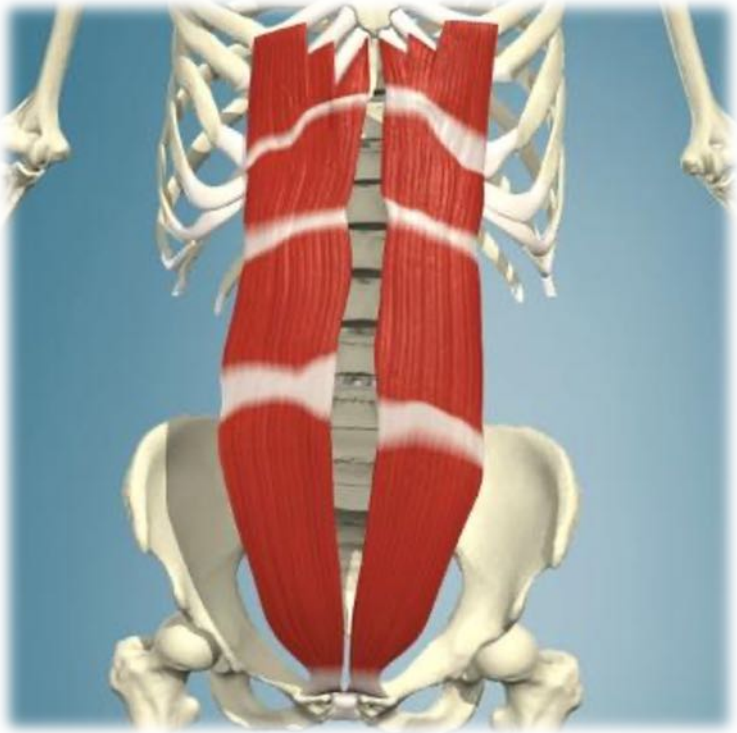
Joint action

- Extension of vertebral column.
- Rotation of vertebral column.
- Important to lumbar spine stability because it is a ‘local’ muscle, controlling the fine positioning of adjacent vertebrae.

Anterior Abdominal Wall Muscles

Level 3 Anatomy and Physiology
for Exercise and Health

Rectus abdominis



Origin

- Pubis and symphysis pubis

Insertion

- Cartilages of ribs 5–7 and base of sternum

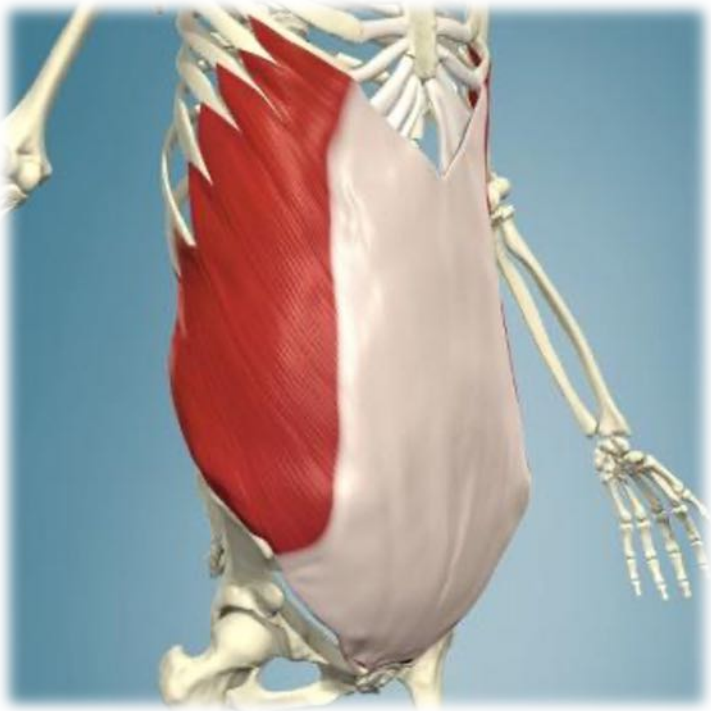
Joints crossed

- Intervertebral joints of lumbar and thoracic vertebrae

Joint function

- Flexion of vertebral column

External obliques



Origin

- Outer surface of bottom 8 ribs

Insertion

- Mainly linea alba, also iliac crest

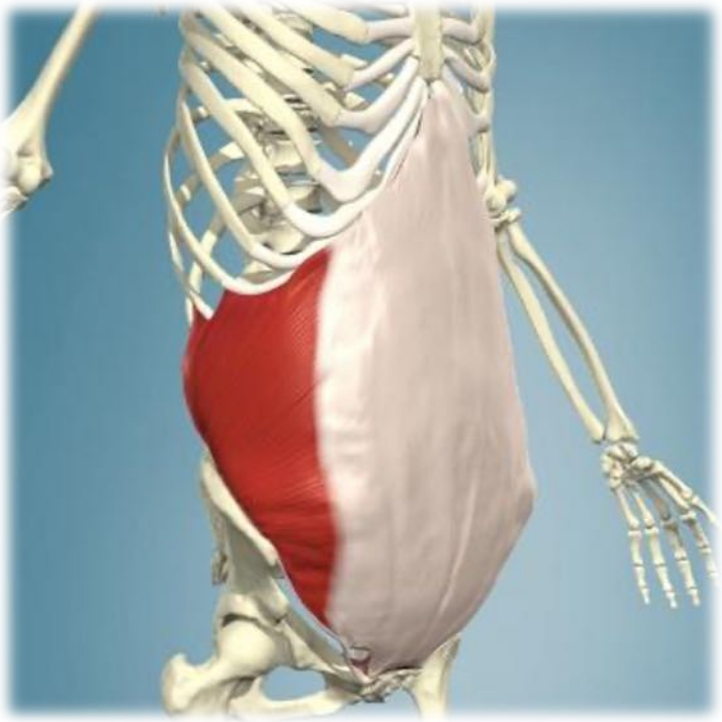
Joints crossed

- Intervertebral joints of lumbar and thoracic vertebrae

Joint function

- Bilaterally: flexion of vertebral column. Tilts pelvis posteriorly
- Unilaterally: rotation and lateral flexion (in combination with internal obliques

Internal obliques



Origin

- Thoracolumbar fascia, iliac crest.

Insertion

- Linea alba, bottom 3 ribs.

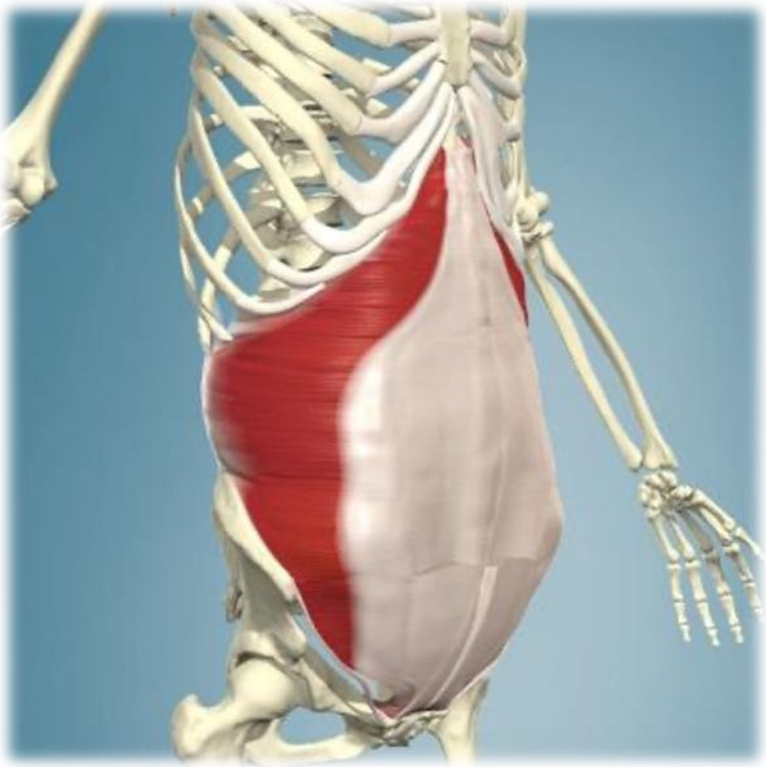
Joint crossed

- Intervertebral joints of lumbar lower thoracic vertebrae.

Joint function

- Bilaterally: flexion of vertebral column
- Unilaterally: rotation and lateral flexion (in combination with external obliques).
- Stabilises lumbar spine by creating tension through the thoracolumbar fascia

Transverse abdominis



Origin

- Thoracolumbar fascia, cartilage of lower 6 ribs and Iliac crest

Insertion

- Linea alba

Joint crossed

- Intervertebral joints of lumbar vertebrae

Joint function

- Compression of abdominal cavity, and increasing intra-abdominal pressure
- Support of abdominal contents
- Stabilises lumbar spine by creating tension through the thoracolumbar fascia and increasing intra-abdominal pressure

Muscles of the Hip and Pelvic Girdle

Level 3 Anatomy and Physiology for Exercise and Health

Iliacus

Origin

- Inside surface of ilium

Insertion

- Top of femur (shares tendon with psoas major)

Joint crossed

- Hip

Joint action

- Flexes hip

Psoas major

Origin

- Bodies, transverse processes and intervertebral discs of all lumbar vertebrae and T12

Insertion

- Top of femur (shares tendon with iliacus)

Joints crossed

- Hip and intervertebral joints of lumbar vertebrae

Joint action

- Origin fixed: flexes hip
- Insertion fixed: pulls on spine to increase the lumbar lordosis
- Unilaterally: assists in lateral flexion of the trunk
- Stabilises lumbar spine

Sartorius

Origin

- Anterior and laterally on the iliac spine

Insertion

- Tibia (medially)

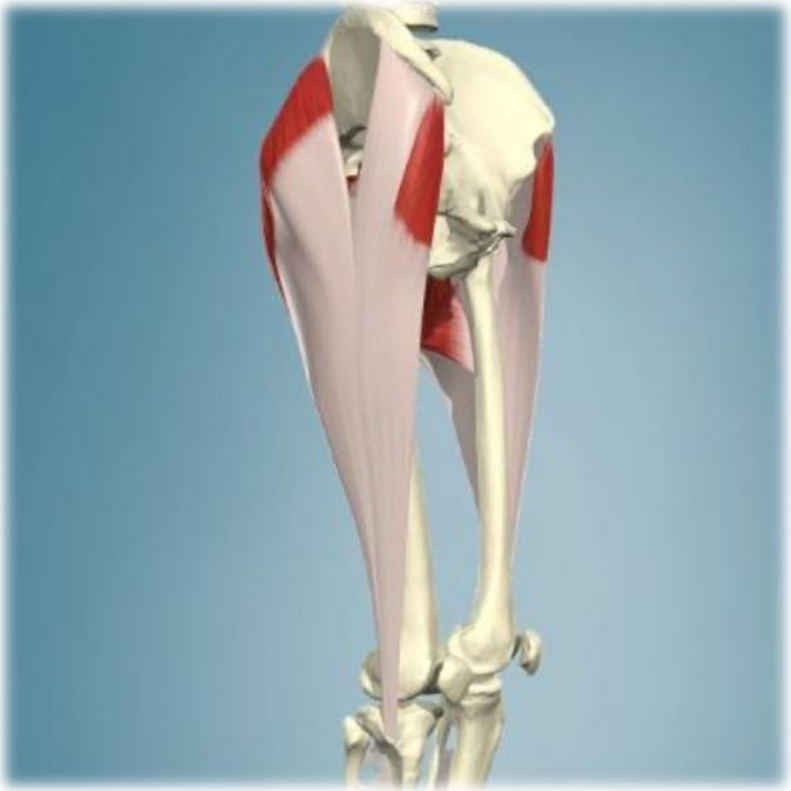
Joint crossed

- Hip and knee

Joint action

- Flexion and lateral rotation of hip, flexion of the knee

Tensor Fascia Latae



Origin

- Crest of ilium

Insertion

- Iliotibial tract

Joint crossed

- Hip and knee (via iliotibial tract)

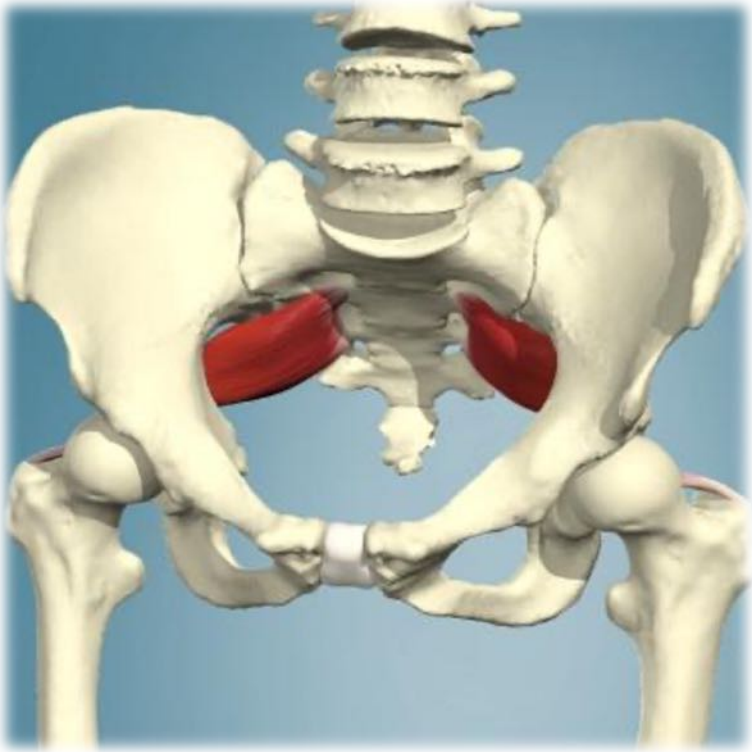
Joint action

- Flexes hip

Abducts hip

- Medially rotates hip

Piriformis



Origin

- Anterior surface of sacrum

Insertion

- Top of femur (greater trochanter)

Joint crossed

- Hip

Joint action

- Abducts hip
- Assists in lateral rotation of hip (however, with hip flexed, may assist in medial rotation)

Adductor group (longus, magnus, brevis)

Origin

- Pubis

Insertion

- Medial/posterior surface of femur

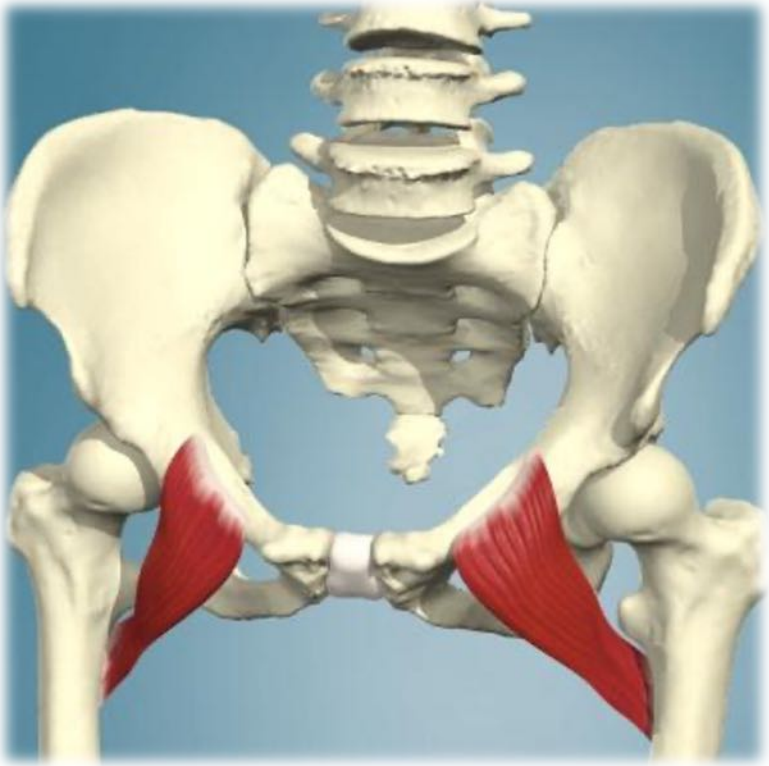
Joint crossed

- Hip

Joint action

- Adducts hip

Pectineus



Origin

- Pubis

Insertion

- Femur

Joint crossed

- Hip

Joint action

- Adducts and flexes the hip

Gracilis

Origin

- Pubis

Insertion

- Top of tibia (just below the knee joint)

Joint crossed

- Hip and knee

Joint action

- Adducts hip
- Assists in knee flexion (helps hamstrings)

Gluteals/Abductors

Gluteus Maximus

Gluteus Minimus

Gluteus Medius

Origin

- Ilium and Sacrum (Gluteus maximus only)

Insertion

- Femur

Joint crossed

- Hip

Joint action

- Extends and outwardly rotates the hip (Gluteus maximus)
- Abducts and inwardly rotates the hip (Gluteus minimus and medius)

Muscles of the Upper Leg

Level 3 Anatomy and Physiology
for Exercise and Health

Hamstrings group: biceps femoris, semimembranosus, semitendinosus

Biceps Femoris

Semitendinosus

Semimembranosus

Origin

- All three muscles: Ischium
- Short head of biceps femoris:
  half way down posterior surface of femur

Insertion

- Semimembranosus, semitendinosus: tibia
- Biceps femoris: head of fibula

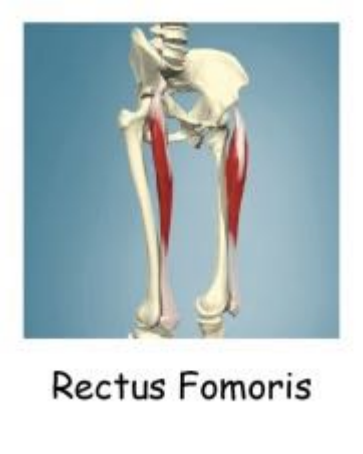
Joints crossed

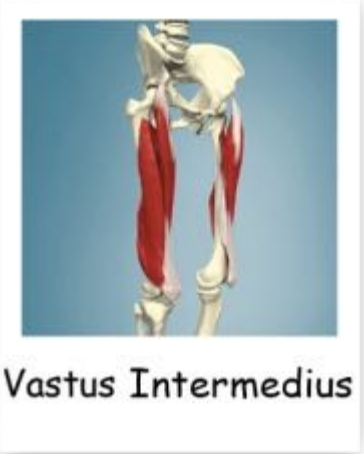
- Knee and hip

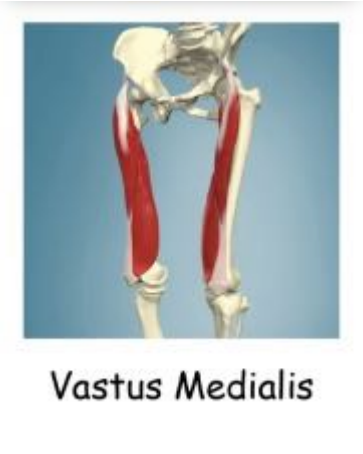
Joint action

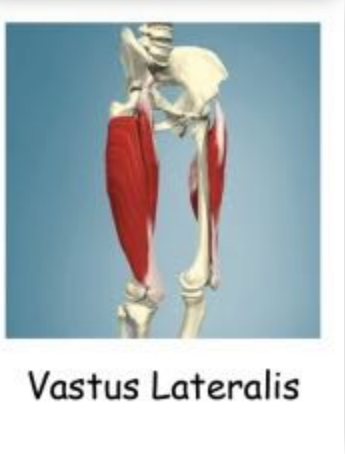
- Knee flexion
- Hip extension

Quadriceps: rectus femoris, vastus medialis, intermedius, lateralis


Rectus Fomoris


Vastus Intermedius


Vastus Medialis


Vastus Lateralis

Origin

- Rectus femoris: iliac spine and top of acetabulum

  Vastus medialis/intermedius/lateralis: femur

Insertion

- Front of tibia via patella tendon

Joints crossed

- Knee and hip (rectus femoris is the only quadriceps to cross both hip and knee joints)

Joint action

- All four muscles extend the knee
- The rectus femoris also flexes the hip

Muscles of the Lower Leg

Level 3 Anatomy and Physiology
for Exercise and Health

Gastrocnemius

Origin

- Condyles of femur, just above the knee

Insertion

- Calcaneus via calcaneal (Achilles) tendon

Joints crossed

- Ankle and knee

Joint action

- Ankle plantarflexion
- Assists in knee flexion

Soleus

Origin

- Tibia, fibula and interosseus membrane

Insertion

- Calcaneus via calcaneal (Achilles) tendon

Joint crossed

- Ankle

Joint action

- Ankle plantarflexion

Tibialis anterior

Origin

- Lateral condyle of tibia, upper half of lateral surface of tibia, and interosseus membrane

Insertion

- Underside of medial cuneiform bone and first metatarsal

Joint crossed

- Ankle

Joint action

- Ankle dorsiflexion
- Subtalar joint inversion (turns sole of foot inwards)

Core Stability

Level 3 Anatomy and Physiology
for Exercise and Health

Learning Outcomes

- Describe the structure and function of the stabilising muscles and ligaments of the spine
- Describe local muscle changes that can take place due to insufficient stabilisation
- Explain the potential problems that can occur as a result of postural deviations
- Explain the impact of core stabilisation exercise

Posture

- '*the arrangement of body parts in a state of balance*'
  - Correct posture:
    - A solid foundation for all movements
    - Optimal biomechanical efficiency
    - Balance between the right and left sides and the front and back of the body
    - Reduces the risk of injury
    - Reduces the risk of degeneration of muscles and joints

Posture

- Static posture:
  - Alignment when the body is still
- Dynamic posture:
  - Alignment when the body is moving (walking, running, lifting)
- Core stability:
  - Ability to prevent unwanted movement from the body's centre
- Neutral spine
  - The position of the spine in which impact and forces can be absorbed and transferred most effectively

Core Stability

Core stability is provided by three different systems:

- Passive system
  - Spinal column and the spinal ligaments
- Active system
  - Muscular activity
- Neural control
  - Feedback from the proprioceptors

Benefits of Core Stability

- Decreased injury risk
- Improved application of force
- Improved appearance
- Improved balance and motor skills
- Reduced low back pain
- Improved lung efficiency
- Decreased risk of falls in the elderly and frail

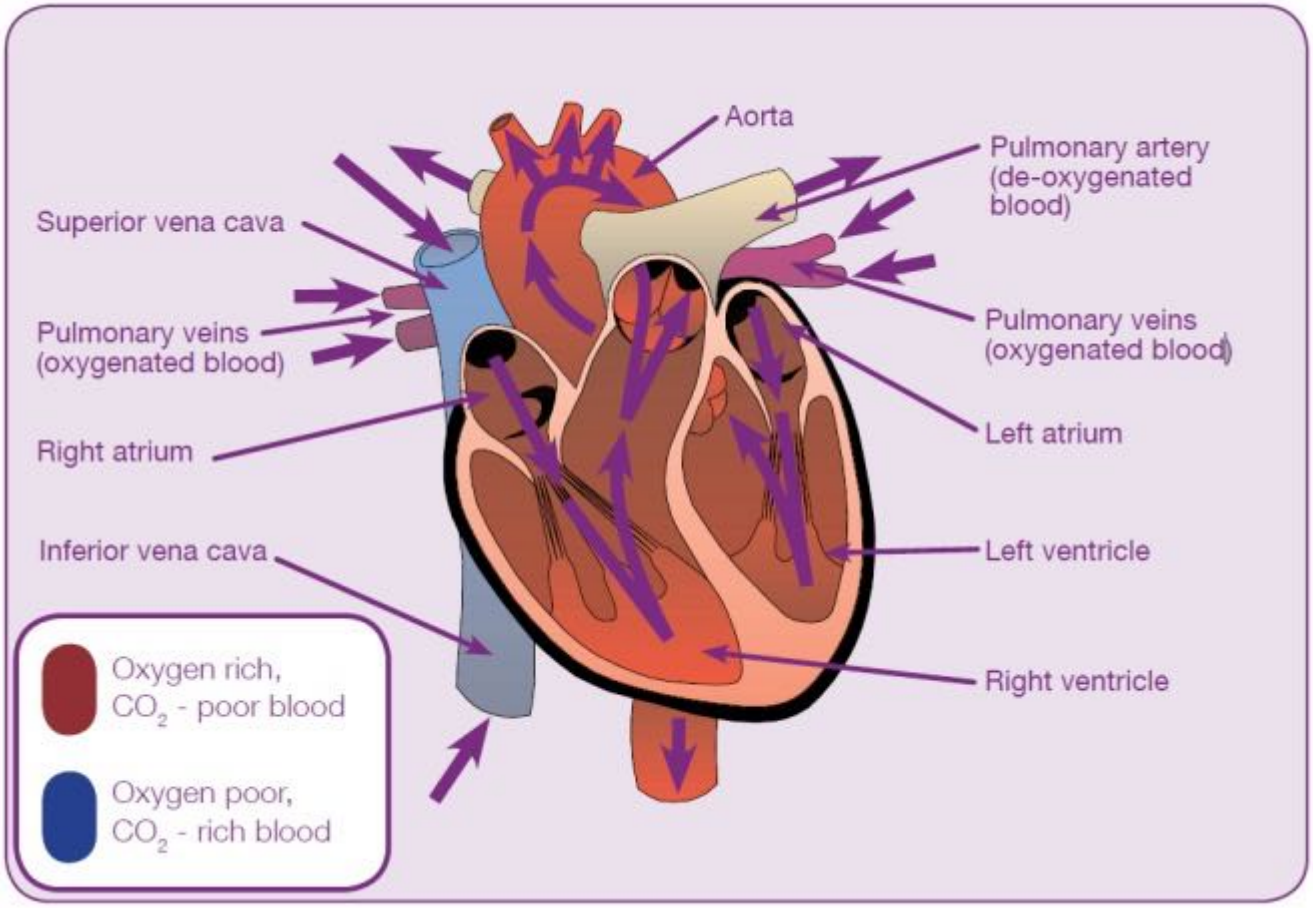
The Cardiorespiratory System

Level 3 Anatomy and Physiology for Exercise and Health

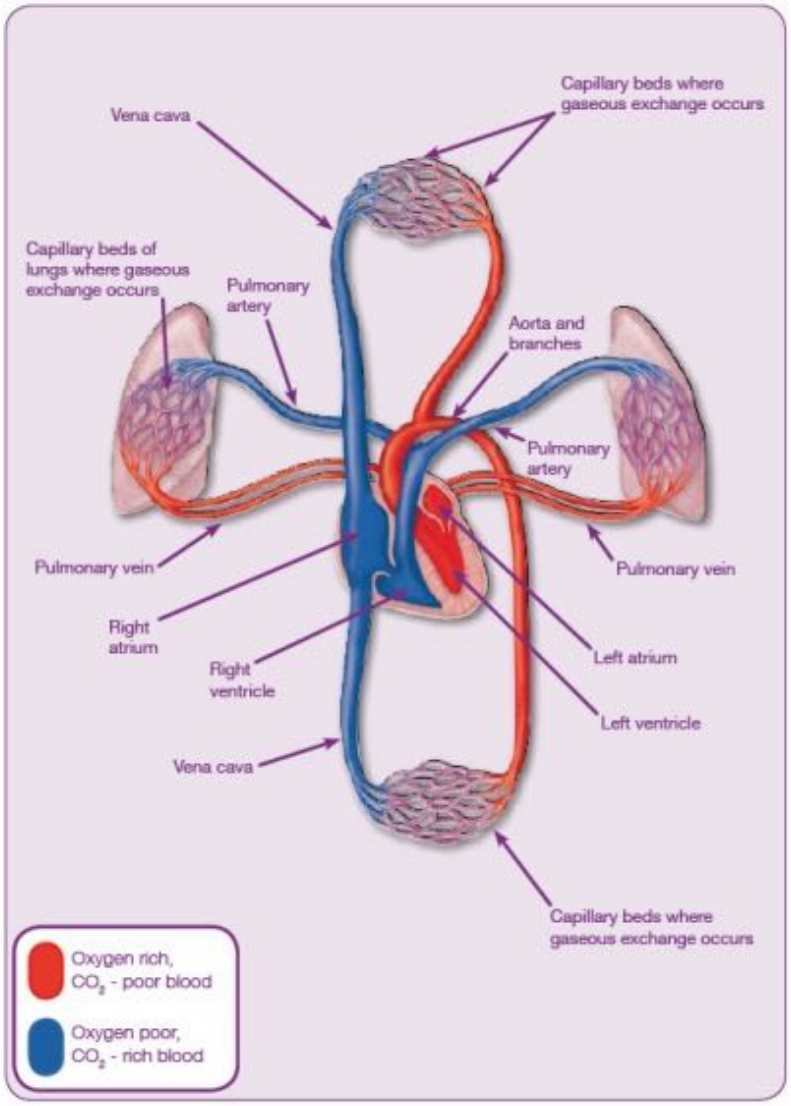
Learning Outcomes

- Understand the heart and circulatory system and its relation to exercise and health
  - Explain the function of heart valves
  - Describe coronary circulation
  - Explain the effect of disease processes on the structure and function of blood vessels
  - Explain the short and long term effects of exercise on blood pressure
  - Explain the cardiovascular benefits and risks of endurance / aerobic training
  - Define blood pressure classifications

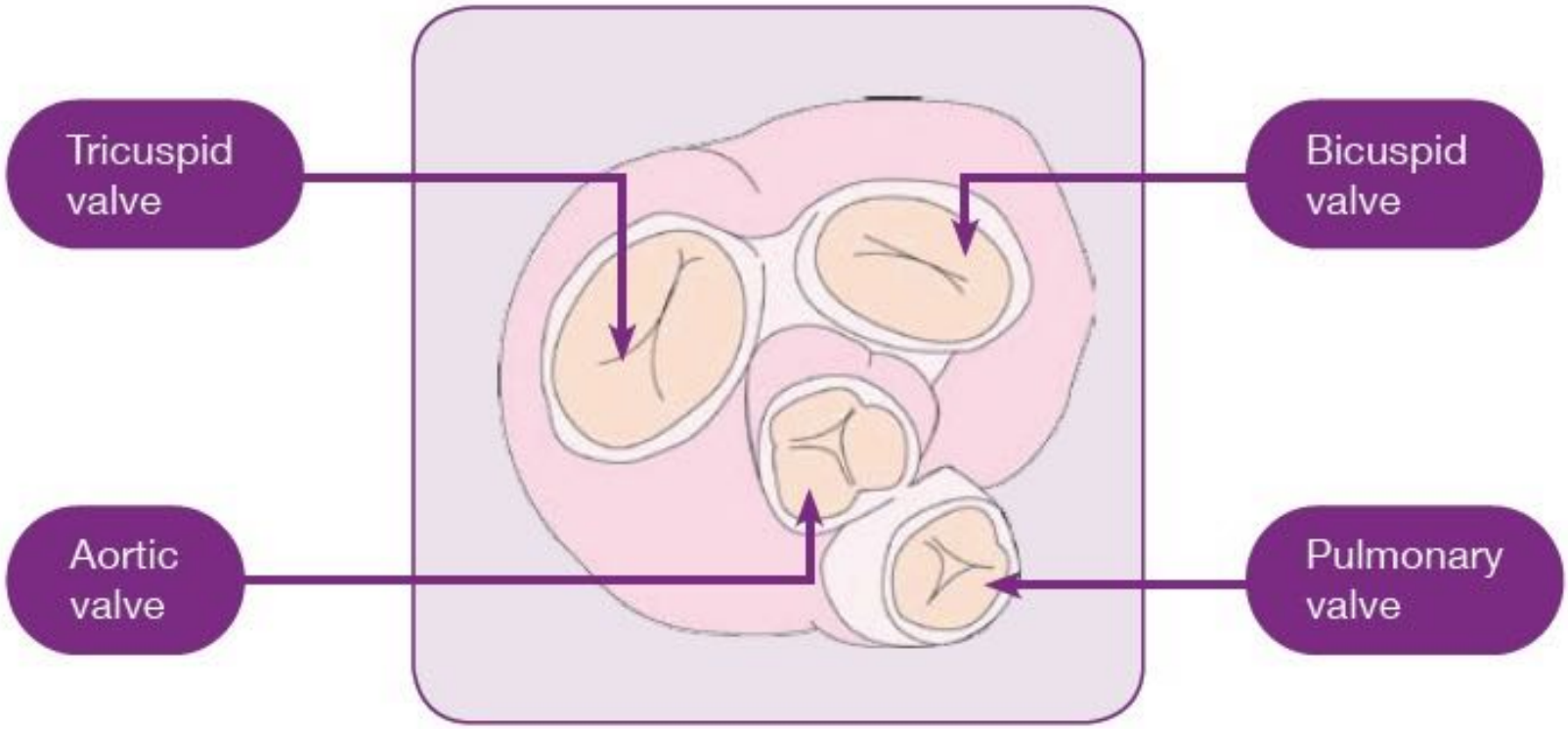
The Heart


Aorta
Pulmonary artery (de-oxygenated blood)
Superior vena cava
Pulmonary veins (oxygenated blood)
Pulmonary veins (oxygenated blood)
Right atrium
Left atrium
Inferior vena cava
Left ventricle
Right ventricle
Oxygen rich, CO_2 - poor blood
Oxygen poor, CO_2 - rich blood

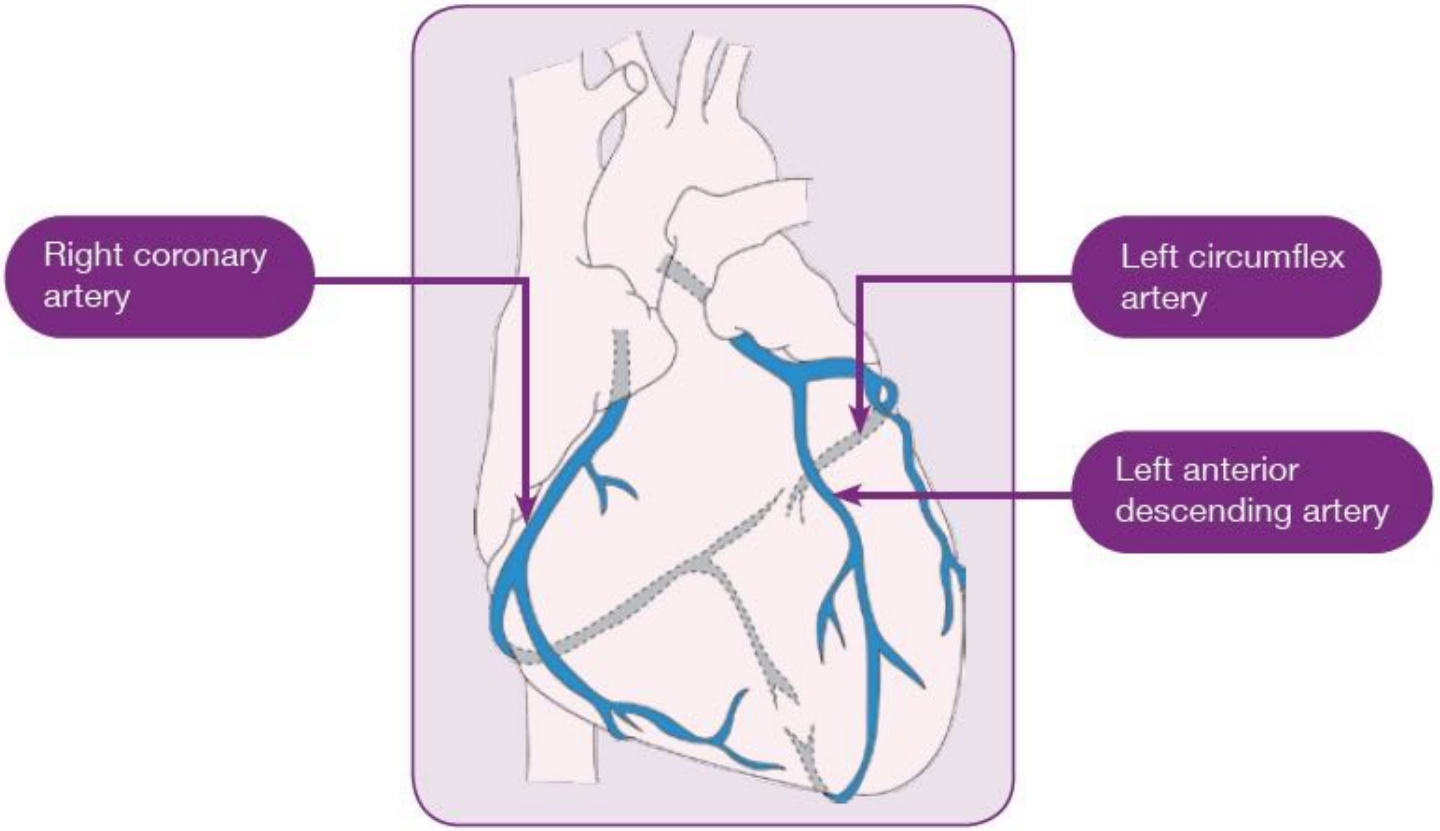
The human circulation system



The Heart Valves



The Coronary Arteries



Respiratory Volumes

- Tidal Volume
  - Amount of air moved in and out of the lungs in once breath
- Residual Volume
  - Amount of air left in the lungs after exhalation
- Vital Capacity
  - Maximum amount of air that can be inhaled and exhaled in one breath

The Nervous System

Level 3 Anatomy and Physiology
for Exercise and Health

Learning Outcomes

- Describe the specific roles of:
  - The nervous system
  - The central and peripheral nervous systems
- Describe nervous control and the transmission of a nervous impulse
- Describe the structure and function of neuron
- Explain the role of the motor unit
- Explain the process of motor recruitment
- Explain the function of proprioceptors and the stretch reflex
- Explain reciprocal inhibition
- Explain the neuromuscular adaptation associated with exercise
- Explain the benefits of improved neuromuscular efficiency

The Nervous System

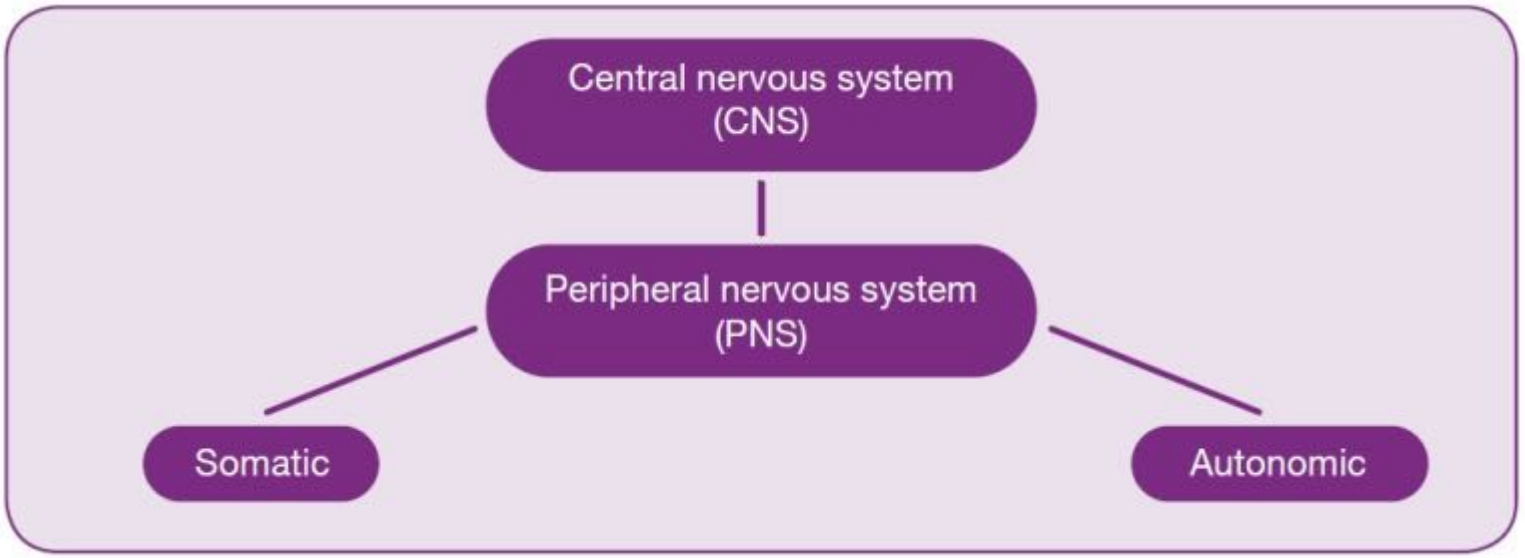
- Functions
  - Controls all the actions of all bodily systems
  - Maintain ‘homeostasis’
    - The body maintaining balance to operate effectively

The Nervous System

- Sensory input
  - To sense changes inside and outside the body
- Interpretation
  - To analyse and interpret incoming information
- Motor output
  - To respond to the information by activating the relevant bodily system

The Nervous System

Structure



The Central Nervous System (CNS)

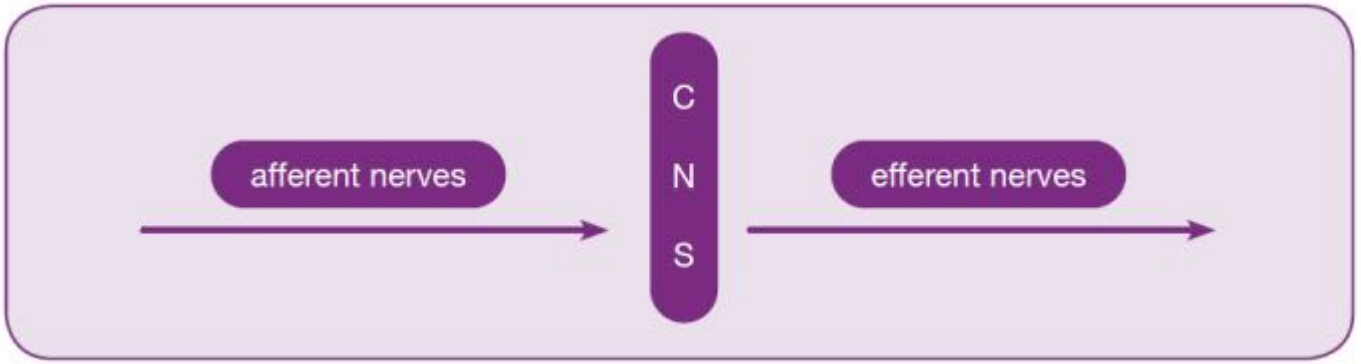
- The brain and the spinal cord
  - Receives messages from the peripheral nervous systems (PNS)
  - Interpretation
  - Sending out the correct motor response

The Peripheral Nervous System (PNS)

- The incoming and outgoing nerves to the spinal cord
  - Afferent nerves – sensory neurons carrying information about changes
  - Efferent nerves – carry information about the required response to a change

Afferent and Efferent Nerves

- **A**fferent Incoming information about changes
- **C**NS Interpretation and decision making
- **E**fferent Outgoing information about a response



The Autonomic and Somatic Nervous System

- **The somatic nervous system –** This branch is of the PNS is concerned with changes in the external environment. It senses movement, touch, pain, skin temperature etc. It is under our conscious control

- **The autonomic nervous system –** This branch of the PNS is concerned with changes in the internal environment. It senses hormonal status, functioning of internal organs, controls cardiac and smooth (involuntary) muscles and the endocrine glands that secrete hormones. The autonomic nervous system is **not** under our conscious control.

Branches of the Autonomic Nervous System

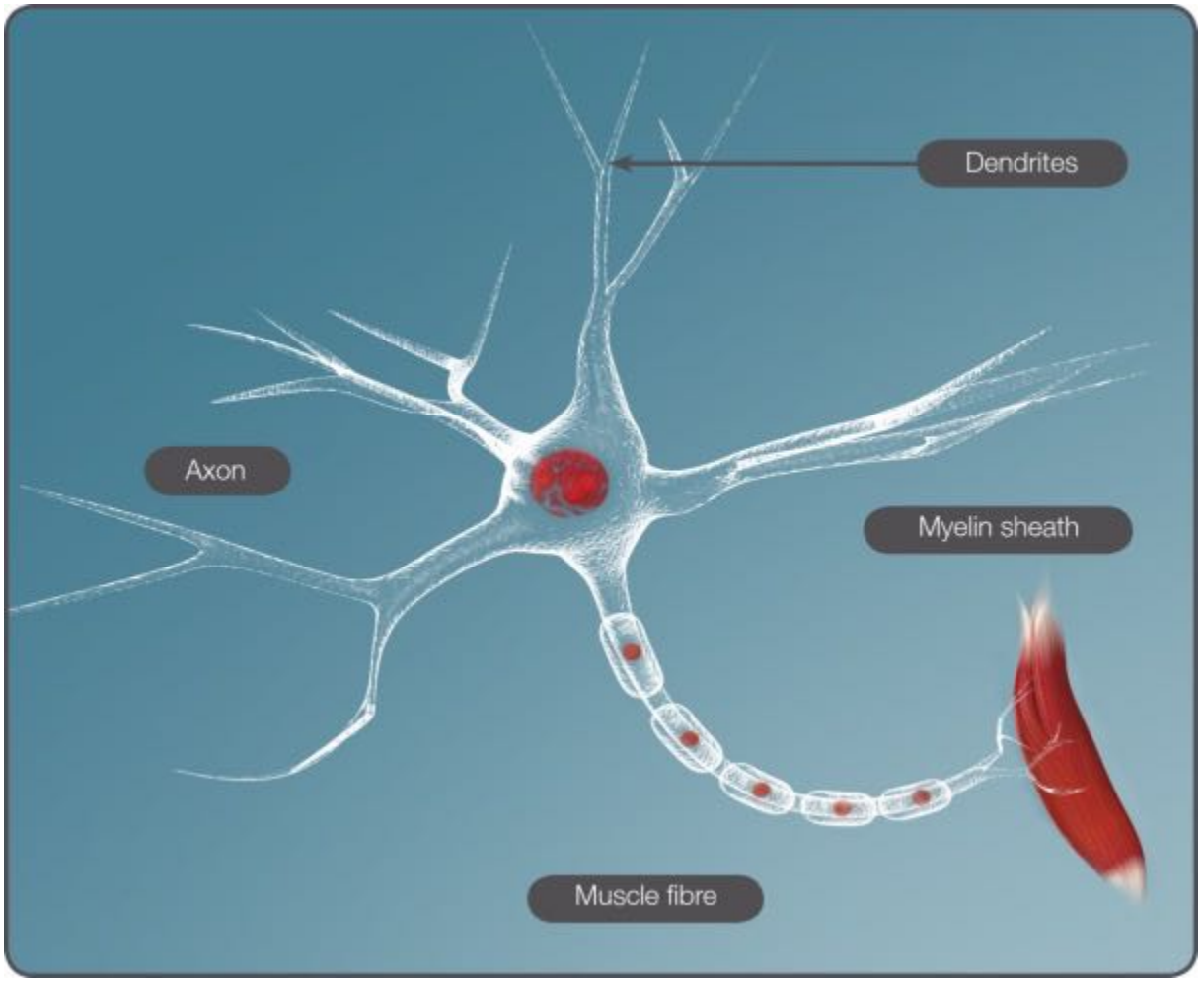
- Efferent nerves that are under control of the autonomic nervous system are divided into two types

- **Sympathetic nerves**
  - Increased heart rate
  - Increased breathing rate
  - More forceful contraction of the heart leading to increased stroke volume
  - Vasoconstriction of the arteries and arterioles to increase blood pressure

- **Parasympathetic nerves**
  - Parasympathetic nerves are responsible for **decreasing** activity and are more active during times of relaxation and calm.

- The sympathetic and parasympathetic nervous systems are constantly working together to help maintain homeostasis

The Structure of a Neuron



Sensory Organs

- Sensors for changes in the internal environment operate through the autonomic nervous system. These sensors include:

- **Chemoreceptors –** Present throughout the body to detect changes in levels of chemicals such as carbon dioxide for respiration and calcium for muscle function.

- **Thermoreceptors –** Present in all tissues to detect temperature changes

- **Baroreceptors –** Found mainly in the walls of the arteries to detect changes in blood pressure

- **Proprioceptors –** Found in muscles and tendons to detect changes in body position

Muscle Spindles

- Located in the muscle
- Detect changes in muscle length
- Bring about reflexive contraction of skeletal muscle to prevent injury (stretch reflex)

Golgi Tendon Organs

- Located in the muscle tendon
- Detects excessive tension in the muscle
- Brings about reflexive relaxation of skeletal muscle to prevent injury (inverse stretch reflex)

The Endocrine System

Level 3 Anatomy and Physiology
for Exercise and Health

Learning Outcomes

- Describe the functions of the endocrine system
- Identify the major glands in the endocrine system
- Explain the function of hormones

The Endocrine System

- The endocrine system works in tandem with the nervous system to maintain homeostasis

- If the CNS receives information from afferent nerves to show that the body is out of a homeostatic state, efferent nerves may send information to directly stimulate a response, or may send information to an endocrine gland to release a hormone

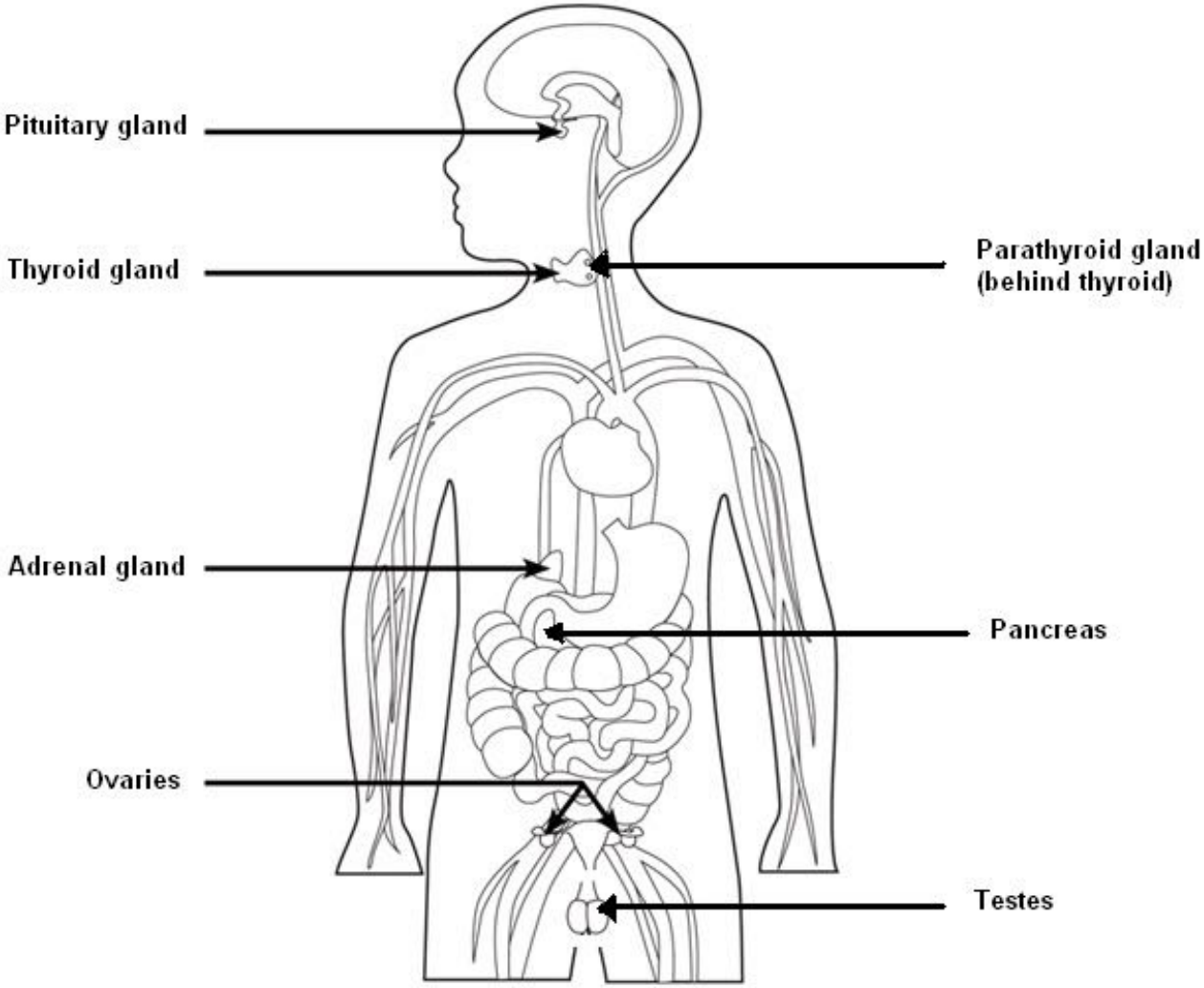
The Endocrine System

- Regulation of homeostasis is achieved through feedback loops. Feedback loops are either positive or negative:

- **Negative feedback loop** – The most common form of feedback loop and the usual means of maintaining homeostasis. The body detects an internal change and activates mechanisms that reverse that change, for example, the stimulation of the pancreas to secrete insulin in response to high blood glucose levels or stimulation of the parathyroid glands to secrete parathyroid hormone when blood calcium levels are low.

- **Positive feedback loops –** These are less common and rather than reversing a change will activate responses that speed up a detected change. An example of this is the action of oestrogen during the menstrual cycle. Oestrogen released by the ovaries stimulates other endocrine glands to secret hormones that further increase levels of oestrogen.

The Glands


Pituitary gland
Thyroid gland
Parathyroid gland
(behind thyroid)
Adrenal gland
Pancreas
Ovaries
Testes

Energy Systems

Level 3 Anatomy and Physiology
for Exercise and Health

Learning Outcomes

- Understand energy systems and their relation to exercise
  - Describe the three energy systems used for the production of ATP
  - Describe the relative contribution of each energy system to total energy usage and different intensity levels
  - Describe the fuels used by each energy system
  - Identify the by-products of each energy system

Energy - Carbohydrate

- 4kcal per gram
- 60 – 65% of daily calorie intake
- Stored in muscle and liver cells in the form of glycogen
- Glycogenolosis
  - Conversion of glycogen into glucose

Energy - Fat

- 9 kcal per gram
- 30% daily calorie intake
- Stored as adipose tissue
- Lipolysis
  - Breakdown of triglycerides into fatty acids

Energy - Protein

- Used as the building material for growth and repair
- 4kcal per gram
- 10 – 12% daily calorie intake
- Gluconeogenesis
  - The breakdown of proteins into amino acids in the liver to produce glucose

Energy

- Energy is released in the body by the breakdown of carbohydrates, fat and protein to produce:
  - Adenosine Triphosphate (ATP)
  - The body's energy 'currency'

The Energy Systems

- Phosphocreatine system
  - Used for high intensity / short duration activities (about 6 – 10 seconds)
  - Anaerobic
  - Energy supplied by creatine phosphate

Phosphocreatine System

- Adaptations to training:
  - Increased stores of creatine phosphate
  - Faster breakdown of creatine phosphate
  - Increased production and release of creatine phosphate in the liver

The Energy Systems

- Lactic acid system
  - Used for moderate to high intensity / short duration activities (about 90 seconds)
  - Anaerobic
  - Energy supplied by glycogen

Lactic Acid System

- Adaptations to training:
  - Increased subjective tolerance to discomfort of lactate build up
  - Increased glycogen storage
  - Improved anaerobic glycolysis
  - Improved lactic acid removal
  - Increased anaerobic threshold and point of OBLA
  - Work harder for longer

The energy systems

- Aerobic system
  - Used for low to moderate intensity / longer duration activities
  - Aerobic
  - Energy supplied by glycogen and fatty acids

Aerobic System

- Adaptations to training:
  - Increased uptake and utilisation of oxygen in the muscle
  - Improved capillarisation
  - Increased size and number of mitochondria
  - Increased fat metabolism
  - Increased glycogen storage
  - Raised aerobic and anaerobic threshold
  - Increased VO2 max