



# Anatomy and physiology for exercise and health

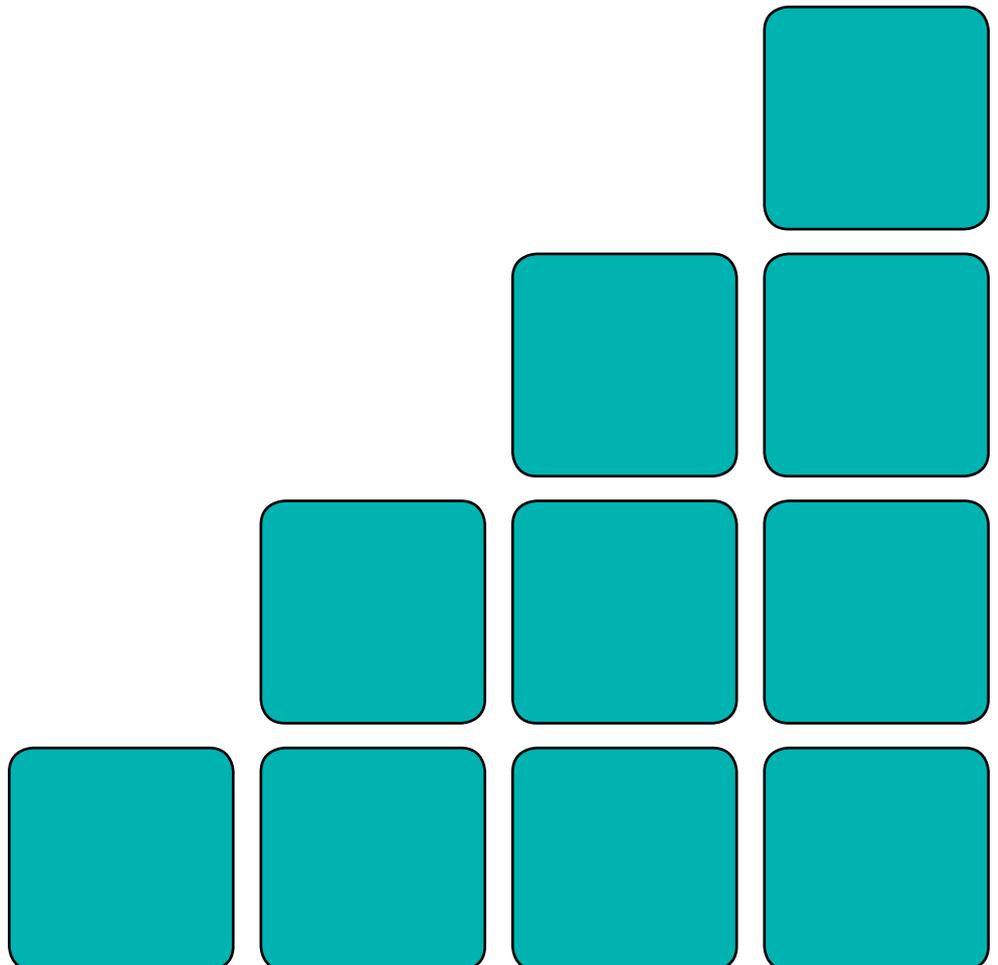
UV30536

A/600/9051

Learner name:

Learner number:

VRQ





# UV30536

## Anatomy and physiology for exercise and health

It is the aim of this unit to develop your knowledge and understanding of the anatomy and physiology underpinning exercise and health.

Level

**3**

Credit value

**6**

GLH

**43**

Observation(s)

**0**

External paper(s)

**1**



# Anatomy and physiology for exercise and health

## Learning outcomes

On completion of this unit you will:

1. Understand the heart and circulatory system and its relation to exercise and health
2. Understand the musculoskeletal system and its relation to exercise
3. Understand postural and core stability
4. Understand the nervous system and its relation to exercise
5. Understand the endocrine system and its relation to exercise and health
6. Understand energy systems and their relation to exercise

## Evidence requirements

1. *Knowledge outcomes*  
There must be evidence that you possess all the knowledge and understanding listed in the 'Knowledge' section of this unit. This evidence may include projects, assignments, case studies, reflective accounts, oral/written questioning and/or other forms of evidence.
2. *Tutor/Assessor guidance*  
You will be guided by your tutor/assessor on how to achieve learning outcomes in this unit. All outcomes must be achieved.
3. *External paper*  
Knowledge and understanding in this unit will be assessed by an external paper.  
**There is one external paper that must be achieved.**

# Developing knowledge

## Achieving knowledge outcomes

You will be guided by your tutor and assessor on the evidence that needs to be produced. Your knowledge and understanding will be assessed using the assessment methods listed below:

- Observed work performance
- Witness testimony/statements
- Audio-visual media
- Evidence of prior learning or attainment
- Written questions
- Oral questions
- Assignments
- Case studies
- Professional discussion
- Employer-provided question papers and tests
- E-assessment.

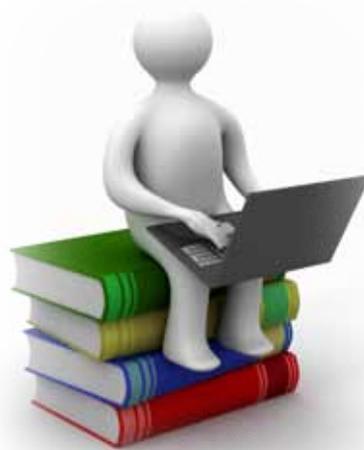
## Achieving the external paper

The external paper will test your knowledge of all criteria in this section. **A pass mark of 70% must be achieved.**

Your assessor will complete this table when the 70% pass mark has been achieved.

Paper	Date achieved	Assessor initials
1 of 1		

# Knowledge

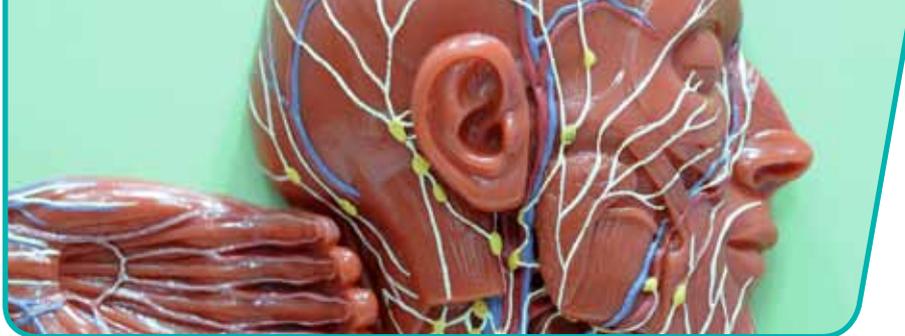


## Outcome 1

### Understand the heart and circulatory system and its relation to exercise and health

You can:	Portfolio reference / Assessor initials*
a. Explain the function of the heart valves	
b. Describe coronary circulation	
c. Explain the effect of disease processes on the structure and function of blood vessels	
d. Explain the short and long term effects of exercise on blood pressure, including the valsalva effect	
e. Explain the cardiovascular benefits and risks of endurance/aerobic training	
f. Define blood pressure classifications and associated health risks	

*\*Assessor initials to be inserted if orally questioned.*



## Outcome 2

### Understand the musculoskeletal system and its relation to exercise

You can:	Portfolio reference / Assessor initials*
a. Explain the cellular structure of muscle fibres	
b. Describe the sliding filament theory	
c. Explain the effects of different types of exercises on muscle fibre type	
d. Identify and locate the muscle attachment sites for the major muscles of the body	
e. Name, locate and explain the function of skeletal muscle involved in physical activity	
f. Identify the anatomical axis and planes with regard to joint actions and different exercises	
g. Explain the joint actions brought about by specific muscle group contractions	
h. Describe joints/joint structure with regard to range of motion/movement and injury risk	
i. Describe joint movement potential and joint actions	
j. Describe the structure of the pelvic girdle and associated muscles and ligaments	

\*Assessor initials to be inserted if orally questioned.

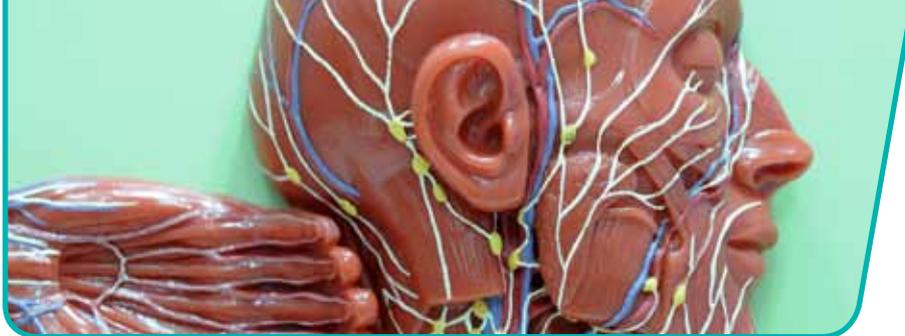


## Outcome 3

### Understand postural and core stability

You can:	Portfolio reference / Assessor initials*
a. Describe the structure and function of the stabilising ligaments and muscles of the spine	
b. Describe local muscle changes that can take place due to insufficient stabilisation	
c. Explain the potential effects of abdominal adiposity and poor posture on movement efficiency	
d. Explain the potential problems that can occur as a result of postural deviations	
e. Explain the impact of core stabilisation exercise and the potential for injury/aggravation of problems	
f. Explain the benefits, risks and applications of the following types of stretching: <ul style="list-style-type: none"> <li>• static (passive and active)</li> <li>• dynamic</li> <li>• proprioceptive neuromuscular facilitation</li> </ul>	

*\*Assessor initials to be inserted if orally questioned.*



## Outcome 4

### Understand the nervous system and its relation to exercise

You can:	Portfolio reference / Assessor initials*
a. Describe the specific roles of: <ul style="list-style-type: none"> <li>• the central nervous system (CNS)</li> <li>• the peripheral nervous system (PNS) including somatic and autonomic systems</li> </ul>	
b. Describe nervous control and transmission of a nervous impulse	
c. Describe the structure and function of a neuron	
d. Explain the role of a motor unit	
e. Explain the process of motor unit recruitment and the significance of a motor unit's size and number of muscle fibres	
f. Explain the function of muscle proprioceptors and the stretch reflex	
g. Explain reciprocal inhibition and its relevance to exercise	
h. Explain the neuromuscular adaptations associated with exercise/ training	
i. Explain the benefits of improved neuromuscular co-ordination/ efficiency to exercise performance	

\*Assessor initials to be inserted if orally questioned.

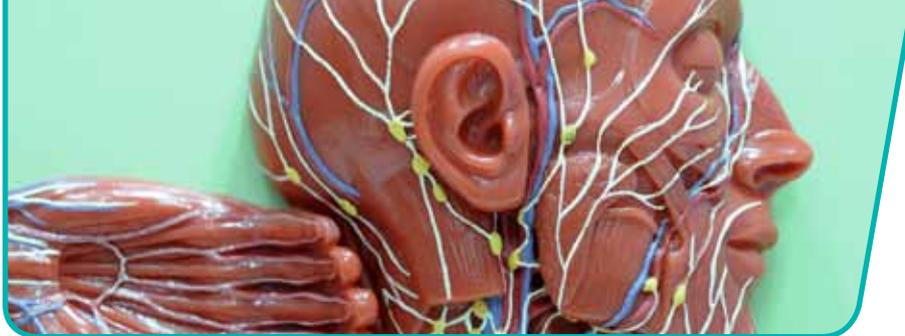


## Outcome 5

### Understand the endocrine system and its relation to exercise and health

You can:	Portfolio reference / Assessor initials*
a. Describe the functions of the endocrine system	
b. Identify the major glands in the endocrine system	
c. Explain the function of hormones including: <ul style="list-style-type: none"> <li>• growth hormone</li> <li>• thyroid hormones</li> <li>• corticosteroids</li> <li>• catecholamines</li> <li>• insulin</li> <li>• glucagon</li> </ul>	

\*Assessor initials to be inserted if orally questioned.



## Outcome 6

### Understand energy systems and their relation to exercise

You can:	Portfolio reference / Assessor initials*
a. Identify the contribution of energy according to: <ul style="list-style-type: none"> <li>• duration of exercise/activity being performed</li> <li>• type of exercise/activity being performed</li> <li>• intensity of exercise/activity being performed</li> </ul>	
b. Identify the by-products of the three energy systems and their significance in muscle fatigue	
c. Describe the effect of endurance training/advanced training methods on the use of fuel for exercise	

*\*Assessor initials to be inserted if orally questioned.*

# Unit content



This section provides guidance on the recommended knowledge and skills required to enable you to achieve each of the learning outcomes in this unit. Your tutor/assessor will ensure you have the opportunity to cover all of the unit content.

## Outcome 1: Understand the heart and circulatory system and its relation to exercise and health

**Function of heart valves:** Heart structure (ventricles, atria, interventricular septum, interatrial septum), atrioventricular valves (tricuspid valve, bicuspid valve, chordate tendinae, papillary muscle), semi-lunar valves (aortic and pulmonary), function of valves (control blood flow through heart chambers, prevent backflow of blood).

**Coronary circulation:** Circulatory process (superior and inferior vena cava, right atrium, tricuspid valve, right ventricle, pulmonary semi-lunar valve, pulmonary arteries, pulmonary circulation, pulmonary veins, left atrium, bicuspid valve, left ventricle, aortic semi-lunar valves, aorta, systemic circulation), blood (oxygenated, deoxygenated).

**Disease processes and the blood vessels:** Structure and function (arteries, arterioles, capillaries, veins, venules), diseases (arteriosclerosis, atherosclerosis), processes (thickening of artery walls, loss of elasticity, endothelial damage, smooth muscle fibre proliferation, lesions formed by fatty plaque).

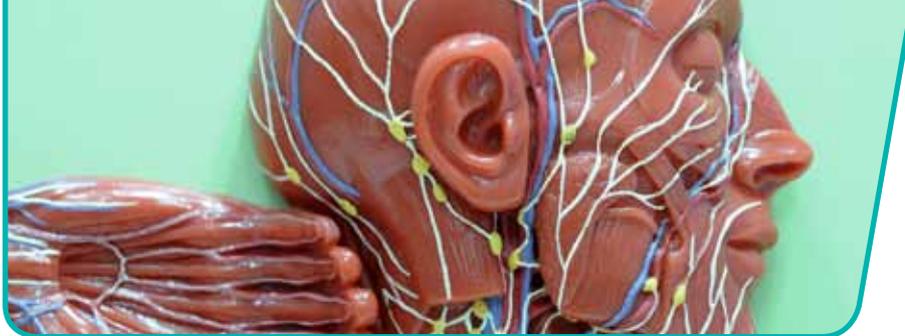
**Blood pressure and exercise:** Definition of blood pressure (systolic pressure, diastolic pressure), blood pressure classifications (hypotension, normal, high normal, mild hypertension, moderate hypertension, severe hypertension), associated health risks of hypertension (stroke, coronary heart disease, coronary artery disease, kidney disease, loss of vision), short term effects of exercise (no change in diastolic pressure, progressive increase in systolic pressure), long term

effects of exercise (reduction in resting blood pressure, improved regulation of blood pressure), valsalva effect.

### Cardiovascular benefits and risks of endurance/aerobic training:

**Benefits** – increased heart strength and efficiency, increased capillary network, increased elasticity of blood vessels, improved blood flow distribution, improved blood cholesterol profile, reduced blood pressure, improved ability to tolerate heat, reduced risk of cardiovascular diseases.

**Risks** – overexertion, aggravation of cardiovascular contra-indications to exercise, overtraining, overuse injuries.



## Outcome 2: Understand the musculoskeletal system and its relation to exercise

**Sliding filament theory:** Actin, myosin, cross-bridges, troponin-tropomyosin, complex, depolarisation, calcium ions, adenosine triphosphate, shortening of sarcomere, motor unit recruitment.

**Exercise and muscle fibre type:** Muscle fibre type characteristics (I – slow oxidative, IIa – fast oxidative/glycolytic, IIb – fast glycolytic), effects of aerobic exercise on type I fibres (increased concentration of aerobic enzymes, increased size and number of mitochondria, increased ability to use fat as an energy source, increased storage of muscle glycogen, increased supply of intramuscular fat, increased myoglobin, increased number of capillaries), effects of resistance training on type II fibres (increase in muscle mass and cross-sectional area, possible increase in number of type II muscle fibres, increased motor unit recruitment).

**Structure of muscle:** Muscle structure (epimysium, perimysium, endomysium), cellular muscle structure (sarcolemma, myofibrils, sarcoplasm, sarcoplasmic reticulum, sarcomere, actin, myosin, mitochondria, terminal cisternae, t-tubules, troponin, tropomyosin), other microscopic structures (Z lines, A and I bands, H zone, M line).

**Axial and appendicular skeleton:** Names and locations of axial bones (cranium, cervical vertebrae, thoracic vertebrae, lumbar vertebrae, sacral vertebrae, sternum, ribs, coccyx), names and locations of appendicular bones (scapula, clavicle, humerus, ulna, radius, carpals, metacarpals, phalanges, ilium, ischium, pubis, femur, patella, tibia, fibula, tarsals, calcaneus, metatarsals).

### Major skeletal muscles and attachment sites:

Names and locations of major muscles to include rotator cuff (teres minor, supraspinatus, subscapularis, infraspinatus), shoulder girdle (pectoralis major, pectoralis minor, levator scapulae, serratus anterior, trapezius, rhomboids major/minor, teres major), spinal extensors (erector spinae, iliocostalis, longissimus, spinalis, multifidus, quadratus lumborum), hip flexors (iliopsoas, iliacus, psoas major/minor), adductors (magnus, brevis, longus, pectineus, gracilis, sartorius), abductors (gluteus medius, gluteus minimus, piriformis, tensor fascia latae), abdominals (rectus abdominus, internal and external obliques, transverse abdominus), intercostals, diaphragm, quadriceps (rectus femoris, vastus intermedius, vastus medialis, vastus lateralis), hamstrings (biceps femoris, semitendinosus, semimembranosus), tibialis anterior, sternocleidomastoid, scalenes, deltoids (anterior, medial posterior), gastrocnemius, soleus, tibialis posterior, biceps brachii, brachialis, coracobrachialis, triceps brachii, gluteus maximus, latissimus dorsi, major muscle attachment sites (origin, insertion).

**Function of skeletal muscle:** Functions (movement, maintain posture and stability, heat generation), principles of muscle work (muscles pull on bones, muscle contract in fibre direction, muscle cross joints, muscles work in pairs), leverage (fulcrum, resistance, effort), types of levers during exercise (first class, second class, third class), muscle contractions during exercise (dynamic concentric, dynamic eccentric, isotonic, isometric), muscle roles during exercise (agonist, antagonist, fixator, synergist).



## Outcome 2: Understand the musculoskeletal system and its relation to exercise (continued)

**Anatomical axis and planes:** Frontal plane (anterior/posterior axis movements (adduction, abduction, lateral flexion, eversion, inversion)), sagittal plane (bilateral axis movements (flexion, extension)), transverse plane (vertical axis movements (internal rotation, external rotation, horizontal flexion/adduction, horizontal extension/abduction)), associated exercises in different planes and axis.

### Joint structure:

**Fibrous** – synarthrosis, immovable, have no joint cavity, are connected via fibrous connective tissue e.g. skull bones are connected by fibrous joints.

**Cartilaginous** – amphiarthrosis, slightly moveable, a joint in which the surfaces are connected by disks of fibrocartilage, as between vertebrae.

**Synovial** – diarthrosis, freely moveable, all diarthroses have this characteristic space between the bones that is filled with synovial fluid.

**Structure of a synovial joint** – joint capsule, ligaments, synovial fluid, articular cartilage, bone.

**Types and locations of synovial joint** – gliding, ellipsoid, hinge, saddle, pivot, ball and socket.

**Associated range and stability of motion/movement of synovial joint types** – range norms, factors affecting stability (shape of articular surfaces, capsule, ligaments, muscle tone, gravity).

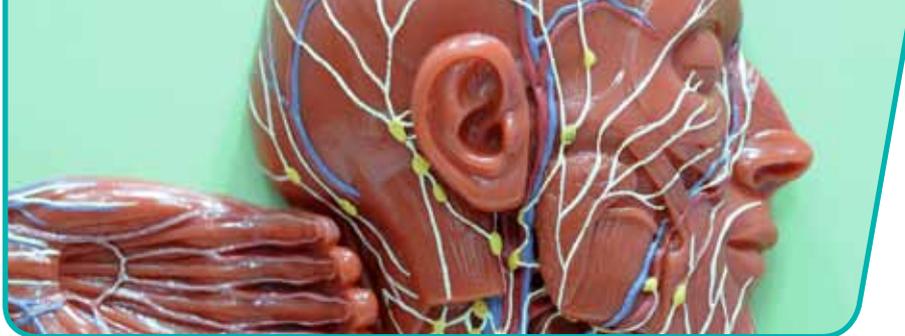
**Associated injury risk to joints types and ligaments** – e.g. joints must be used in correct plane, joint must be aligned, joints not taken beyond end range, greater

range of movement allows increased risk of injury.

### Joint movement potential and actions:

Shoulder (flexion, extension, abduction, adduction, horizontal flexion/adduction, horizontal extension/abduction, internal rotation, external rotation), elbow (flexion, extension, supination, pronation), shoulder girdle (elevation, depression, protraction, retraction), spine (flexion, extension, lateral flexion, rotation), hip (flexion, extension, abduction, adduction, internal rotation, external rotation), knee (flexion, extension), ankle (plantarflexion, dorsiflexion, inversion, eversion), significance of joint type and structure for movement potential, associated joints crossed by muscles, associated muscle group contractions, analysis of different multi-joint and single joint exercises.

**Structure of pelvic girdle:** Structural bones (ilium, ischium, pubis, sacro-iliac joint), associated muscles (iliopsoas, pectineus, rectus femoris, sartorius, adductors, gluteus maximus, hamstrings, hip abductors), ligaments (iliolumbar, sacrospinous, sacrotuberous, anterior and posterior sacroiliac), pubis symphysis articulation, sacroiliac articulation, importance of pelvic girdle for weight bearing exercise, male and female differences (femur angle, injury risk).



## Outcome 3: Understand postural and core stability

**Structure of the spine:** Vertebrae structure (facet joints, vertebral foramen, spinal cord, spinal canal, cartilaginous discs), specific functions of vertebral regions (cervical, thoracic, lumbar, sacrum, coccyx).

**Stabilising ligaments and muscles of the spine:** Structure and function, ligaments (ligamentum flavum, anterior and posterior longitudinal ligaments), intrasegmental and intersegmental ligament systems, role of spinal ligaments in core stability, location and role of local postural stabilisers (lumbar multifidus, transversus abdominus, diaphragm, pelvic floor muscles, abdominal aponeurosis, thoracolumbar fascia), location and role of global phasic stabilisers (rectus abdominis, internal obliques, external obliques, transverse abdominis, erector spinae, quadratus lumborum).

**Local muscle changes due to insufficient stabilisation:** Stabilisation systems, reasons for insufficient stabilisation (heredity, medical conditions, lifestyle, ageing, muscle imbalances), muscle changes (muscles lengthened, muscles shortened, weak/inactive muscles, overactive/strong muscles, imbalanced kinetic chain, compensation patterns, synergistic dominance, inefficient movements).

**Effects of abdominal adiposity and poor posture:** Inefficient movement patterns, compensation, muscle imbalances, stability, alignment, centre of gravity excursions.

**Postural deviations:** Deviations (flat back, sway back, kyphosis, lordosis, scoliosis), importance of deviations for exercise safety, potential problems of deviations (muscle imbalances and compensation,

inefficient movement patterns, joint and muscle pain, spinal disorders), methods of identifying deviations (postural analysis form, postural photography, postural analysis computer software), referral to appropriate professionals (GP, physiotherapist), reasons and procedures for referral.

**Impact of core stabilisation exercises:** Definition of core stability (maintaining spinal alignment and pelvic position, statically and dynamically), impact (improved posture, improved motor skill performance, improved power application, muscle balance throughout kinetic chain, injury prevention for spine and shoulder girdle, improved aesthetics), potential for injury and aggravation of problems (improper technique, contra-indicated exercises for specific postural problems and deviations, importance of maintaining neutral spine, importance of maintaining correct spinal curvature).

**Benefits, risks and applications of stretching:** Types of stretching (static active and passive, dynamic, CRAC, proprioceptive neuromuscular facilitation), benefits (improved range of motion, improved posture, reduced risk of injury, improved functional ability), risks (improper technique leading to overstretching, injury to muscles and tendons, injury to ligaments and joint capsules), applications (general and specific warm up, cool down, flexibility development, functional development, injury rehabilitation).



## Outcome 4: Understand the nervous system and its relation to exercise

**Roles of the nervous system:** Main functions (sense changes to stimuli, information processing, response to stimuli), central nervous system components (brain, spinal cord), CNS roles (receive messages from peripheral nervous system about environment, interprets information, sends messages back to the peripheral nervous system), peripheral nervous system components (sensory neurons, motor neurons), PNS roles (transmits information from receptors to CNS, transmits information from CNS to muscles and glands), peripheral nervous system divisions (autonomic nervous system, somatic nervous system, sympathetic system, parasympathetic system).

**Specific nervous system roles:** Somatic system roles (sensory input, control of voluntary muscle), autonomic system roles (sense hormonal balance, internal organ function, control of involuntary muscle, control of endocrine glands), sympathetic division roles (increase heart rate, increase breathing rate, mobilise energy stores, regulation of blood pressure, blood flow redistribution, most active during exercise), parasympathetic division (slows down functions, more active during rest and recovery).

**Nervous control and nerve impulse transmission:** Role of the brain and spinal cord, nerve impulse, sensory neurones, receptor organs, synapse, motor neurones, axon terminal, acetylcholine, neuromuscular junction, effector organs, action potentials.

**Structure and function of a neuron:** Structure (dendrites, nucleus, cytoplasm, axon, myelin sheath, nodes of Ranvier,

nerve endings), function (transmit signals to muscles).

**Role of a motor unit:** In muscle contraction, small motor units (type I), large motor units (type II), size principle, factors affecting recruitment patterns (specific movement pattern, high and low firing threshold, skill and experience of participant), motor unit recruitment.

**Muscle proprioceptors and the stretch reflex:** Function of muscle spindles (detect changes in muscle length), function of golgi tendon organs (detect changes in muscle tension), stretch reflex (contraction of stretched muscle, reflex arc).

**Reciprocal inhibition:** Agonist muscle contraction, antagonist muscle relaxation, relevance to exercise (allows appropriate muscle contraction, can be used to promote flexibility development).

**Neuromuscular adaptations to exercise/training:** Aerobic training adaptations (improved aerobic capacity of trained muscles, glycogen sparing, increased fat utilisation), resistance training adaptations (improved motor recruitment, increased ability to achieve stronger muscle contractions, muscle fibre hypertrophy, muscle fibre hyperplasia, improved recruitment of fast twitch fibres), types of motor skills training (reaction time, balance, co-ordination, speed, agility, spatial awareness), motor skills training adaptations (growth of new nervous system connections, increased frequency of nerve impulses to motor units, improved synchronous motor unit recruitment, improved intermuscular co-ordination, automatic performance of movement patterns), methods of motor skill development (short training duration,



## Outcome 4: Understand the nervous system and its relation to exercise (continued)

repetition, progressing movement speed, whole-part-whole, progressive layering of demands on motor skills, positive reinforcement and feedback).

**Benefits of improved neuromuscular coordination:** Improved movement efficiency and economy, improved accuracy of movement patterns, improved force generation, improved stability, improved spatial awareness, automatic movement patterns.

## Outcome 5: Understand the endocrine system and its relation to exercise and health

**Functions of the endocrine system:** Maintains homeostasis, regulation of growth, development and metabolism, production of hormones, close links with nervous system.

**Major glands:** Location and role to include pituitary, thyroid, parathyroid, pancreas, adrenal glands, kidney, testes, and ovaries.

**Functions of hormones:** Growth hormone (growth of body cells, protein anabolism, elevation of blood glucose), thyroid hormones (metabolism, growth, development, nervous system control), corticosteroids (regulate metabolism), adrenalin and noradrenalin (control of sympathetic nervous system, 'fight or flight' response before exercise), insulin (lowers blood glucose, increases lipogenesis, stimulates protein synthesis), glucagon (raises blood glucose, conversion of nutrients to glucose for energy release).



## Outcome 6: Understand energy systems and their relation to exercise

**Energy contribution:** Energy systems (phosphogen system/ATP-PC, glycolysis/glycolytic system, aerobic system), proportion of energy system contribution (exercise type, exercise duration, exercise intensity), proportion of energy system contribution during different sports and activities (e.g. distance running, football, tennis, weightlifting, sprinting).

**By-products:** Phosphogen (adenosine diphosphate, phosphate, hydrogen ions), glycolysis (lactic acid), aerobic (water, carbon dioxide), associated significance of by-products in muscle fatigue (limitation of mechanical and biochemical muscle contraction processes, lactate threshold, onset of blood lactate accumulation (OBLA)).

**Effects of endurance training:** On relative proportions of fuel use for exercise, glycogen sparing, ability to utilise fats at higher exercise intensities, increased lactate threshold, improved ability to tolerate and remove lactate, lower lactate levels following exercise.

# Notes

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