Anatomy and physiology for exercise

UV20522

H/600/9013

Learner name:

Learner number:

VRQ

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Statement of unit achievement

By signing this statement of unit achievement you are confirming that all learning outcomes, assessment criteria and range statements have been achieved under specified conditions and that the evidence gathered is authentic.

This statement of unit achievement table must be completed prior to claiming certification.

Unit code	Date achieved	Learner signature	Assessor initials	IV signature (if sampled)

Assessor tracking table

All assessors using this Record of Assessment book must complete this table. This is required for verification purposes.

Assessor name	Assessor signature	Assessors initials	Assessor number (optional)

UV20522

Anatomy and physiology for exercise

It is the aim of this unit to develop your knowledge and understanding of the anatomy and physiology relating to exercise programming for apparently healthy adults of all ages.

Level

2

Credit value

6

GLH

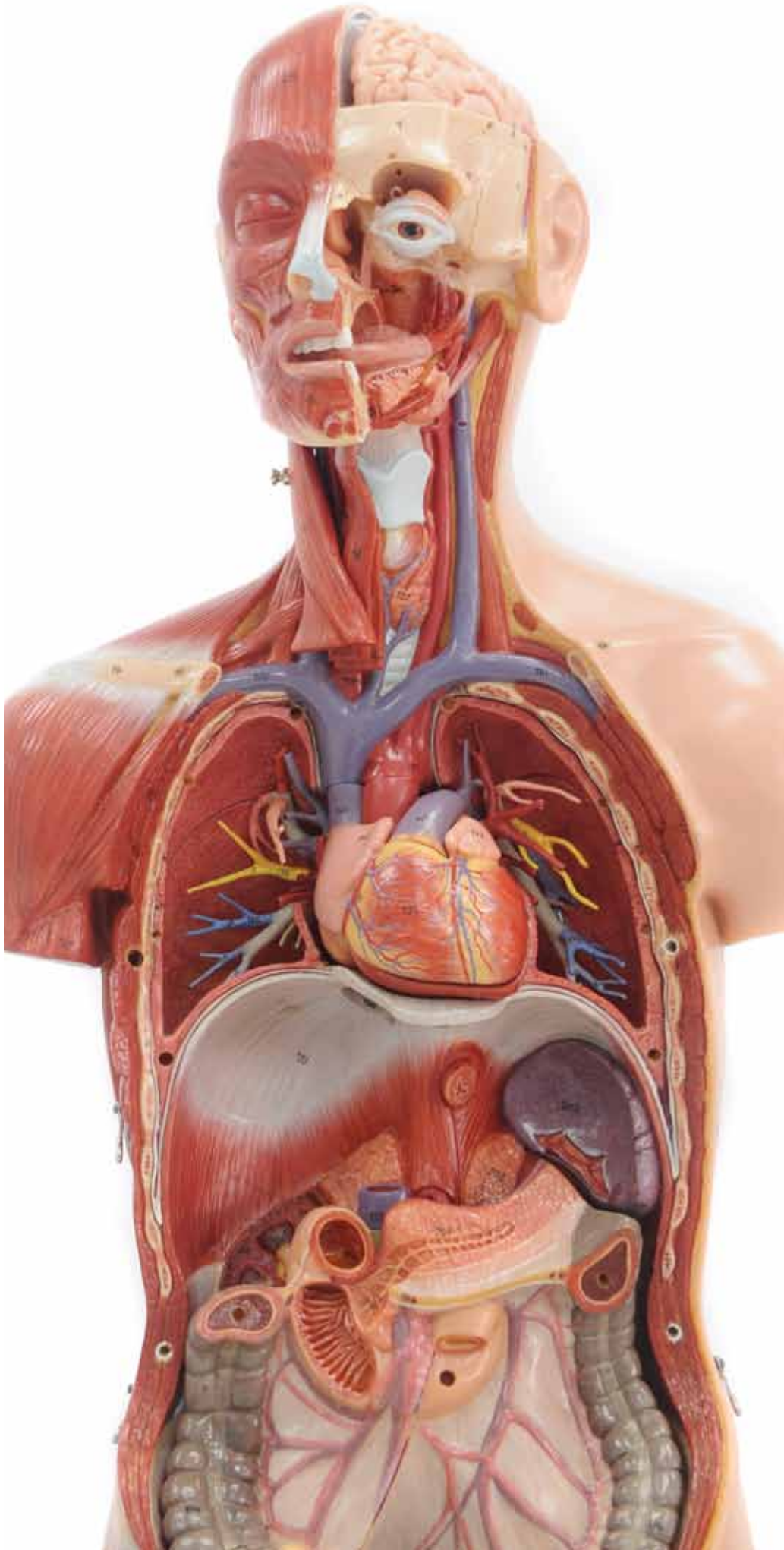
41

Observation(s)

0

External paper(s)

1



Anatomy and physiology for exercise

Learning outcomes

On completion of this unit you will:

1. Understand the structure and function of the circulatory system
2. Understand the structure and function of the respiratory system
3. Understand the structure and function of the skeleton
4. Understand joints in the skeleton
5. Understand the muscular system
6. Understand the life course of the musculoskeletal system and its implications for special populations exercise
7. Understand energy systems and their relation to exercise
8. Understand the nervous system and its 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 structure and function of the circulatory system

You can:	Portfolio reference / Assessor initials*
a. Identify the location of the heart	
b. Describe the function of the heart	
c. Describe the structure of the heart	
d. Describe how blood moves through the four chambers of the heart	
e. Describe systemic and pulmonary circulation	
f. Describe the structure and functions of blood vessels	
g. Define blood pressure	
h. Identify blood pressure classifications	

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

Outcome 2

Understand the structure and function of the respiratory system

You can:	Portfolio reference / Assessor initials*
a. Identify the location of the lungs	
b. Describe the function of the lungs	
c. Describe the structure of the lungs	
d. Identify the main muscles involved in breathing	
e. Describe the passage of air through the respiratory tract	
f. Describe the process of gaseous exchange of oxygen and carbon dioxide in the lungs	

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

Outcome 3

Understand the structure and function of the skeleton

You can:	Portfolio reference / Assessor initials*
a. Describe the basic functions of the skeleton	
b. Identify the structures of the axial skeleton	
c. Identify the structures of the appendicular skeleton	
d. Explain the classification of bones	
e. Explain the structure of long bones	
f. Explain the stages of bone growth	
g. Describe posture in terms of: • Curves of the spine • Neutral spine alignment • Potential ranges of motion of the spine • Postural deviations to include kyphosis, lordosis, scoliosis and the effect of pregnancy	

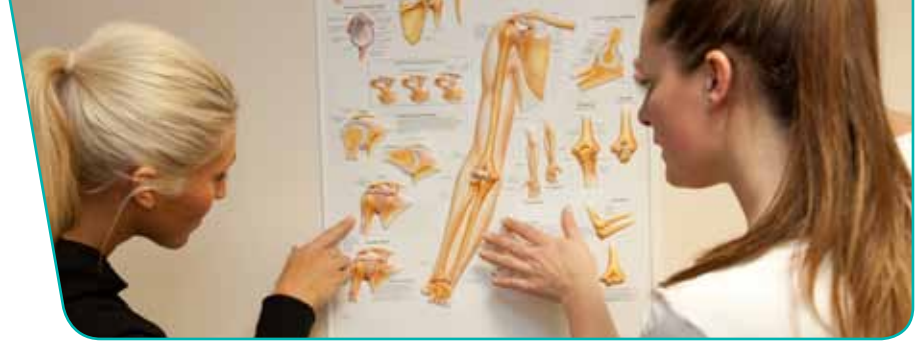
**Assessor initials to be inserted if orally questioned.*

Outcome 4

Understand joints in the skeleton

You can:	Portfolio reference / Assessor initials*
a. Describe the classification of joints	
b. Describe the structure of synovial joints	
c. Describe the types of synovial joints and their range of motion	
d. Describe joint movement potential and joint actions	

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



Outcome 5

Understand the muscular system

You can:	Portfolio reference / Assessor initials*
a. Identify the three types of muscle tissue	
b. Define the characteristics and functions of the three types of muscle tissue	
c. Describe the basic structure of skeletal muscle	
d. Name and locate the anterior skeletal muscles	
e. Name and locate the posterior skeletal muscles	
f. Describe the structure and function of the pelvic floor muscles	
g. Describe the different types of muscle action	
h. Identify the joint actions brought about by specific muscle group contractions	
i. Identify skeletal muscle fibre types and their characteristics	

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

Outcome 6

Understand the life course of the musculoskeletal system and its implications for special populations exercise

You can:	Portfolio reference / Assessor initials*
a. Describe the life course of the musculoskeletal system, including relevant tendon, ligament, muscle, joint and bone mineral density changes, and their implications for exercise, plus specific implications for working with: • Young people in the 14-16 age range • Antenatal and postnatal women • Older people (50+)	

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

Outcome 7

Understand energy systems and their relation to exercise

You can:	Portfolio reference / Assessor initials*
a. Describe how carbohydrates, fats and proteins are used in the production of energy/adenosine triphosphate	
b. Explain the use of the three energy systems during aerobic and anaerobic exercise	

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

Outcome 8

Understand the nervous system and its relation to exercise

You can:	Portfolio reference / Assessor initials*
a. Describe the role and functions of the nervous system	
b. Describe the principles of muscle contraction	
c. Describe the 'all or none law'/motor unit recruitment	
d. Describe how exercise can enhance neuromuscular connections and improve motor fitness	

**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 structure and function of the circulatory system

Location of the heart: Located centrally in the chest, mediastinum, thorax, between lungs, apex towards left hip.

Function and structure of the heart: Function of heart (circulation of blood, receiving and pumping blood to body and lungs), structure of heart (myocardium, septum, atria, ventricles, atrio-ventricular valves, semi-lunar valves, aorta, superior vena cava, inferior vena cava, pulmonary veins, pulmonary arteries).

Blood flow through heart chambers: Pulmonary circulation, deoxygenated blood, vena cava, right atrium, tricuspid valve, right ventricle, semi-lunar valve, pulmonary artery, lungs, gaseous exchange, oxygenated blood, pulmonary vein, left atrium, bicuspid valve, left ventricle, semi-lunar valve, aorta, systemic circulation, functional considerations (e.g. stroke volume, cardiac output).

Systemic and pulmonary circulation: Systemic (oxygenated blood from lungs, pulmonary vein, left atrium, left ventricle, aorta, arteries, arterioles, capillaries, muscles and organs), pulmonary (deoxygenated blood from muscles and organs, capillaries, venules, veins, vena cava, right atrium, right ventricle, deoxygenated blood to the lungs for oxygenation).

Structure and function of blood vessels: Arteries (tunica interna, tunica media, tunica externa), arterioles, capillaries, veins (tunica interna, tunica media, tunica externa, one way valves), venules, comparison between blood vessels (wall thickness, internal diameter, direction of blood flow, pressure, presence of valves), functions of blood vessels (transport blood, blood flow distribution by vasoconstriction and vasodilation), function of arteries and arterioles (transport oxygenated blood to muscles and organs), functions of veins and venules (transport deoxygenated blood back to the heart, venous return), functions of capillaries (exchange of gases and nutrients between blood and tissues).

Blood pressure: Definition of blood pressure (pressure exerted by blood on vessel wall), systolic pressure (contraction), diastolic pressure (relaxation), blood pressure classifications (hypotension, normal, high normal, mild hypertension, moderate hypertension, severe hypertension), short and long term effects of exercise on blood pressure.

Outcome 2: Understand the structure and function of the respiratory system

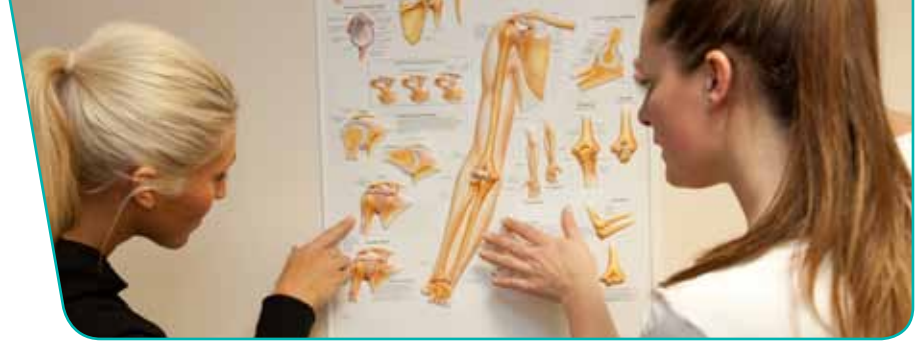
Location of the lungs: Located laterally in the chest on the left and right sides, mediastinum, thorax, pleural membrane layer, visceral membrane layer, serous membrane layer.

Function and structure of the lungs: Function of lungs (paired organs for ventilation, external and internal respiration, elimination of carbon dioxide, supply of oxygen), structure of lungs (left lung – two lobes, right lung – three lobes, bronchus, bronchioles, sub-divisions, capillaries, alveoli, alveolar sacs).

Muscles involved in breathing: Inhalation (inspiration), exhalation (expiration), muscles involved (diaphragm, external intercostals), forced inspiration accessory muscles (sternocleidomastoids, scalenes, pectoralis minor), forced expiration muscles (internal intercostals, transversus abdominus, rectus abdominus), functional considerations (e.g. total lung capacity, vital capacity).

Passage of air during breathing: Upper respiratory tract (mouth, nose and pharynx), lower respiratory tract (larynx, trachea, bronchi, bronchioles), alveoli, alveolar sacs.

Process of gaseous exchange: Surface area for gas exchange (300 million alveoli, 2400km of airways), partial pressure difference (higher and lower partial pressures), diffusion of gases, effect of breathing rate and depth, relative composition of inhaled air (21% oxygen, 0.04% carbon dioxide), relative composition of alveolar air (14% oxygen, 5.5% carbon dioxide), relative composition of exhaled air (16% oxygen, 4.5% carbon dioxide).



Outcome 3: Understand the structure and function of the skeleton

Functions of the skeleton: Support and shape, protection, muscle attachment and movement, production of blood cells, mineral homeostasis, storage of energy.

Structures of axial skeleton: Names and locations of bones including cranium, cervical vertebrae (7), thoracic vertebrae (12), lumbar vertebrae (5), sacral vertebrae (5), coccyx (3-5), intervertebral discs, sternum, ribs.

Structures of appendicular skeleton: Names and locations of bones including scapula, clavicle, humerus, radius, ulna, carpals, metacarpals, phalanges, ilium, ischium, pubis, femur, patella, tibia, fibula, tarsals, metatarsals, phalanges.

Classification of bones: Long (e.g. femur, tibia), short (e.g. tarsals, carpals), flat (e.g. scapula, pelvis), irregular (e.g. vertebrae), sesamoid (e.g. patella), classification based on structure and function.

Structure of long bone: Characteristics (greater length than width, slightly curved), structure (diaphysis, epiphyses, metaphysis, articular cartilage, periosteum, medullary, endosteum, compact bone, spongy bone, bone marrow).

Stages of bone growth: Development of cartilage, growth of cartilage, development of ossification centre, development of diaphysis and epiphysis, ossification (osteoblasts, osteoclasts), changes in bone growth with age, importance of calcium, factors affecting bone density (exercise, age and osteoporosis).

Posture and curves of the spine: Natural mild S-shaped curve of the spine (cervical and lumbar lordoses, thoracic and spinal kyphoses), primary curves of the spine, secondary (developmental) curves of the spine.

Posture and neutral spine alignment: Optimum position of spine and pelvis, maintenance of the natural spinal curvature (cervical, thoracic, lumbar), maintenance of posture in standing, sitting, lying positions.

Posture and potential ranges of motion of the spine: Cervical (rotation, flexion and extension), thoracic (rotation, limited flexion and extension), lumbar (flexion, extension, hyperextension), sacral (no range of motion), coccyx (no range of motion), normal thoracic kyphosis (20-45°), normal lumbar lordosis (20-45°), scoliosis (a right-left curve of more than 10°).

Postural deviations: Excessive deviations (hyperlordotic and hyperkyphotic), less than normal deviations (hypolorditic and hypokyphotic), definitions and causes (kyphosis, lordosis, scoliosis), effect of pregnancy on posture (e.g. how carrying a baby affects the natural curve).

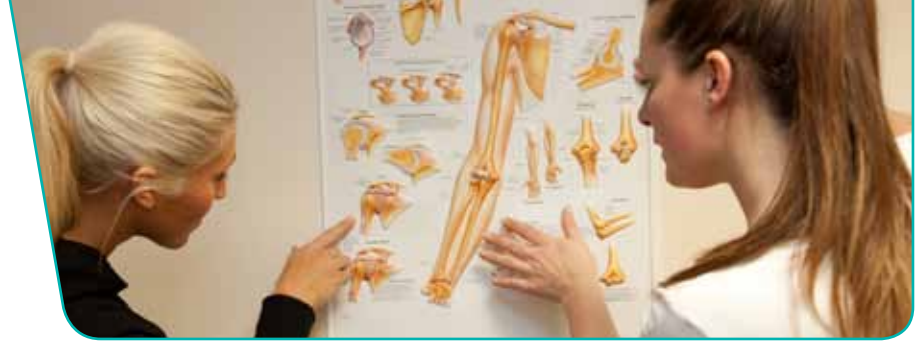
Outcome 4: Understand joints in the skeleton

Classification of joints: Structural classifications, fibrous (e.g. cranium), cartilaginous (e.g. vertebrae), synovial (e.g. knee), functional classifications (synarthrosis/immovable, amphiarthrosis/slightly moveable, diarthrosis/freely moveable).

Structure of synovial joints: Articular capsule, fibrous capsule, synovial cavity, synovial membrane, synovial fluid (lubrication), articular cartilage (shock absorption, decrease friction between bones), bursae (shock absorption), ligaments (attach bone to bone, joint stability).

Types of synovial joints and range of motion: Gliding (side to side, back and forth e.g. between carpals and tarsals), pivot (rotation e.g. atlas and axis), saddle (flexion, extension, abduction, adduction, circumduction e.g. thumb), ellipsoid (flexion, extension, abduction, adduction, circumduction e.g. wrist), ball and socket (flexion, extension, abduction, adduction, rotation, circumduction e.g. hip and shoulder), hinge (flexion and extension e.g. knee and elbow).

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), actions during different exercises.



Outcome 5: Understand the muscular system

Muscle tissue types, characteristics and functions: Skeletal muscle (striated, voluntary, very large fibre diameter, short to moderate fibre length, fast speed of contraction, attach to bones, e.g. quadriceps), cardiac muscle (striated, involuntary, large fibre diameter, moderate fibre length, moderate speed of contraction, e.g. heart muscle/myocardium), smooth muscle (no striations, involuntary, small fibre diameter, short to long fibre length, slow speed of contraction, e.g. artery walls).

Structure of skeletal muscle: Tendon (attach muscle to bone), epimysium, perimysium, endomysium, fascicle, muscle fibres, myofibrils, myofilaments (actin, myosin), sarcolemma, sarcomere (Z discs, H zone, M line, A band, I bands), arrangement of fasciculi (parallel, fusiform, pennate).

Muscle names and locations: Anterior muscles (pectoralis major, anterior deltoids, medial deltoids, biceps, rectus abdominis, obliques, transverse abdominis, hip flexors, quadriceps, adductors, anterior tibialis), posterior muscles (trapezius, rhomboids, medial deltoids, posterior deltoids, triceps, latissimus dorsi, erector spinae, gluteals, abductors, hamstrings, gastrocnemius, soleus), diaphragm, intercostals.

Structure and function of pelvic floor muscles: Levator ani (pubococcygeus, puborectalis, and iliococcygeus), coccygeus, associated connective tissues which span the area underneath the pelvis (perineum, perineal membrane, perinela pouch), pelvic cavity, function (stability of the pelvis, support bladder and bowel, support uterus in women).

Types of muscle action: Definitions of muscle contractions (isotonic concentric, isotonic eccentric, static/isometric, isokinetic), definitions of muscle roles (agonist/prime mover, antagonist, synergist/assistor, fixator), contractions and muscle roles during different exercises.

Joint actions: Pectoralis major (adduction of arm, horizontal flexion of arm), deltoids (abduction of the shoulder, flexion and extension of the shoulder), biceps (flexion of the elbow), rectus abdominis (flexion of the spine), obliques (lateral flexion and rotation of the spine), transverse abdominis (isometric stabilisation of the spine), hip flexors (flexion of the hip), quadriceps (extension of the knee, flexion of the hip), adductors (adduction of the hip), anterior tibialis (dorsi flexion of the ankle), trapezius (extension of the neck, elevation of the shoulder, depression of the scapula, retraction of the scapula), triceps (extension of the elbow), latissimus dorsi (adduction of the shoulder, shoulder extension), erector spinae (extension of the spine), gluteals (extension of the hip), abductors (abduction of the hip), hamstrings (flexion of the knee, extension of the hip), gastrocnemius (plantar flexion of the ankle, assist flexion of knee), soleus (plantar flexion of ankle with bent knee), joint actions during different exercises.

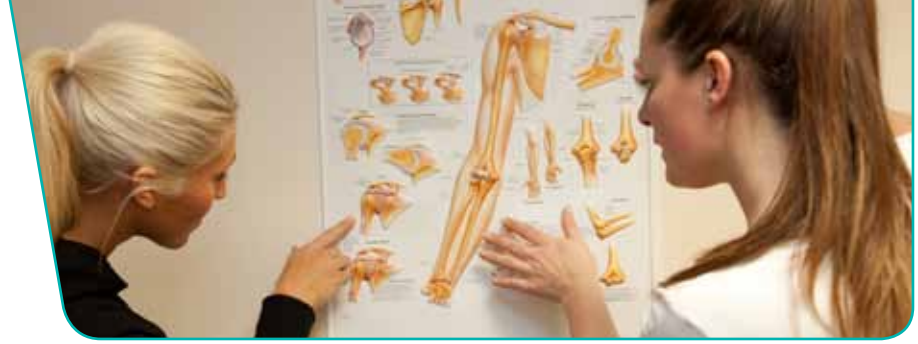
Muscle fibre types and characteristics: Fast twitch type 2 (white in colour, high intensity, short duration, low in mitochondria, low in myoglobin, fast contraction speed, fast to fatigue), slow twitch oxidative type 1 (red in colour, low intensity, long duration/endurance, high in mitochondria, high in myoglobin, slow contraction speed, resistant to fatigue).

Outcome 6: Understand the life course of the musculoskeletal system and its implications for special populations exercise

Life course of the musculoskeletal system for young people between 14-16 years: Life course (muscular hypertrophy, strength and power development, increase in bone density, strengthened attachment of tendons and ligaments), implications for exercise (differentiation between improvements through natural development or exercise, consideration of developing joint structures, gradual warm up and cool down, avoid heavy resistance exercises, use RPE to monitor exercise intensity, resistance training should use light weights and high reps, emphasise correct exercise technique, rest and recovery to avoid overuse and over training).

Life course of the musculoskeletal system for antenatal and postnatal women: Life course (weight gain, decreased bone density, increased force at joints and tendons, excessive lumbar lordosis, joint and ligament laxity in the lumbar spine, change in centre of gravity, weakness in abdominal muscles, widening of sacroiliac joints and pubic symphysis, increase in anterior pelvic tilt), implications for exercise (avoid supine exercise after 16 weeks of pregnancy, avoid prone exercise, avoid prolonged motionless standing, avoid heavy isometric or overhead resistance exercise, avoid leg adduction and abduction against resistance, avoid loaded forward flexion, avoid rapid changes of direction, avoid uncontrolled twisting or ballistic movements, avoid risk of falling or trauma, avoid high intensity or impact exercise, avoid crunching and twisting abdominal exercises).

Life course of the musculoskeletal system for older people (50+): Life course (1-2% loss in physical fitness each year, loss of neuromuscular function, signs and symptoms of potentially serious musculoskeletal disease, muscular atrophy and decreased muscular strength, decrease in bone density and bone strength, demineralisation in bones, development of osteoporosis, degradation of ligaments and tendons, implications for exercise (undertake longer and more gradual mobility and warm up, undertake a gradually tapered cool down, exercise intensity must be at a challenging but health related level, use RPE scale to monitor intensity, emphasise correct exercise technique, increase duration of transitions, simplify exercise when required, learn new exercises at the most basic level, avoid extreme spinal flexion).



Outcome 7: Understand energy systems and their relation to exercise

Nutrients and the production of energy: Carbohydrates (e.g. bread, pasta), proteins (e.g. meat, fish), fats (e.g. cheese, butter, energy yield per gram of macronutrient), carbohydrates (break down into glucose, glycogen storage in muscles and liver), fats (break down into fatty acids in presence of oxygen, stored as adipose tissue, protection, energy store), protein (break down into amino acids, growth and repair of muscle, used for energy when other nutrients are depleted), water (hydration), adenosine triphosphate (ATP – break down and resynthesis, energy equation).

Energy systems: Energy molecules (ADP, ATP), systems (creatine phosphate system, glycolytic system, aerobic system).

Use of energy systems during exercise: Creatine phosphate system (high intensity activity of 6-10 seconds), glycolytic system (moderate to high intensity activity of up to 90 seconds), aerobic system (low to moderate intensity of above 90 seconds), the energy continuum for intensity and duration, relative percentage contributions of energy systems during different activities.

Outcome 8: Understand the nervous system and its relation to exercise

Roles and functions 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 functions and 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).

Principles of muscle contraction: Sliding filament theory (myosin and actin, cross bridges, shortening of sarcomere), process (attachment of myosin to actin, power stroke, detachment, ATP and energy transfer).

Motor unit recruitment: Motor units (motor neuron, muscle fibre), small motor units (type I), large motor units (type II), all or none law (if a stimulus is above threshold individual muscle fibres fully contract, if a stimulus is below threshold muscles fibres do not contract), strength of muscle contraction.

Exercise and neuromuscular enhancement: 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), motor skills training adaptations (growth of new nervous system connections, increased frequency of nerve impulses to motor units, improved synchronous motor unit recruitment, improved inter-muscular co-ordination, automatic performance of movement patterns).