Unit Specification

USP186 – Applied anatomy for exercise, fitness, health and wellbeing

Unit reference number: R/617/2594

Level: 3
Guided Learning (GL) hours: 80

Overview

This unit provides an applied knowledge and understanding of anatomy and physiology in relation to exercise, fitness programming, health and wellbeing.

Learners will develop their knowledge and understanding of the structure and function of the main body systems including the skeletal, muscular, circulatory, respiratory, nervous, endocrine, digestive and energy systems. They will develop understanding of the changes to these body systems throughout the lifespan and in response to exercise.

Learners will apply their understanding of the body systems when exploring exercise and fitness programming and when exploring the role of exercise for maintaining health and wellbeing.

Learning outcomes

On completion of this unit, learners will:

LO1 Understand the structure and function of the skeletal system in relation to exercise, health, and fitness programming

LO2 Understand the structure and function of the muscular system in relation to exercise, health, and fitness programming

LO3 Understand the structure and function of the circulatory system in relation to exercise, health, and fitness programming

LO4 Understand the structure and function of the respiratory system in relation to exercise, health, and fitness programming

LO5 Understand the structure and function of the nervous system in relation to exercise, health, and fitness programming

LO6 Understand the structure and function of the endocrine system in relation to exercise, health, and fitness programming

LO7 Understand the role and function of the energy systems in relation to exercise, health, and fitness programming

LO8 Understand the structure and functions of the digestive system

LO9 Understand the effects of exercise, health and fitness programming on the body systems

LO10 Understand the life course of the anatomical and physiological systems of the body

Unit content

LO1 Understand the structure and function of the skeletal system in relation to exercise, health and fitness programming

Anatomical reference points
Taught content
• The anatomical position • Reference terms of location – anterior and posterior, superior and inferior, superficial and deep, proximal and distal, medial and lateral

Anatomical planes of movement
Taught content

• Frontal (coronal), sagittal and transverse
• Planes and axis of movement
  - Frontal (coronal) 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

Functions of the skeleton
Taught content
• Support and shape • Protection of internal organs • Muscle attachment and movement • Production of blood cells • Storage of minerals, mineral homeostasis

Bones of the axial and appendicular skeleton
Taught content
• Axial – cranium, cervical vertebrae (7), thoracic vertebrae (12), lumbar vertebrae (5), sacral vertebrae (5), coccyx (3-5), sternum, ribs • Appendicular – scapula, clavicle, humerus, radius, ulna, carpals, metacarpals, phalanges, ilium, ischium, pubis, femur, patella, tibia, fibula, tarsals, metatarsals, phalanges

Classifications of different bones
Taught content
• Classification of bones based on shape, structure or function - Long (e.g. femur, tibia) - Short (e.g. tarsals, carpals) - Flat (e.g. scapula, pelvis) - Irregular (e.g. vertebrae) - Sesamoid (e.g. patella)

Stages of bone growth and the structures of a long bone
Taught content
• 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) • Long bone structure – characteristics (greater length than width, slightly curved), structure (diaphysis, epiphyses, metaphysis, articular cartilage, periosteum, medullary, endosteum, compact bone, spongy/cancellous bone, bone marrow)

Structure of the spine in relation to posture and range of motion
Taught content
• Vertebrae structure (facet joints, vertebral foramen, spinal cord, spinal canal, cartilaginous discs) • Natural mild S-shaped curve of the spine (cervical and lumbar lordosis, thoracic and spinal kyphosis), primary curves of the spine, secondary (developmental) curves of the spine • Optimum position of spine and pelvis, maintenance of the natural spinal curvature (cervical, thoracic, lumbar), maintenance of posture in standing, sitting, lying positions • Normal thoracic kyphosis (20 - 45°), normal lumbar lordosis (20 - 45°), scoliosis (a right/left curve of more than 10°) • Range of motion of vertebral regions - Cervical (rotation, flexion and extension) - Thoracic (rotation, limited flexion and extension - Lumbar (flexion, extension, hyperextension) - Sacral (no movement) - Coccyx (no movement) • Medical conditions associated with dysfunctional stabilisation and common spinal disorders and postural deviations – excessive deviations (hyperlordotic and hyperkyphotic), less than normal deviations (hyperlordotic and hypokyphotic), definitions and causes (hyperkyphosis, hyperlordosis, scoliosis), effect of pregnancy on posture (e.g. how carrying a baby affects the natural curve)

- Stabilising ligaments 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
- The effects of exercise on posture
    - Core stabilisation exercises
    - Potential for injury and aggravation of problems

Skeletal structures of the pelvic girdle

Taught content

- Structural bones (ilium, ischium, pubis, sacro-iliac joint)
- 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 (effect of pelvic width on femur Q-angle and the relation to knee injury risk)

Joint classifications and their structure

Taught content

- Structural and functional classification – fibrous/immovable (e.g. cranium), cartilaginous/slightly movable (e.g. vertebrae), synovial/freely movable (e.g. knee)
- 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 – amphiarthosis, slightly movable, a joint in which the surfaces are connected by disks of fibrocartilage, as between vertebrae
- Synovial – diarthrosis, freely movable, all diarthroses have this characteristic space between the bones that is filled with synovial fluid. 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)

Different types of synovial joints, their location, range of motion and joint actions

Taught content

- All types of synovial joint
    - 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 and radioulnar joints (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 and foot (plantarflexion, dorsiflexion, inversion, eversion)
- Joint actions during different exercises, 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
- 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. positions of strength and weakness, shearing forces, joint alignment during movement, greater range of movement allows increased risk of injury
- Effects of exercise and considerations
    - Short-term – synovial fluid, joint lubrication, increased circulation of blood and delivery of nutrients
    - Long-term – increased bone mineral density, increased joint stability and mobility, effects of appropriate or inappropriate repetitive loading on cartilage

Exercise and movement considerations in relation to the skeletal system
Taught content

• The effect of exercise variables on biomechanics and kinesiology
  - Levers – 1st class, 2nd class and 3rd class
  - Centre of gravity
  - Momentum
  - Force
  - Planes of motion
  - Length – tension relationship
  - Open and closed chain kinetic movements
• Examples of all the above
• Advantages and disadvantages of all the above

LO2 Understand the structure and function of the muscular system in relation to exercise, health and fitness programming

Different types of muscle tissue and the characteristics and functions of each type
Taught content
• 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) • Skeletal muscle (striated, voluntary, up to very large fibre diameter, short to moderate fibre length, up to fast speed of contraction, attach to bones, e.g. quadriceps)

Different skeletal muscle fibre types and their characteristics
Taught content
• 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) • Fast twitch or intermediate type 2a (pink or white in colour, intermediate contraction speed and rate of fatigue, adapt characteristics to training to become more like type 1 or type 2b fibres) • Fast twitch type 2b (white in colour, high intensity, short duration, low in mitochondria, low in myoglobin, fast contraction speed, fast to fatigue)

Structure of skeletal muscle and the sliding filament theory
Taught content
• Gross muscle structure – tendon (attach muscle to bone), epimysium, perimysium, endomysium, fascicle • Arrangement of fasciculi (parallel, fusiform, pennate) • Cellular structure – muscle fibres, myofibrils, myofilaments (actin, myosin), sarcolemma, sarcomere • Sliding filament theory (myosin and actin, cross bridges, shortening of sarcomere), process (attachment of myosin to actin, power stroke, detachment, ATP and energy transfer)

Names and location of all major muscles

Taught content

- Attachment sites – origins and insertions
- Local, deep, global and superficial muscles
- 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
- Rotator cuff muscles – suprapinatus, infraspinatus, teres minor and subscapularis

Types of muscle action and joint actions

Taught content

- 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 joint actions and exercises
    - 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)
    - External and internal obliques (lateral flexion and rotation of the spine)
    - Transversus abdominis (isometric stabilisation of the spine)
    - Hip flexors – iliacus, psoas major, rectus femoris (flexion of the hip)
    - Quadriceps – rectus femoris, vastus lateralis, vastus intermedius, vastus medialis (extension of the knee, flexion of the hip)
    - Adductors – adductor magnus, adductor longus, adductor brevis, gracilis, pectineus (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)
    - Gluteus maximus (extension of the hip)
    - Abductors – gluteus medius, tensor fasciae latae (abduction of the hip)
    - Hamstrings – biceps femoris, semimembranosus, semitendinosus (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)

Muscles of the pelvic floor and pelvic girdle
Taught content
• 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) • Pelvic girdle – associated muscles (iliopsoas, pectineus, rectus femoris, sartorius, adductors, gluteus maximus, hamstrings, gluteus medius, gluteus minimus, piriformis)

Stabilising muscles of the spine and their role in maintaining optimum posture and stability
Taught content
• Location and role of local postural stabilisers (lumbar multifidus, transversus abdominis, diaphragm, pelvic floor muscles, abdominal aponeurosis, thoracolumbar fascia), location and role of global phasic stabilisers (rectus abdominis, internal obliques, external obliques, rectus abdominis, erector spinae, quadratus lumborum) • 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, hyperkyphosis, hyperlordosis, 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 correct motor sequencing during movements and exercises)

LO3 Understand the structure and function of the circulatory system in relation to exercise, health and fitness programming

Structure and function of the cardiovascular system

Taught content

- Structure - Heart, blood and blood vessels
- Function
    - Transport of – oxygen, carbon dioxide, nutrients, waste products, hormones, medication
    - Regulation of – body temperature
    - Protection – blood loss and fighting foreign microbes

Function and structure of the heart

Taught content

- Located centrally in the chest, mediastinum, thorax, between lungs, apex towards left hip
- Function of heart – circulation of blood, receiving and pumping blood to body and lungs
- Structure of heart – endocardium, myocardium, septum, atria, ventricles, interventricular septum, interatrial septum, atrio-ventricular valves (bicuspid valve, tricuspid valve), semi-lunar valves (aortic and pulmonary), blood vessels (aorta, superior vena cava, inferior vena cava, pulmonary veins, pulmonary arteries)
- Function of valves – control blood flow through heart chambers, prevent backflow of blood
- Cardiac conduction – sinoatrial node, atrioventricular node, right and left bundle branches, bundle of His, Purkinje fibres

Blood flow through the heart chambers and different circulatory systems

Taught content

- Functional considerations – heart rate (maximal and resting), stroke volume, cardiac output
- Systemic (oxygenated blood from lung capillaries, venules, pulmonary veins, left atrium, bicuspid valve, left ventricle, aortic semi-lunar valve, aorta, arteries, arterioles, capillaries of muscles and organs)
- Pulmonary (deoxygenated blood from muscles and organs, capillaries, venules, veins, 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)
- Coronary – circulation of blood to the heart (oxygenated blood, root of aorta, aortic sinuses, epicardial coronary arteries, left coronary artery, circumflex artery, left anterior descending artery, right coronary artery, anastomoses, marginal arteries, cardiac veins, right atrium)
- Other – renal, brain and hepatic portal system

Composition of blood
Taught content
• Plasma, plasma proteins, red blood cells (erythrocytes), white blood cells (leukocytes) and platelets (thrombocytes)

Structure and function of blood vessels
Taught content
• Types – arteries, arterioles, capillaries, venules, veins • Structure – comparison between blood vessels (wall thickness, internal diameter, direction of blood flow, pressure, presence of one way valves) • Functions – transport blood, blood flow distribution by vasoconstriction and vasodilation - Arteries and arterioles (systemic arteries transport oxygenated blood away from the heart to muscles and organs; pulmonary arteries carry deoxygenated blood to lungs) - Veins and venules (systemic veins transport deoxygenated blood back to the heart from tissues and organs, venous return, blood pooling; pulmonary veins carry oxygenated blood from the lungs to the heart) - Capillaries (exchange of gases and nutrients between blood and tissues or blood and alveolar air in lungs)

Effects of disease processes on the blood vessels and the effect on blood pressure
Taught content
• Diseases (arteriosclerosis, atherosclerosis) • Processes (inflammation, thickening of artery walls, loss of elasticity, endothelial damage, smooth muscle fibre proliferation, lesions formed by fatty plaque • Definition of blood pressure – pressure exerted by blood on vessel wall - Systolic pressure (pressure exerted during systole, ventricular contraction) - Diastolic pressure (residual pressure during diastole, ventricular relaxation) • Blood pressure classifications – see NICE guidance for current classifications for clinical blood pressure (hypertension) 140/90 - Associated health risks of hypertension – cardiovascular disease, stroke, coronary heart disease, coronary artery disease, kidney disease, loss of vision • Factors affecting blood pressure – nutrition, exercise, alcohol, smoking, stress, medication, medical conditions and age • Effects of exercise - Short term – no change in diastolic pressure, progressive increase in systolic pressure during CV training, rapid and greater increase in SBP during resistance training, beware of Valsalva manoeuvre during resistance training as this can cause a sharp severe increase followed by a sudden drop in blood pressure, reduced BP for up to 24 hours after physical activity - Long term – reduction in resting blood pressure, improved regulation of blood pressure

LO4 Understand the structure and function of the respiratory system in relation to exercise, health and fitness programming

Structure and function of the respiratory system

Taught content

- Nose – cilia, mucus and goblet cells
- Structure of lungs – left lung – two lobes, right lung – three lobes, trachea, bronchi, bronchioles, sub-divisions, alveoli, capillaries
- Diaphragm
- Function of lungs – paired organs for ventilation, external respiration, elimination of carbon dioxide, supply of oxygen
- Location of the lungs - laterally in the chest on the left and right sides, thorax

Muscles involved in breathing and the passage of air through the respiratory system

Taught content

- Muscles used
    - During normal breathing – inhalation (inspiration), exhalation (expiration), muscles involved – diaphragm, external intercostals
    - During forced inspiration accessory muscles - sternocleidomastoids, scalenes, pectoralis minor
    - During forced expiration accessory muscles – internal intercostals, transversus abdominus, rectus abdominus
- Functional considerations – 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

Taught content

- 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
    - Gaseous exchange lungs external respiration (oxygen in alveoli passes to pulmonary capillaries and carbon dioxide in capillaries passes to alveoli) removed via exhalation
    - Gaseous exchange in tissues internal respiration (oxygen in capillaries passes into cells for aerobic energy production, carbon dioxide in cells moves to local capillaries for circulation back to heart and lungs for removal)
- 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)

LO5 Understand the structure and function of the nervous system in relation to exercise, health and fitness programming

Roles and functions of the different components of the nervous system

Taught content

- 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, higher cognitive processes)
- 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 (somatic nervous system, autonomic nervous system (ANS), and subdivisions of ANS (sympathetic branch, parasympathetic system)
    - 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 roles (slows down functions, more active during rest and recovery)

Characteristics of different types of nerves

Taught content

- Types of nerves – motor, sensory, inter-neurons
- Structure and function of a neuron
    - Structure – dendrites, nucleus, cytoplasm, axon, axon terminals, myelin sheath, nodes of Ranvier, nerve endings, cell body
    - Function – transmit signals to muscles
- Neuralgia – supporting structure – astrocytes, oligodendrocytes and microcytes

Relationship between the nervous system and principles of muscle contraction and motor unit recruitment

Taught content

- 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)
- Motor unit recruitment – motor units (motor neuron, muscle fibre), 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), 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
- 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) inverse stretch reflex (inhibition of muscle contraction, reflex arc)
- Reciprocal inhibition – agonist muscle contraction, antagonist muscle relaxation, relevance to exercise (allows appropriate muscle contraction, can be used to promote flexibility development)

How exercise enhances neuromuscular activity and improves motor fitness

Taught content

- Resistance training adaptations (improved motor recruitment, improved recruitment of fast twitch fibres)
- Types of motor skills training (reaction time, balance, coordination, 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 coordination, automatic performance of movement patterns)
- Methods of motor skill development (short training duration, repetition, progressing movement speed, whole-part-whole, progressive layering of demands on motor skills, positive reinforcement and feedback)
- Benefits of improved neuromuscular co-ordination – improved movement efficiency and economy, improved accuracy of movement patterns, improved force generation, improved stability, improved spatial awareness, automatic movement patterns

LO6 Understand the structure and function of the endocrine system in relation to exercise, health and fitness programming

Functions of the endocrine system
Taught content
• Maintains homeostasis • Regulation of growth • Development and metabolism • Production of hormones • Close links with nervous system

Major glands, their locations and hormones excreted
Taught content
• Major glands – hypothalamus, pituitary, thyroid, parathyroid, pancreas, pineal, adrenal glands, kidney, testes and ovaries • Major hormones – thyroxine, adrenaline, noradrenaline, human growth hormone, melatonin, cortisol, insulin, glucogon, oestrogen, progesterone, testosterone, adrenocorticotropic hormone (ACTH)

Functions of hormones
Taught content
• Functions of hormones – thyroxine, adrenaline, noradrenaline, human growth hormone, melatonin, cortisol, insulin, glucogon, oestrogen, progesterone, testosterone, adrenocorticotropic hormone (ACTH) - Growth hormone (growth of body cells, protein anabolism, elevation of blood glucose) - Thyroid hormone – thyroxine and parathyroid hormone (metabolism, growth, development, nervous system control) - Corticosteroids – cortisol (regulate metabolism, stress hormone) - Adrenaline and noradrenaline (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)

LO7 Understand the roles and function of the energy systems in relation to exercise, health and fitness programming

Macronutrients and their role in the production of energy

Taught content

- Carbohydrates (e.g. bread, pasta), proteins (e.g. meat, fish), lipids (e.g. cheese, butter, energy yield per gram of macronutrient)
- Carbohydrates (break down into glucose, glycogen storage in muscles and liver)
- Lipids (fats and oils) (break down into fatty acids in presence of oxygen, stored as adipose tissue, protection, energy store)
- Proteins (break down into amino acids, growth and repair of muscle, used for energy when other nutrients are depleted)

Energy systems used during exercise and the by-products of different systems

Taught content

- Adenosine triphosphate (ATP – break down and re-synthesis, energy equation)
- Energy systems (Phosphocreatine system, anaerobic lactic acid system, aerobic system – glycolysis and lipolysis)
    - Creatine phosphate system (high intensity activity of 6 – 10 seconds), e.g. 100 metre sprint, throwing, explosive events
    - Anaerobic lactic acid system (moderate to high intensity activity of up to 90 seconds), e.g. 400 metre sprint
    - Aerobic system (low to moderate intensity of above 90 seconds), e.g. long distance events
- By-products
    - Phosphocreatine system (adenosine diphosphate, phosphate, creatine, all by-products re-used)
    - Anaerobic lactic acid system Hydrogen ions (acid) lactate ions (buffer)
    - Aerobic system (metabolic 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)
- The effects of exercise on the energy systems
    - The energy continuum for intensity and duration, relative percentage contributions of energy systems during different activities/sports (exercise type, exercise duration, exercise intensity)
    - Effect of training on the relative proportions of fuel used for exercise, glycogen sparing, ability to utilise fats at higher exercise intensities, increased lactate threshold, improved ability to tolerate and remove lactate
- Anabolism, catabolism and excess post-exercise oxygen consumption (EPOC)

LO8 Know the structure and function of the digestive system

Structure of digestive system
Taught content
• Mouth, tongue, teeth, salivary glands (parotid, submandibular, sublingual, buccal), pharynx (epiglottis), oesophagus, stomach, small intestine (duodenum, jejunum, ileum), pancreas, liver, gall bladder, large intestine, rectum, anus

Functions of the digestive system
Taught content
• Ingestion • Mouth – mastication, food chewed and moistened, salivary amylase breaks down starch into simple sugars • Oesophagus – peristalsis pushes food towards the stomach. No chemical breakdown • Stomach – pepsin breaks protein down into smaller amino acid chains. Peptides and lipase break down short chain triglycerides into fatty acids and monoglycerides. Hydrochloric acid kills bacteria and enables enzymes, e.g. pepsin, to perform their actions. Food churned and broken down into chyme • Small intestine (duodenum, jejunum and ileum) - breaks down nutrients into usable components. Chemical digestion using bile to emulsify lipids (fats) and pancreatic juice containing enzymes. Transports nutrients into blood stream • Pancreas – exocrine gland, secretes pancreatic juice containing enzymes that assist breakdown of carbohydrates, protein and fat in small intestine. Role of pancreatic enzymes - trypsin, amylase, lipase • Liver – secretion of bile to emulsify fat and assist breakdown and absorption of fats • Gall bladder – located under the liver, stores and releases bile into small intestine • Large intestine – final stage of digestive process. Partial breakdown of cellulose (soluble fibre), reabsorption of the water from undigested food, undigested food fibre forms faeces and pass to the rectum • Rectum – expels faeces • Kidneys – help to keep blood composition constant. Filter blood to remove excess water and waste products, which are secreted as urine • Appendix – no known function in digestion. Vestigial part of colon with an immune system function

How the macronutrients are digested and absorbed
Taught content
• Carbohydrates are digested and absorbed as glucose/sugars • Fats are digested and absorbed as fatty acids • Proteins are digested and absorbed as amino acids • Digestive enzymes and other substances - Salivary amylase – released in the mouth (enzyme in saliva) – breaks down carbohydrates - Hydrochloric acid – gastric juice released in the stomach - Pepsin – released in the stomach, breaks down protein - Lipase – released by the pancreas into the small intestine, breaks down fats - Amylase – released by the pancreas, breaks down carbohydrates into glucose - Trypsin – released by the pancreas, breaks down protein into amino acids - Bile acids – produced by the liver, stored in the gallbladder, released into the small intestine

Role of dietary fibre in the maintenance of gut function
Taught content
• Soluble fibre - dissolves in the water of the digestive system - May assist with reducing cholesterol in the blood - Increasing dietary intake of soluble fibre can help to reduce constipation - Sources of soluble fibre – oats, fruit, vegetables, golden linseeds • Insoluble fibre or non-starch polysaccharide (NSP) – does not dissolve in water - Passes through the gut without being broken down - Helps other foods transit through the digestive system more easily - Prevents digestive problems and keeps the bowels healthy - Sources of insoluble fibre – fruit, oats, nuts, seeds, root vegetables, cereals and wholemeal bread

Timescales for digestion
Taught content
• Food will initially travel relatively quickly through the digestive system • Within 6 to 8 hours, it has usually moved its way through the stomach, small intestine, and large intestine • Once in the large intestine, partially digested food can sit for more than a day while it's broken down even more • Digestion rate can be determined by what is eaten - Meat and fish – contain complex protein and fat, can take up to 2 days to digest fully - Fruit and vegetable – contain more fibre, usually digest in less than a day - Processed foods – a few hours • Approximately 24 to 72 hours to move through the whole digestive tract (the specific time will depend on the quantity and types of foods eaten

Importance of fluid
Taught content
• Assist with the removal of waste from the body • Enables the transport and absorption of nutrients around the body • Prevents constipation • Supports chemical reactions - chemical reactions in all cells take place in water

LO9 Understand the effects of exercise, health and fitness programming on the body systems

Effects of exercise, health and fitness programming on the skeletal system
Taught content
• 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. positions of strength and weakness, shearing forces, joint alignment during movement, greater range of movement allows increased risk of injury; transmission of stress caused by body weight, impact and bone density; key joints at risk (shoulder and spine); increased loading on synergists; biomechanical inefficiency • Effects of different types of exercise and attached risks and benefit - Weight-bearing and non-weight-bearing - Acute and chronic effects - Neutral spine alignment and stability • Effects of exercise and considerations for fitness programming and health benefits - Short-term – synovial fluid, joint lubrication, increased circulation of blood and delivery of nutrients - Long-term – increased bone mineral density, increased joint stability and mobility, effects of appropriate or inappropriate repetitive loading on cartilage • Health conditions affecting the skeletal system, e.g. osteoporosis, osteoarthritis, low back pain • The role of osteoclasts, osteoblasts, hormones, body weight, calcium and vitamin D in bone density

Effects of exercise, health and fitness programming on the neuromuscular system

Taught content

- Response of muscles to overuse, underuse, misuse
    - Shortening or weakening
    - Altered roles/synergists working as prime movers
    - Delayed onset muscle soreness (DOMS)
    - Muscle fatigue
- Resistance training adaptations – improved motor recruitment, improved recruitment of fast twitch fibres
- Types of motor skills training – reaction time, balance, coordination, 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 coordination, automatic performance of movement patterns
- Methods of motor skill development – short training duration, repetition, progressing movement speed, whole-part-whole, progressive layering of demands on motor skills, positive reinforcement and feedback
- Benefits of improved neuromuscular co-ordination – improved movement efficiency and economy, improved accuracy of movement patterns, improved force generation, improved stability, improved spatial awareness, automatic movement patterns
- Effects of different types of exercise and attached risks and benefits
- Health conditions affecting the nervous and muscular systems, e.g. Parkinson's disease, multiple sclerosis

Effects of exercise, health and fitness programming on the cardiovascular and respiratory system

Taught content

- The effects and benefits of aerobic endurance exercise for fitness and health
- Benefits – increased heart strength and efficiency, increased capillary network, increased stroke volume and cardiac output, 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 contraindications to exercise, overtraining, overuse injuries
- Health conditions affecting the cardiovascular and respiratory systems, e.g. cardiovascular disease, hypertension, angina, stroke, coronary heart disease (CHD), chronic obstructive pulmonary disease (COPD), asthma. Also the effects of obesity and diabetes on the cardiovascular system

Effects of exercise on the energy systems
Taught content
• The energy continuum for intensity and duration, relative percentage contributions of energy systems during different activities/sports (exercise type, exercise duration, exercise intensity) • Effect of training on the relative proportions of fuel used for exercise, glycogen sparing, ability to utilise fats at higher exercise intensities, increased lactate threshold, improved ability to tolerate and remove lactate

Effects of exercise on the digestive system
Taught content
• Diversion of blood flow away from intestines and digestive organs during exercise caused by sympathetic nervous system dominance and blood shunting, i.e. capillary sphincters constrict blood vessels to digestive system • Slowing of digestive processes during exercise due to reduced blood flow • Can lead to upper digestive system discomfort and vomiting if large meals are eaten shortly before exercising • Exercise speeds up transit time of faeces and prevents constipation, reducing risk of colon cancer and other diseases of large intestine • Some types of exercise, e.g. long distance running, can cause lower abdominal cramps and diarrhoea as water is not absorbed form the large intestine

LO10 Understand the life course of the anatomical and physiological systems of the body

Life course of the anatomical systems and the implications of exercise for specific populations

Taught content

- Young people (13 – 18)
  - Life course – muscular hypertrophy, strength and power development, increase in bone density (growth spurts), growth plate injury risk, strengthened attachment of tendons and ligaments, cardio and respiratory differences between children, young people and adults (risks of overheating, exercise intensity), developmental stages
  - Implications for exercise – consideration to safeguarding legislation, 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 over-use and over-training
- Antenatal and postnatal women
  - Life course – trimesters, weight gain, increased blood volume, reduced vital capacity of lungs, increased force at joints and tendons, postural changes (excessive lumbar lordosis), joint and ligament laxity in the lumbar spine, change in centre of gravity, weakness in abdominal and pelvic floor muscles, linea alba separation (diastasis recti), widening of sacroiliac joints and pubic symphysis, increase in anterior pelvic tilt, effects of different hormones (relaxin, oestrogen, progesterone), contra-indications listed in ACSM guidelines
  - Implications for exercise – avoid supine exercise after 16 weeks of pregnancy, avoid prone exercise, avoid prolonged motionless standing, avoid heavy isometric 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
- Older adults
  - Life course – 1-2% loss in physical fitness each year, loss of neuromuscular function, risks of chronic health conditions, muscular atrophy and decreased muscular strength, decrease in bone density and bone strength, demineralisation in bones, development of osteoporosis, degradation of ligaments and tendons (osteoarthritis), postural changes (kyphosis), changes in vision and hearing, balance issues
  - 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, consider postural stability and balance, risk of falls for frailer, older adults
- Disabled people
  - Awareness of medical conditions and physical impairments that present disabling symptoms – visual and auditory impairment, low back pain, chronic obstructive pulmonary disease (COPD), fibromyalgia, gout, osteoarthritis, rheumatoid arthritis, tendonitis, ataxia, dystonia, Huntingdon's disease, multiple system atrophies,

Parkinson's disease, Cerebral Palsy, spinal cord injury, mental illness, cancer, limb amputation, dementia, Down's syndrome, HIV / AIDS, stroke, heart attack

- Implications for exercise – consideration to equality, inclusion and safeguarding legislation, communication with relevant medical and healthcare professionals, research of exercise contra-indications, individualised exercise prescription, adaptation of exercise technique, emphasis on movement quality, stable body positioning to prevent falls, client-centred approach

Assessment requirements

1. Knowledge outcomes

Learning Outcome	Assessment Criteria	Assessment requirement
LO1 Understand the structure and function of the skeletal system in relation to exercise, health and fitness programming	1.1. Describe the anatomical reference points	External theory examination
	1.2. Explain the anatomical planes of movement	
	1.3. Describe the functions of the skeleton	
	1.4. Describe the bones of the axial and appendicular skeleton	
	1.5. Describe the classifications of different bones	
	1.6. Explain the stages of bone growth and the structures of a long bone	
	1.7. Describe the structure of the spine in relation to posture and range of motion	
	1.8. Describe the skeletal structures of the pelvic girdle	
	1.9. Describe the joint classifications and their structure	
	1.10. Explain the different types of synovial joints, their location, range of motion and joint actions	
	1.11. Describe the exercise and movement considerations in relation to the skeletal system	

Learning Outcome	Assessment Criteria	Assessment requirement
LO2 Understand the structure and function of the muscular system in relation to exercise, health and fitness programming	2.1. Describe the different types of muscle tissue and the characteristics and functions of each type	External theory examination
	2.2. Describe the different skeletal muscle fibre types and their characteristics	
	2.3. Explain the structure of skeletal muscle and the sliding filament theory	
	2.4. Describe the names and location of all major muscles	
	2.5. Describe the types of muscle action and joint actions	
	2.6. Describe the muscles of the pelvic floor and pelvic girdle	
	2.7. Describe the stabilising muscles of the spine and their role in maintaining optimum posture and stability	

Learning Outcome	Assessment Criteria	Assessment requirement
LO3 Understand the structure and function of the circulatory system in relation to exercise, health and fitness programming	3.1. Describe the structure and function of the cardiovascular system	External theory examination
	3.2. Explain the function and structure of the heart	
	3.3. Describe flow of blood through the heart chambers and different circulatory systems	
	3.4. Describe the composition of blood	
	3.5. Describe the structure and function of blood vessels	
	3.6. Describe the effects of disease processes on the blood vessels and the effect on blood pressure	

Learning Outcome	Assessment Criteria	Assessment requirement
LO4 Understand the structure and function of the respiratory system in relation to exercise, health and fitness programming	4.1. Explain the structure and function of the respiratory system	External theory examination
	4.2. Describe the muscles involved in breathing and the passage of air through the respiratory system	

Learning Outcome	Assessment Criteria	Assessment requirement
LO5 Understand the structure and function of the nervous system in relation to exercise, health and fitness programming	5.1. Describe the roles and functions of the different components of the nervous system	External theory examination
	5.2. Describe the characteristics of different types of nerves	
	5.3. Explain the relationship between the nervous system and principles of muscle contraction and motor unit recruitment	
	5.4. Explain how exercise enhances neuromuscular activity and improves motor fitness	

Learning Outcome	Assessment Criteria	Assessment requirement
LO6 Understand the structure and function of the endocrine system in relation to exercise, health and fitness programming	6.1. Describe functions of the endocrine system	External theory examination
	6.2. Describe the major glands, their locations and hormones excreted	
	6.3. Describe the functions of hormones	

Learning Outcome	Assessment Criteria	Assessment requirement
LO7 Understand the roles and function of the energy systems in relation to exercise, health and fitness programming	7.1. Explain the macronutrients and their role in the production of energy	External theory examination
	7.2. Explain the energy systems used during exercise and the by-products of different systems	

Learning Outcome	Assessment Criteria	Assessment requirement
LO8 Understand the structure and functions of the digestive system	8.1. Describe the structure of digestive system	External theory examination
	8.2. Describe the functions of the digestive system	
	8.3. Describe how the macronutrients are digested and absorbed	
	8.4. Explain the role of dietary fibre in the maintenance of gut function	
	8.5. Describe the timescales for digestion	
	8.6. Describe the importance of fluid	

Learning Outcome	Assessment Criteria	Assessment requirement
LO9 Understand the effects of exercise, health and fitness programming on the body systems	9.1. Describe the effects of exercise, health and fitness programming on the skeletal system	External theory examination
	9.2. Describe the effects of exercise, health and fitness programming on the neuromuscular system	
	9.3. Describe the effects of exercise, health and fitness programming on the cardiovascular and respiratory system	
	9.4. Describe the effects of exercise on the energy systems	
	9.5. Describe the effects of exercise on the digestive system	

Learning Outcome	Assessment Criteria	Assessment requirement
LO10 Understand the life course of the anatomical and physiological systems of the body	10.1. Describe the life course of the anatomical systems and the implications of exercise for specific populations	External theory examination

External theory examination

There must be evidence that the learners possess all the knowledge and understanding listed in the knowledge section of the unit specifications. Knowledge and understanding of this unit will be assessed through an external exam paper. This will consist of a multiple-choice question paper.

The external theory examination will test knowledge and understanding from across the theory content of LO1 – LO10. Learners should use the unit content section of this unit and listed assessment criteria to aid revision.

Resources

The special resources required for this unit are access to a real or realistic working environment which supports learners and helps them to apply their knowledge of anatomy and physiology to an exercise, fitness and health context within a gym environment.

Learners should have the opportunity to apply their knowledge in the planning and instruction of safe and effective exercise programmes for a range of clients. To include:

- Aerobic and anaerobic systems
- Muscle balance
- Heart rate response to exercise
- Long and short term physiological response to exercise
- Energy demands of different activities
- Tailoring exercise to meet individual needs and goals

To prepare them for work in the role of a personal trainer, learners should have opportunities to apply appropriate methods and techniques to support achievement of a range of different clients and facilitate each client's desired physiological goals.

Best practice should be encouraged by giving learners the opportunity to access current research and guidelines that inform exercise science (e.g. NICE, ACSM, BASES, BHFNC, Department of Health).

Document History

Version	Issue Date	Changes	Role
v1.0	28/09/2018	First published	Qualifications Manager
v2.0	19/10/2018	Amendment to the assessment criteria headings following technical review	Qualifications Administrator
v3.0	26/11/2018	Removal of assessment criteria verbs from learning outcomes	Qualification Administrator