iUSP146 – Anatomy and physiology for exercise and health

URN – H/617/5614

Guided Learning Hours: 43

Learning outcome	Assessment criteria	Taught content
LO1 Understand the heart and circulatory system and its relation to exercise and health	1.1. Explain the function of the heart valves	• Layers - Pericardium - Myocardium - Endocardium • Chambers - Right atrium - Right ventricle - Left atrium - Left ventricle - Septum – muscular wall separating left and right sides • Vessels - Superior vena cava - Inferior vena cava - Pulmonary artery - Pulmonary vein - Aorta • Control of heart beat - Sinoatrial node - Atrioventricular node - Bundle of His • The heart valves and their functions to include: - Tricuspid valve - Mitral/bicuspid valve - Pulmonary valve - Aortic valve

	1.2. Describe the coronary circulation	• Left and right coronary arteries branch out from aorta forming a network of capillaries within the heart wall (myocardium) delivering oxygenated blood. Coronary veins take deoxygenated blood away • Sequence of events - Atrial systole - Ventricular systole - Ventricular diastole • Cardiac output - Heart rate - Stroke volume (preload, contractility, afterload)
	1.3. Explain the effect of disease processes on the structure and function of blood vessels	• To include the cause and effects of the following: - Anaemia - Varicose veins - Haemophilia - Arteriosclerosis - Atherosclerosis - HIV/Aids - High cholesterol - Hepatitis A, B and C - Coronary thrombosis - Angina - Pacemaker fitted - Haemorrhoids - Phlebitis - Thrombus - Leukaemia - Raynaud's disease - Nosebleeds - Stress - Palpitations

	1.4. Explain the short and long-term effects of exercise on blood pressure, including the Valsalva effect	• Short term effects – heart rate increases, blood pressure increases • Long term effects – lower resting heart rate, quicker recovery rate • Positive/beneficial effects • Negative/detrimental effects • Valsalva effect to include: - Blood pressure can rise drastically when expiratory force has occurred - Pressure that builds up can stop the flow of blood to the heart - Venous activity is stalled causing sudden release of pressure causing the heart's output rate to increase rapidly - Normal cardiac output is restored after about 24 seconds, pressure usually rising before returning to normal
	1.5. Explain the cardiovascular benefits and risks of endurance/aerobic training	• Increases blood volume • Increases stroke volume • Decreases resting heart rate • Decreases recovery time • Increases VO2 • Helps control body weight • Helps maintain and build healthy bones, joints and muscles • Improves mobility • Promotes psychological wellbeing • Reduces depression • Reduces stress and anxiety • Reduces risk of premature death • Reduces risk of dying from heart disease • Reduces risk of developing diabetes • Reduces risk of developing high blood pressure • Reduces risk of dying of colon cancer
	1.6. Define blood pressure classifications and associated health risks	• Define blood pressure • Factors which produce, maintain and affect blood pressure • Causes and effects of hypo and hypertension • Way in which blood pressure is measured

LO2 Understand the musculoskeletal system and its relation to exercise	2.1. Explain the cellular structure of muscle fibres	• Cardiac muscle - Striated - Involuntary • Smooth muscle - Non-striated (smooth) - Involuntary • Skeletal muscle - Striated - Voluntary - Fascicle - Fibre - Myofibril - Epimysium - Perimysium - Endomysium
	2.2. Describe the sliding filament theory	• Sarcomeres • Sarcolemma • Myofibrils - Actin and myosin filaments • Troponin • Cross bridges
	2.3. Explain the effects of different types of exercises on muscle fibre type	• Slow twitch - Type I - Red • Fast twitch - Type IIa (fast oxidative glycolytic) - Type IIb (fast glycolytic) - White • Muscle physiology changes between sessions to include: - Increased mitochondria - Oxidative enzymes and capillaries • How a muscle contracts to include: - The motor unit - Axon terminals - Acetylcholine - Sodium ions - The action potential - The sodium/potassium pump

		- Sliding filament theory – including sarcoplasmic reticulum, calcium ions and ATP - All-or-none law of muscle physiology - Muscle fatigue and oxygen debt
	2.4. Identify and locate the muscle attachment sites for the major muscles of the body	• Trunk/torso - Sternocleidomastoid - Levator scapulae - Splenius capitis - Scalenes - Trapezius - Rhomboid major - Rhomboid minor - Infraspinatis - Supraspinatis - Subscapularis - Teres major - Teres minor - Serratus anterior - Latissimus dorsi - Erector spinae - Quadratus lumborum - Piriformis - Multifidus - Gluteus maximus - Gluteus medius - Gluteus minimus - Pectoralis major - Pectoralis minor - Intercostal - Diaphragm - Abdominus rectus - Abdominus transversalis - Internal oblique - External oblique - Iliopsoas: ▪ Iliacus ▪ Psoas major • Arm - Deltoid

		- Coracobrachialis - Biceps - Triceps - Brachialis - Brachioradialis - Pronator teres - Supinator radii brevis - Extensor carpi radialis - Extensor carpi ulnaris - Extensor carpi digitorum - Flexor carpi radialis - Flexor carpi ulnaris - Flexor carpi digitorum • Leg/thigh - Quadriceps: ▪ Rectus femoris ▪ Vastus lateralis ▪ Vastus medialis ▪ Vastus intermedius - Hamstrings: ▪ Biceps femoris ▪ Semitendinosus ▪ Semimembranosus ▪ Tensa fascia lata ▪ Iliotibial band ▪ Pectinius ▪ Adductor longus ▪ Adductor magnus ▪ Adductor brevis ▪ Gracilis ▪ Sartorius • Lower leg - Gastrocnemius - Soleus - Tibialis anterior - Peroneus longus - Flexor digitorum longus - Extensor digitorum longus - Extensor hallucis longus

	2.5. Name, locate and explain the function of skeletal muscle involved in physical activity	• Trunk/torso - Sternocleidomastoid - Levator scapulae - Splenius capitis - Scalenes - Trapezius - Rhomboid major - Rhomboid minor - Infraspinatis - Supraspinatis - Subscapularis - Teres major - Teres minor - Serratus anterior - Latissimus dorsi - Erector spinae - Quadratus lumborum - Piriformis - Multifidus - Gluteus maximus - Gluteus medius - Gluteus minimus - Pectoralis major - Pectoralis minor - Intercostal - Abdominus rectus - Abdominus transversalis - Diaphragm - Internal oblique - External oblique - Illiopsoas: ▪ Iliacus ▪ Psoas major • Arm - Deltoid - Coracobrachialis - Biceps - Triceps

		- Brachialis - Brachioradialis - Pronator teres - Supinator radii brevis - Extensor carpi radialis - Extensor carpi ulnaris - Extensor carpi digitorum - Flexor carpi radialis - Flexor carpi ulnaris - Flexor carpi digitorum • Leg/thigh - Quadriceps: ▪ Rectus femoris ▪ Vastus lateralis ▪ Vastus medialis ▪ Vastus intermedius - Hamstrings: ▪ Biceps femoris ▪ Semitendinosus ▪ Semimembranosus ▪ Tensa fascia lata ▪ Iliotibial band ▪ Pectinius ▪ Adductor longus ▪ Adductor magnus ▪ Adductor brevis ▪ Gracilis ▪ Sartorius • Lower leg - Gastrocnemius - Soleus - Tibialis anterior - Peroneus longus - Flexor digitorum longus - Extensor digitorum longus - Extensor hallucis longus • Muscles acting over the following areas: - Trunk - Shoulder and upper arm

		- Forearm, wrist and hand - Hip and upper leg - Lower leg, ankle and foot • In terms of improving strength and functioning, understand the need for: - Strengthening of specific muscles/muscle groups - Achieving balance for optimal results
	2.6. Identify the anatomical axis and planes with regard to joint actions and different exercises	• Sagittal • Median • Frontal • Transverse • Joint actions to include: - Flexion - Extension - Hyper-extension - Abduction - Adduction - Internal rotation - External rotation - Circumduction - Elevation - Depression - Lateral flexion - Horizontal flexion and extension - Supination - Pronation - Dorsiflexion - Plantarflexion - Inversion - Eversion
	2.7. Explain the joint actions brought about by specific muscle group contractions	• Fibrous joints - Fixed • Cartilaginous joints - Slightly moveable • Synovial joints - Freely moveable ▪ Ball and Socket ▪ Hinge

		▪ Pivot ▪ Gliding ▪ Saddle ▪ Condyloid - Give examples of where in the body they would be found • Role in producing movement - Agonist/prime mover - Antagonist - Synergist - Fixators/stabilisers • Types of contraction - Isotonic – concentric and eccentric - Isometric (static) - Isokinetic
	2.8. Describe joints/joint structure with regard to range of motion/movement and injury risk	• Spine - Structure - Actions and range of movement ▪ Flexion ▪ Extension ▪ Rotation ▪ Side flexion - Postural deformities ▪ Kyphosis ▪ Lordosis ▪ Scoliosis • Major synovial joints - Shoulder - Elbow - Wrist - Hip - Knee - Ankle - Actions and range of movement

	2.9. Describe joint movement potential and joint actions	• Horizontal adduction • Horizontal abduction • Internal and external rotation • Eversion • Inversion • Elevation • Depression • Retraction • Protraction
	2.10. Describe the structure of the pelvic girdle and associated muscles and ligaments	• Sacrum and coccyx and caudal part of the axial skeleton in the posterior dorsal • Posterior pair of hip bones consisting of - ischium, ilium and pubis • Muscles and ligaments of the pelvic girdle

LO3 Understand postural and core stability	3.1. Describe the structure and function of the stabilising ligaments and muscles of the spine	• Erector spinae - Iliocostalis - Longissimus - Spinalis • Lumbar multifidus • Quadratus lumborum • Illiopsoas • Gluteus maximus • Gluteus medius • Gluteus minimus • Rectus abdominus • Internal and external obliques • Abdominus tranversalis • Tensor fascia lata • Pelvic floor
	3.2. Describe local muscle changes that can take place due to insufficient stabilisation	• Rationale for stabilisation to exist because of excessive forces on the spine • Neutral zone control from the muscular system • Intra-abdominal pressure and its role in stabilisation • Thoracolumbar fascia and its role in stabilisation • Abdominal bracing and its role in stabilisation • The gluteal complex and its role in stabilisation of the spine reducing the risk of low back pain

		• Stabilising - Deep muscles - Shorter than mobilizing muscles - Working for long periods of time - Holding tone - Needing endurance - 20-30% of maximum voluntary contraction (MVC) • Mobilising - Big movements - Working in phases - Lie closer to the surface than stabilising muscles - Usually long - Fatigue quickly - Work at between 40-100% of maximum voluntary contraction (MVC)
	3.3. Explain the potential effects of abdominal adiposity and poor posture on movement efficiency	• Medical conditions associated with dysfunctional stabilisation e.g. common spinal disorders • The impact of core stabilisation exercise and the potential for injury/aggravation of problems • To include the different factors that may influence posture: - Hereditary - Injury - Illness – mental and physical - Work related factors – type of job - Hobby/sport related influences - Environmental - Emotional - Sustained positions - Repetitive movements - Fashion - The relationship between centre of gravity excursions and adiposity deviation • Posture positioning for everyday situations include: - Sitting at a desk/computer/watching TV - Standing incorrectly - Lying in bed - Driving – correct mirror positioning/wheel grip - Functional professional posture

	3.4. Explain the potential problems that can occur as a result of postural deviations	• Dowager's hump • Round shoulders • Winged scapulae • Midriff bulge • Protruding abdomen • Knock knees • Bow legged • Flat back • Sway back • Kyphosis • Lordosis • Scoliosis • Stress related weight changes and postural defect • If in doubt refer to the appropriate professional
	3.5. Explain the impact of core stabilisation exercise and the potential for injury/aggravation of problems	• Methods of contraction of abdominis transversalis • Methods of abdominal bracing • The use of stabilisation equipment • Stability equipment exercises • Floor based exercises • Reasons for participant exclusion • Imbalances associated with incorrect stabilisation
	3.6. Explain the benefits, risks and applications of the following types of stretching: • Static (passive and active) • Dynamic • Proprioceptive neuromuscular facilitation (PNF)	• Static (passive and active) • Ballistic • Dynamic • Proprioceptive neuromuscular facilitation (PNF)

LO4 Understand the nervous system and its relation to exercise	4.1. Describe the specific roles of: • The central nervous system (CNS) • The peripheral nervous system (PNS) including somatic and autonomic systems	• Central nervous system - Brain: ▪ Cerebrospinal fluid ▪ Cerebrum ▪ Cerebellum ▪ Pons varolii ▪ Medulla oblongata ▪ Hypothalamus ▪ Brain stem - Spinal cord: ▪ Cerebrospinal fluid • Peripheral nervous system - 31 pairs of spinal nerves • Somatic nervous system • Autonomic nervous system - Sympathetic - Parasympathetic • Understand how regular activity can enhance neurological functioning • The effects of stress on the nervous system • Describe the way in which stress affects the fear, fight and flight syndrome • Describe the way in which various parts of the sympathetic and parasympathetic nervous systems can be affected by stress and its effect on exercise
	4.2. Describe nervous control and transmission of a nervous impulse	• Changes in temperature, pressure and chemicals • Neurotransmitters • Potassium and sodium ions
	4.3. Describe the structure and function of a neuron	• Cell body • Dendrites • Axon • Myelin sheath • Neurilemma • Nodes of Ranvier • End feet/axon terminals • Synapse

	4.4. Explain the role of a motor unit	• Formed by motor end-plates and each nerve and muscle fibres they supply • Serves a functional role in the control of movement
	4.5. Explain the process of motor unit recruitment and the significance of a motor unit's size and number of muscle fibres	• 'All or nothing principle'
	4.6. Explain the function of muscle proprioceptors and the stretch reflex	• Detecting subtle changes in movement, position, tension and force within the body • Golgi tendons • Neural receptors/sense organs • Golgi tendon organs • Muscle spindle cells • Proprioceptive neuromuscular facilitation (PNF)
	4.7. Explain reciprocal inhibition and its relevance to exercise	• An impulse sent from the spinal cord to the antagonistic of the contracting muscle causing the antagonistic to relax
	4.8. Explain the neuromuscular adaptations associated with exercise/training	• Fast twitch motor units • Recruitment, order and different metabolic characteristics • Hypertrophia and hyperplasia • Neural adaptations and atrophy
	4.9. Explain the benefits of improved neuromuscular co-ordination/efficiency to exercise performance	• Improved mitotic proprioceptive facilities • Improved cardiovascular endurance • Improved neuromuscular efficiency (including endurance, and strength etc.) • Increased metabolic activity • Increased capillarisation • Increased number and size of mitochondria • Hypertrophy

LO5 Understand the endocrine system and its relation to exercise	5.1. Describe the functions of the endocrine system	• Define the endocrine system
	5.2. Identify the major glands in the endocrine system	• Explain (with the aid of a diagram) the main endocrine glands and the hormones they secrete • Pituitary - Posterior lobe ▪ Antidiuretic hormone (ADH or vasopressin) - Anterior lobe ▪ Prolactin ▪ Human growth hormone (HGH) ▪ Thyroid stimulating hormone (TSH) ▪ Adrenocorticotrophin hormone (ACTH) ▪ Follicle stimulating hormone (FSH) • Thyroid gland ▪ Thyroxin ▪ Triiodothyronin ▪ Calcitonin • Parathyroids - Parathormone • Thymus - Secretion of T lymphocytes • Pineal - Melatonin • Islets of Langerhans - Insulin - Glucagon - Glycogen • Adrenal medulla - Adrenalin - Noradrenalin • Adrenal cortex - Mineralocorticoids - Glucocorticoids - Sex hormones • Ovaries - Oestrogen - Progesterone • Testes - Testosterone

	5.3. Explain the function of hormones including: • Growth hormone • Thyroid hormones • Corticosteroids • Catecholamines • Insulin • Glucagon	• Growth hormone - Regulates height and weight • Thyroid hormones - Stimulate tissue metabolism - Maintain basic metabolic rate (BMR) • Corticosteroids - Mineralocorticoids – to regulate salts in the body especially sodium chloride and potassium - Glucocorticoids – to metabolise carbohydrates, fats and proteins • Catecholamines - 'Fight-or-flight' hormones released in response to stress • Insulin - To regulate blood sugar levels • Glucagon - Involved in carbohydrate metabolism

LO6 Understand energy systems and their relation to exercise	6.1. Identify the contribution of energy according to: • Duration of exercise/activity being performed • Type of exercise/activity being performed • Intensity of exercise/activity being performed	• Energy systems: - Anaerobic System ▪ Creatine phosphate system (ATP-CP) ▪ Lactate system ▪ Aerobic system
	6.2. Identify the by-products of the three energy systems and their significance in muscle fatigue	• Blood lactate: - Production - Clearance - Accumulation - Onset of blood lactate accumulation (OBLA)
	6.3. Describe the effect of endurance training/advanced training methods on the use of fuel for exercise	• Glycolytic system – anaerobic glycolysis and aerobic glycolysis • Lactic acid • Short term - Increased heart rate - Increased breathing rate - Build-up of carbon dioxide in the bloodstream - Stroke volume - Increased blood flow to capillaries - Cardiac output

		- Systolic pressure - Diastolic pressure - Respiratory rate • Long term - Increase in stroke volume - Lower resting heart rate - Reduced risk of heart disease - Reduction of high blood pressure - Improved blood cholesterol - Reduced body fat - Build-up of carbon dioxide and other metabolic by-products in the blood - Increased capillarisation and use of dead space • Muscular strength - Use of high resistance and low repetitions so that motor unit recruitment is maximized and contractile limits are reached • Muscular endurance - Lower resistance loads and high repetitions which may result in build-up of lactic acid and inhibition of further muscle contraction - Increased endurance capacity in muscles developed between exercise session by the increased numbers of mitochondria, oxidative enzymes and capillaries • Resistance training - Improved posture - Reduced risk of joint and soft tissue injuries - Increased bone density - Improved neuromuscular efficiency • Cardiorespiratory training - Reduced risk of coronary heart disease - Improved body composition • Range of motion training

LO7 Understand the structure and function of the respiratory system in relation to exercise, health and fitness	7.1. Structure and function of the respiratory system	• Nose - Cilia - Mucus - 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
	7.2. Muscles involved in breathing and the passage of air through the respiratory system	• Muscles used - During normal breathing ▪ Inhalation (inspiration) ▪ Exhalation (expiration) ▪ Muscles involved – diaphragm, external and intercostal • During forced inspiration accessory muscles - Sternocleidomastoids - Scalene - Pectoralis minor • During forced expiration accessory muscles - Internal intercostal - Transversus abdominis - Rectus abdominis

		• Functional considerations - Total lung capacity - Vital capacity • Passage of air during breathing - Upper respiratory tract ▪ Mouth ▪ Nose ▪ Pharynx - Lower respiratory tract ▪ Larynx ▪ Trachea ▪ Bronchi ▪ Bronchioles - Alveoli - Alveolar sacs
	7.3. Process of gaseous exchange	• 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)

Assessment	
MCQ	

Guide to taught content
The content contained within the unit specification is not prescriptive or exhaustive but is intended to provide helpful guidance to teachers and learners with the key areas that will be covered within the unit, and, relating to the kinds of evidence that should be provided for each assessment objective specific to the unit learning outcomes.

Document History

Version	Issue Date	Changes	Role
v1	16/08/2019	First published	Qualifications and Regulation Co-ordinator