Year 12

A Level PE

Learner Booklet

*Anatomy & Physiology*

*Exercise Physiology*

*Biomechanics*

Name………………………..

Tutor…………………………

School……………………….

**Anatomy and Physiology**

|  |  |
| --- | --- |
| Section 1.1.a | Skeletal and muscular systems |
| Joints, movements and muscles | Shoulder:   * Flexion, extension, abduction, adduction, horizontal flexion/extension, medial and lateral rotation, circumduction * Deltoid, latissimus dorsi, pectoralis major, trapezius, teres minor   Elbow:   * Flexion, extension * Biceps brachii, triceps brachii   Wrist:   * Flexion, extension * Wrist flexors, wrist extensors   Hip:   * Flexion, extension, abduction, adduction, medial and lateral rotation * Iliopsoas, gluteus maximus, medius and minimus, adductor longus, brevis and magnus   Knee:   * Flexion, extension * Hamstring group: biceps femoris, semi-membranosus, semi-tendinosus * Quadriceps group: rectus femoris, vastus lateralis, vastus intermedius and vastus medialis   Ankle:   * Dorsi flexion, plantar flexion * Tibialis anterior, soleus, gastrocnemius   Planes of movement:   * Frontal * Transverse * Sagittal |
| Functional roles of muscles and types of contraction | Roles of muscles:   * Agonist * Antagonist * Fixator   Types of contraction:   * Isotonic * Concentric * Eccentric * Isometric |
| Analysis of movement | Analyse movement with reference to:   * Joint type * Movement produced * Agonist and antagonist muscles involved * Type of muscle contraction taking place |
| Skeletal muscle contraction | Structure and role of motor units in skeletal muscle contraction;  Nervous stimulation of the motor unit:   * Motor neuron * Action potential * Neurotransmitter * ‘All or none’ law |
| Muscle contraction during exercise of differing intensities and during recovery | Muscle fibre types:   * Slow oxidative * Fast oxidative glycolytic * Fast glycolytic   Recruitment of different fibre types during exercise of differing intensities and during recovery. |

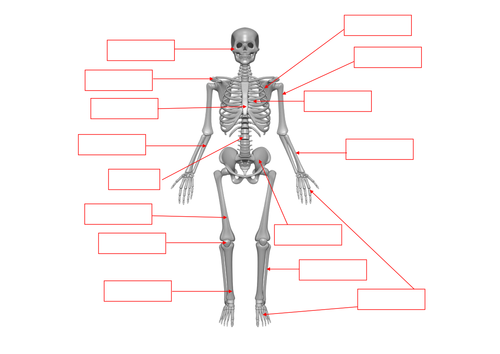
Glossary of key terms

Complete the definitions for the key terms.

|  |  |
| --- | --- |
| Key Term | Definition |
| Abduction |  |
| Action Potential |  |
| Adduction |  |
| Agonist |  |
| All-or-none law |  |
| Antagonist |  |
| Antagonistic muscle action |  |
| Concentric contraction |  |
| Delayed onset muscle soreness |  |
| Dorsi-flexion |  |
| Eccentric contraction |  |
| Extension |  |
| Fast glycolytic muscle fibres |  |
| Fast oxidative glycolytic muscle fibres |  |
| Fixator |  |
| Flexion |  |
| Horizontal extension |  |
| Horizontal flexion |  |
| Isometric contraction |  |
| Isotonic contraction |  |
| Joint |  |
| Ligament |  |
| Movement analysis |  |
| Movement patterns |  |
| Muscle hypertrophy |  |
| Myoglobin |  |
| Neuromuscular system |  |
| Neurotransmitter |  |
| Plane of movement |  |
| Plantar flexion |  |
| Slow oxidative muscle fibres |  |
| Stretch reflex |  |

Skeletal system

Label the skeleton below, identifying where each bone is located.



Planes of movement and movement patterns

Draw a diagram to help show the planes of movement and movement patterns.

|  |  |  |
| --- | --- | --- |
| Frontal Plane | Sagittal Plane | Transverse Plane |
| Flexion | Extension | Dorsi-flexion |
| Plantar-flexion | Abduction | Adduction |
| Horizontal extension | Horizontal flexion | Give a sporting example for a movement in;  Sagittal plane  Frontal plane  Transverse plane |

Muscular system

Label the muscles on the body below. Choose from the following terms below;

Pectoralis major Rectus abdominis Gluteus medius

Biceps brachii Adductor longus Gluteus maximus

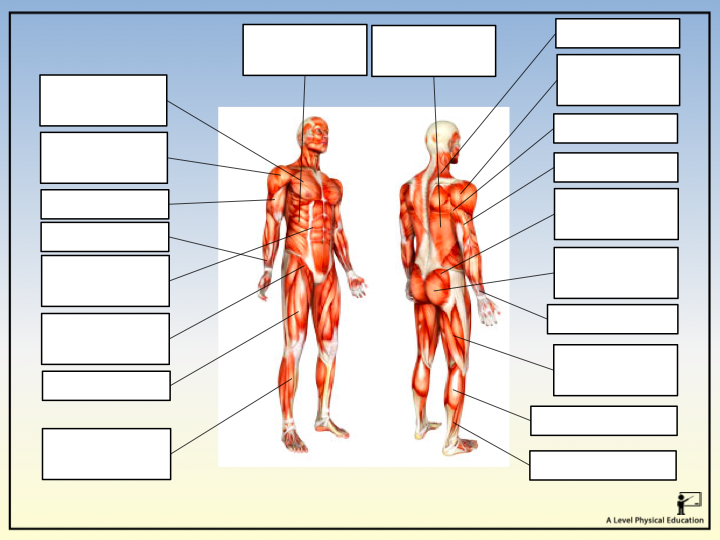
External obliques Rectus femoris Biceps femoris

Wrist flexors Posterior deltoid Gastrocnemius

Tibialis anterior Triceps brachii Soleus

Anterior deltoid Latissimus dorsi Trapezius

Teres major Wrist extensors Iliopsoas



Movement analysis

Consider the picture below, apply your knowledge to perform a movement analysis of the javelin throwers’ right wrist, shoulder, hip, knee and ankle.

Remember to include;

* Joint type
* Articulating bones
* Movement pattern
* Agonist muscle
* Antagonist muscle
* Contraction types

Skeletal muscle contraction

Complete the flow diagram, summarising the role of a motor unit in skeletal muscle contraction;



















**Skeletal and Muscular System**

**Assessment Questions**

1. In order for a muscle to contract, one or more motor units will be stimulated and will follow the ‘all-or-none’ law.
2. Describe the structure of a motor unit (1 mark)
3. What is the ‘all-or-none’ law? (1 mark)
4. What is the effect of stimulating more motor units? (1 mark)
5. Name one agonist and one antagonist at the ankle joint at the point of take-off during a vertical jump. (2 marks)
6. Fig 1. shows a performer doing a sit up.

Fig 1.



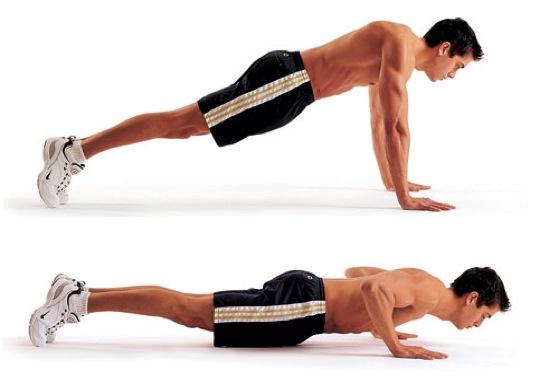
1. Complete the table below to show the movements that take place at the hip joint during the upward and downward phases.

|  |  |  |  |
| --- | --- | --- | --- |
| Phase | Agonist | Antagonist | Type of contraction |
| Upward |  |  |  |
| Downward |  |  |  |

(6 marks)

1. Fig 2 shows a performer in the upward and downward phases of a press-up.

Fig. 2



Analyse the movement for both the upward and downward phases of a press up, including;

* Joint types and movements produced at the elbow
* Muscle functions and types of contraction at the elbow
* The type of contraction of the muscles of the leg.

(10 marks)

|  |  |
| --- | --- |
| Section 1.1.b | Cardiovascular and respiratory systems |
| Cardiovascular system at rest | The relationship between, and resting values for:   * Heart rate * Stroke volume * Cardiac output * Methods of calculating the above   Cardiac cycle:   * Diastole * Systole   Conduction system of the heart linked to the cardiac cycle |
| Cardiovascular system during exercise of differing intensities and during recovery | Effects of different exercise intensities and recovery on:   * Heart rate * Stroke volume * Cardiac output * Methods of calculating the above   Redistribution of cardiac output during exercise of differing intensities and during recovery:   * Vascular shunt mechanism * Role of the vasomotor centre * Role of the arterioles * Role of pre-capillary sphincters   Mechanisms of venous return during exercise of differing intensities and during recovery.  Regulation of heart rate during exercise:   * Neural factors * Hormonal factors * Intrinsic factors |
| Respiratory system at rest | Relationship between resting values for:   * Breathing frequency * Tidal volume * Minute ventilation * Methods of calculating the above   Mechanics of breathing at rest and the muscles involved:   * Diaphragm * External intercostals * At the alveoli * At the muscles |
| Respiratory system during exercise of differing intensities and during recovery | Effects of differing intensities of exercise and recovery on:   * Breathing frequency * Tidal volume * Minute ventilation   Mechanics of breathing during exercise of differing intensities and during recovery, including additional muscles involved:   * Inspiration – sternocleidomastoid, pectoralis minor * Expiration – internal intercostals, rectus abdominis   Regulation of breathing during exercise of different intensities and during recovery:   * Neural control * Chemical control   Effect of differing intensities of exercise and recovery on gas exchange at the alveoli and at the muscles:   * Changes in pressure gradient * Changes in dissociation of oxyhaemoglobin |

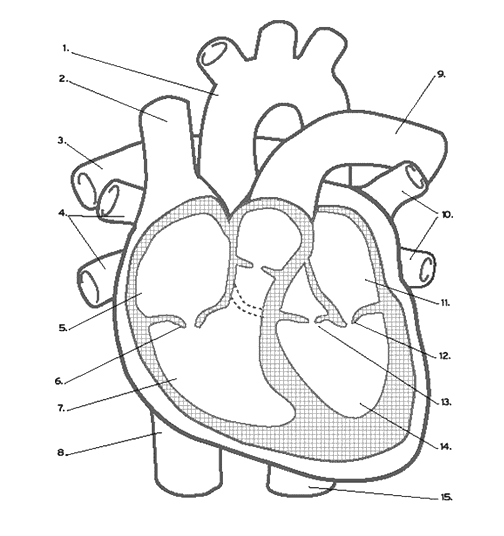
Glossary of key terms

Complete the definitions for the key terms

|  |  |
| --- | --- |
| Key Term | Definition |
| Alveoli |  |
| Arterioles |  |
| Atherosclerosis |  |
| Blood pooling |  |
| Blood viscosity |  |
| Bohr shift |  |
| Bradycardia |  |
| Breathing rate |  |
| Capillarisation |  |
| Carbon dioxide |  |
| Cardiac control centre (CCC) |  |
| Cardiac output (Q) |  |
| Cardiovascular drift |  |
| Chronic Obstructive Pulmonary Disease (COPD) |  |
| Conduction system |  |
| Coronary heart disease (CHD) |  |
| Deoxygenated blood |  |
| Diastole |  |
| Diffusion |  |
| Diffusion gradient |  |
| Dissociation |  |
| Expiration |  |
| Expiratory centre (EC) |  |
| Frank-Starling mechanism (Starling’s law) |  |
| Gaseous exchange |  |
| Haemoglobin |  |
| Heart attack |  |
| Heart rate |  |
| Hypertension |  |
| Hyper-viscosity |  |
| Inspiration |  |
| Inspiratory centre (IC) |  |
| Minute Ventilation |  |
| Mitochondria |  |
| Myogenic |  |
| Oxygenated blood |  |
| Oxyhaemoglobin dissociation curve |  |
| Parasympathetic nervous system |  |
| Partial pressure |  |
| Pre-capillary sphincters |  |
| Pulmonary circuit |  |
| Respiratory control centre (RCC) |  |
| Stroke |  |
| Stroke volume |  |
| Sympathetic nervous system |  |
| Systemic circuit |  |
| Systole |  |
| Tidal Volume |  |
| Vascular shunt mechanism |  |
| Vasoconstrict |  |
| Vasodilate |  |
| Vasomotor control centre (VCC) |  |
| Vasomotor tone |  |
| Venous return |  |

The structure of the heart

Label the diagram of the heart



The cardiac cycle

Describe the pathway of blood through the heart alongside the cardiac cycle. Use the following key terms in your description;

*Sino-atrial node (SA node), Atrio-ventricular node (AV node), bundle of His, bundle branches, purkinje fibres, diastole, atrial systole, ventricular systole.*

Venous return mechanisms

Describe the five mechanisms of venous return.

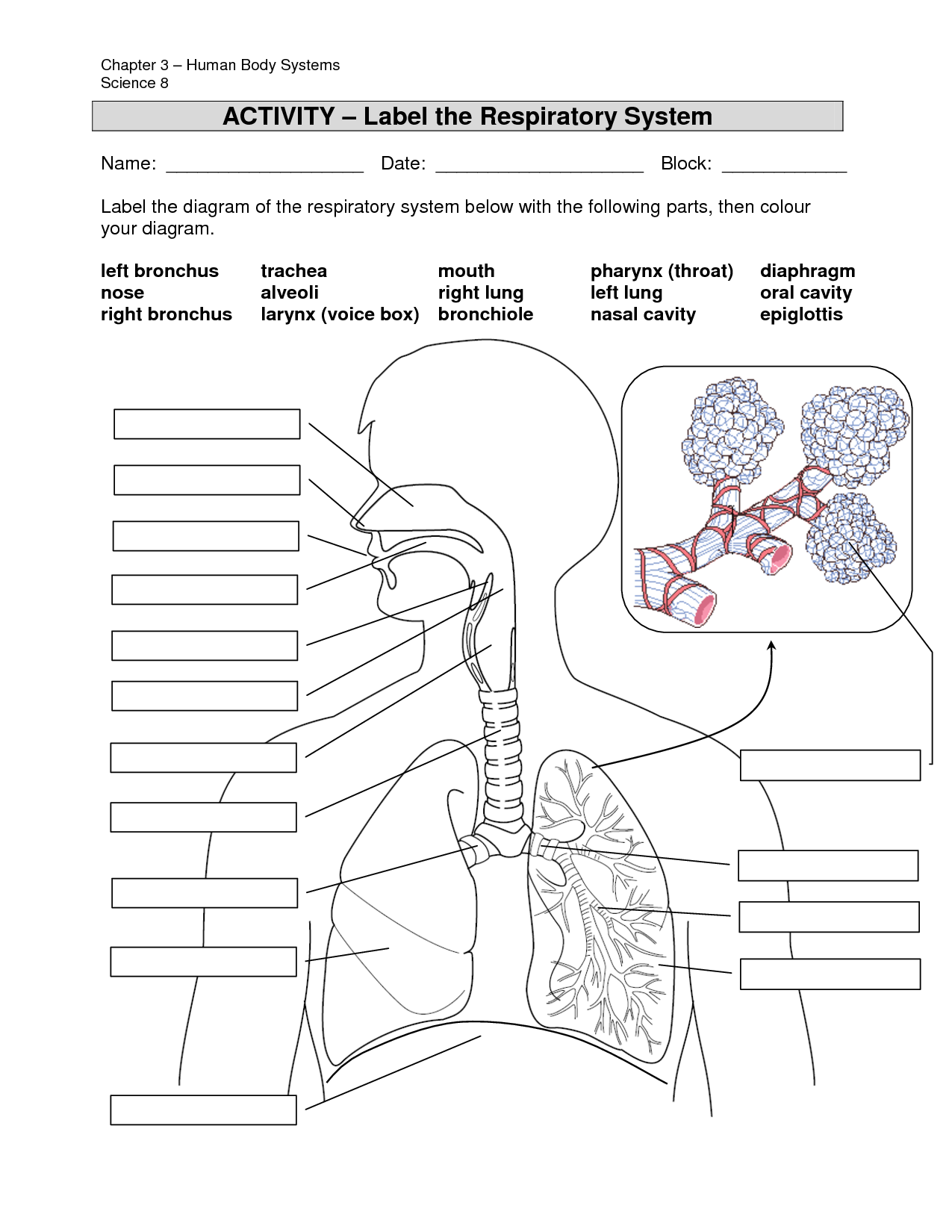
|  |  |  |
| --- | --- | --- |
| 1. | 2. | 3. |
| 4. | 5. | Why is good venous return so important for a sports performer? |

Vascular shunt mechanism

Describe the role of the vasomotor control centre in relation to the vascular shunt mechanism.

The structure of the respiratory system

Label the diagram of the respiratory system



Mechanics of breathing

Describe the mechanics of breathing for each scenario.





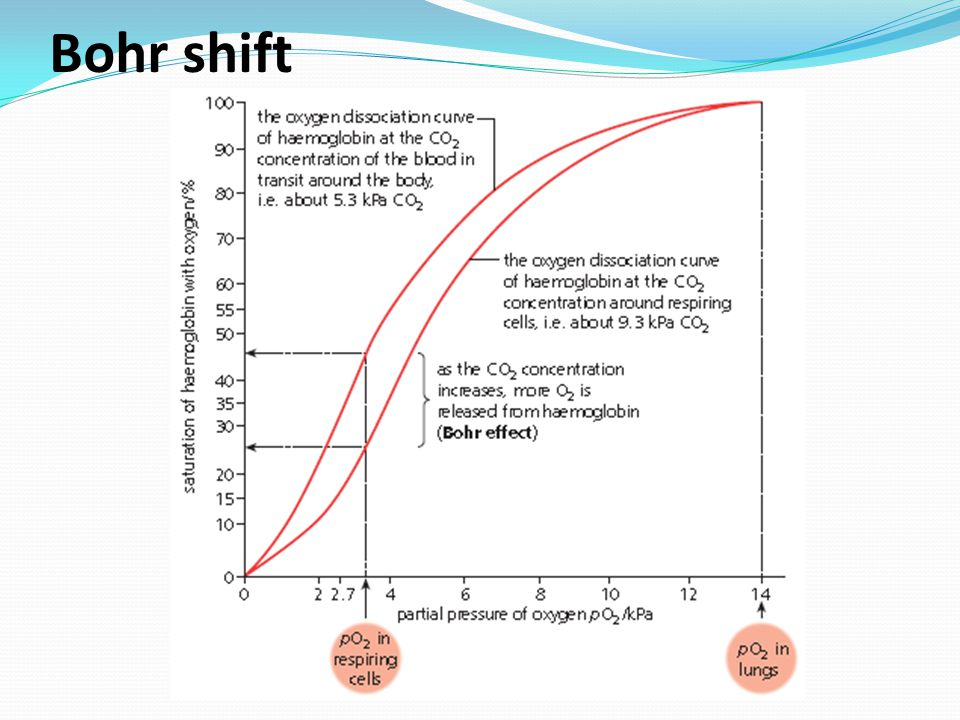




Respiratory regulation

Breathing rates and minute ventilation remain elevated post exercise and gradually reduce, especially if an active recovery is used. Based on the information that the chemical and neural receptors send to the RCC post exercise, write a paragraph explaining why breathing rate and minute ventilation remain high, reducing gradually in recovery.

Bohr shift



Write a paragraph explaining how the oxyhaemoglobin dissociation curve helps explain the transport and increased delivery of oxygen to the muscles during exercise.

**Exercise Physiology**

|  |  |
| --- | --- |
| Section 1.2.a | Diet and nutrition and their effect on physical activity and performance |
| Diet and Nutrition | Function and importance of the components of a healthy, balanced diet:   * Carbohydrates * Proteins * Fats * Minerals * Vitamins * Fibre * Water   Energy intake and expenditure and energy balance in physical activity and performance. |
| Ergogenic aids | Use of ergogenic aids; potential benefits and risks:  Pharmacological aids:   * Anabolic steroids * Erythropoietin (EPO) * Human growth hormone (HGH)   Physiological aids:   * Blood doping * Intermittent hypoxic training (IHT) * Cooling aids   Nutritional aids:   * Amount of food * Composition of meals * Timing of meals * Hydration * Glycogen/carbohydrate loading * Creatine * Caffeine * Bicarbonate * Nitrate |

Glossary of key terms

Complete the definitions for the key terms

|  |  |
| --- | --- |
| Key Term | Definition |
| Anabolic steroids |  |
| Bicarbonate |  |
| Blood doping |  |
| Caffeine |  |
| Carbohydrate |  |
| Cooling aids |  |
| Creatine supplementation |  |
| Energy |  |
| Energy balance |  |
| Energy expenditure |  |
| Energy intake |  |
| Ergogenic aid |  |
| Fats |  |
| Glycaemic Index (GI) |  |
| Glycogen/carbohydrate loading |  |
| Human growth hormone (HGH) |  |
| Intermittent hypoxic training (IHT) |  |
| Metabolic equivalent (MET) value |  |
| Muscle hypertrophy |  |
| Nitrates |  |
| Pharmacological aids |  |
| Physiological aids |  |
| Protein |  |
| Recombinant erythropoietin (RhEPO) |  |
| Saturated fatty acids |  |
| Thermic effect of food (TEF) |  |
| Unsaturated fatty acids |  |
| Vitamins and minerals |  |

Diet and Nutrition

Complete the table for each dietary component summarising the key function and importance of each component for a performer and foods where they can be found.

|  |  |  |
| --- | --- | --- |
| Dietary component | Functions and importance | Sources |
| Carbohydrates |  |  |
| Proteins |  |  |
| Fats |  |  |
| Minerals |  |  |
| Vitamins |  |  |
| Fibre |  |  |
| Water |  |  |

Ergogenic aids

Complete the table for each ergogenic aid.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ergogenic aid | What are they? | Who uses them? | Performance benefits | Risks |
| Anabolic steroids |  |  |  |  |
| Erythropoietin (EPO) |  |  |  |  |
| Human Growth Hormone (HGH) |  |  |  |  |
| Blood doping |  |  |  |  |
| Intermittent hypoxic training (IHT) |  |  |  |  |
| Cooling aids |  |  |  |  |
| Amount, composition and timing of meals |  |  |  |  |
| Glycogen loading |  |  |  |  |
| Hydration |  |  |  |  |
| Creatine |  |  |  |  |
| Caffeine |  |  |  |  |
| Bicarbonate |  |  |  |  |
| Nitrate |  |  |  |  |

QUESTION

Using sporting examples, critically evaluate the use of pharmaceutical and physiological aids in a sport of your choice. (10 marks)

|  |  |
| --- | --- |
| Section 1.2.b | Preparation and training methods in relation to improving and maintaining physical activity and performance |
| Aerobic training | Aerobic capacity and maximal oxygen uptake (VO2max)  How VO2max is affected by:   * Individual physiological make-up * Training * Age * Gender   Methods of evaluating aerobic capacity:   * Laboratory test of VO2max using direct gas analysis * NCF multi-stage fitness test * Queen’s college step test * Cooper 12-minute run   Intensity and duration of training used to develop aerobic capacity:   * Continuous training * High intensity interval training (HIIT)   The use of target heart rates as an intensity guide  Physiological adaptations from aerobic training:   * Cardiovascular * Respiratory * Muscular * Metabolic   Activities and sports in which aerobic capacity is a key fitness component. |
| Strength training | Types of strength:   * Strength endurance * Maximum strength * Explosive/elastic strength * Static and dynamic strength   Factors that affect strength:   * Fibre type * Cross sectional area of the muscle   Methods of evaluating each type of strength:   * Grip strength dynamometer * 1 repetition maximum (1RM) * Press up or sit-up test * Vertical jump test   Training to develop strength:   * Repetitions * Sets * Resistance guidelines used to improve each type of strength * Multi-gym * Weights * Plyometrics * Circuit/interval training * Work intensity * Work duration * Relief interval * Number of work/relief intervals   Physiological adaptations from strength training:   * Muscle and connective tissues * Neural * Metabolic   Activities and sports in which strength is a key fitness component. |
| Flexibility training | Types of flexibility   * Static flexibility (active and passive) * Dynamic flexibility   Factors that affect flexibility   * Type of joint * Length of surrounding connective tissue * Age * Gender   Methods of evaluating flexibility:   * Sit and reach test * Goniometer   Training used to develop flexibility   * Passive stretching * Proprioceptive neuromuscular facilitation (PNF) * Static stretching * Dynamic stretching * Ballistic stretching * Isometric stretching   Physiological adaptations from flexibility training:   * Muscle and connective tissues   Activities and sport which flexibility is a key fitness component |
| Periodisation of training | Periodisation cycles:   * Macrocycle * Mesocycle * Microcycle   Phases of training:   * Preparatory * Competitive * Transition   Tapering to optimise performance  How to plan personal health and fitness programmes for aerobic, strength and flexibility training. |
| Impact of training on lifestyle diseases | The effect of training of lifestyle diseases:   * Cardiovascular system * Coronary heart disease (CHD) * Stroke * Atherosclerosis * Heart attack * Respiratory system * Asthma * Chronic obstructive pulmonary disease (COPD) |

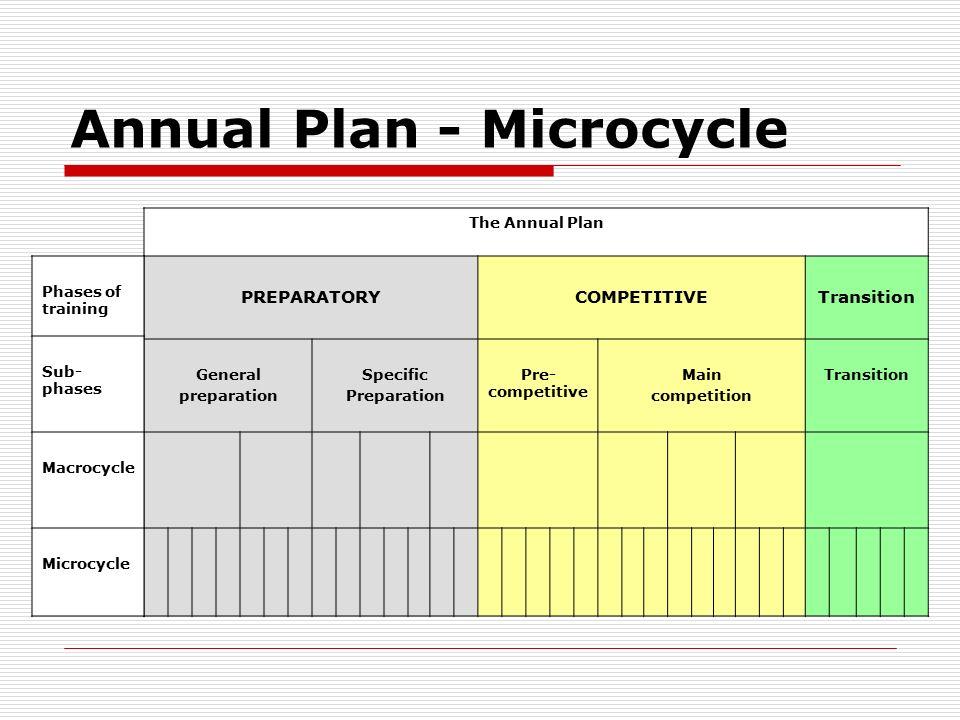
Glossary of key terms

Complete the definitions for the key terms

|  |  |
| --- | --- |
| Term | Definition |
| Adaptation |  |
| Aerobic capacity |  |
| Aerobic work |  |
| Anaerobic work |  |
| Asthma |  |
| Atherosclerosis |  |
| Ballistic stretching |  |
| Basal metabolic rate (BMR) |  |
| Chronic Obstructive Pulmonary Disease (COPD) |  |
| Circuit training |  |
| Continuous training |  |
| Coronary heart disease (CHD) |  |
| Dynamic flexibility |  |
| Explosive strength |  |
| Fartlek training |  |
| FITT |  |
| Heart attack |  |
| High-intensity interval training (HIIT) |  |
| Isometric stretching |  |
| Maximal strength |  |
| Meso-cycle |  |
| Micro-cycle |  |
| Periodisation |  |
| Plyometrics |  |
| Principles of training |  |
| Proprioceptive neuromuscular facilitation (PNF) |  |
| Static active stretching |  |
| Static flexibility |  |
| Static passive stretching |  |
| Strength endurance |  |
| VO2 max |  |
| Work:relief ratio |  |

Periodisation

Use the diagram to help you explain the six main components of a periodised training plan.



Preparation and training methods in relation to improving and maintaining physical activity and performance - Exam Questions

1. Explain how a swimmer would use ‘periodisation’ to prepare for competitions. (4 marks)
2. Some performers break the rules and use banned substances to enhance their  
   performance. Describe the physiological reasons why a performer may use anabolic steroids. (3 marks)
3. The 1500 metres race for men at the 2004 Athens Olympics was won in 3min 34.18s,  
   while the same event for women was won in 3min 57.90s.   
   (a) Identify five structural or physiological characteristics that could account for these differences in times between males and females. (5 marks)
4. Weight training is used by some performers as a method of training because of its effects on the body. Describe five physiological and/or structural changes that occur in the body as a result of a weight-training programme. (5 marks)

**Biomechanics**

|  |  |
| --- | --- |
| Section 1.3.a | Biomechanical principles, levers and the use of technology |
| Biomechanical principles | Define and apply Newton’s laws of motion:   * Newton’s first law: Inertia * Newton’s second law: Acceleration * Newton’s third law: Reaction   Force:   * Net force * Balanced and unbalanced force * Weight * Reaction * Friction * Air resistance * Factors affecting friction and air resistance and their manipulation in sporting performance * Free body diagrams showing vertical and horizontal forces acting on a body at an instant in time and the resulting motion * Calculations of force, momentum, acceleration and weight * Definition of centre of mass * Factors affecting the position of centre of mass * The relationship between centre of mass and stability |
| Levers | Components of a lever system:   * Load * Effort * Fulcrum * Effort arm * Load arm   1st class lever  2nd class lever  3rd class lever  Mechanical advantage of a 2nd class lever |
| Analysing movement through the use of technology | Definitions and uses of:   * Limb kinematics * Force plates * Wind tunnels   How each type of technology may be used to optimise performance in sport. |

Glossary of key terms

Write the definitions for the key terms

|  |  |
| --- | --- |
| Term | Definition |
| Air resistance |  |
| Balanced forces |  |
| Centre of mass |  |
| Force |  |
| Free body diagram |  |
| Friction |  |
| Inertia |  |
| Mechanical advantage |  |
| Mechanical disadvantage |  |
| Net force |  |
| Power output |  |
| Reaction |  |
| Stability |  |
| Streamlining |  |
| Unbalanced forces |  |
| Weight |  |

Newton’s laws of motion

Apply all three of Newton’s laws of motion to a football penalty kick.

Apply all three Newton’s laws of motion to a basketball jump shot.

Apply all three Newton’s laws of motion to a situation in your sport.

Calculations

|  |  |
| --- | --- |
| Term | Equation |
| Velocity |  |
| Momentum |  |
| Acceleration |  |
| Force |  |
| Weight |  |

Friction

Describe the four factors that affect friction.

|  |  |
| --- | --- |
| Roughness of the ground surface | Roughness of the contact surface |
| Temperature | Size of normal reaction |

Air resistance

Describe the four factors that affect air resistance.

|  |  |
| --- | --- |
| Velocity | Shape |
| Frontal cross-sectional area | Smoothness of surface |

Free body diagram

Draw a free body diagram for a) marathon runner travelling at constant velocity b) long-jumper accelerating forwards and upwards at take-off.





Lever Systems

Classification of lever system and a sporting example.

|  |  |  |
| --- | --- | --- |
| Class | Order of components | Sporting example |
| First |  |  |
| Second |  |  |
| Third |  |  |

Mechanical advantage is…

Mechanical disadvantage is…

Biomechanical principles – Exam Questions

1. Using ‘Newton’s First’ and ‘Second Laws of Motion’, explain how a swimmer dives off  
   the starting blocks. (4 marks)
2. During a football game, a performer kicks a ball. Describe the effects of forces on the  
   flight of the ball. (4 marks)
3. Elite golfers use their clubs to overcome the forces acting on the golf ball so that it travels long distances.  
   (a) Describe how the impact of the golf club, gravity and air resistance affect the velocity  
   and acceleration of a golf ball. (4 marks)
4. Explain the term mechanical advantage and apply it to a sporting example of your choice. (3 marks)
5. Using a sporting example of your choice, explain the factors that affect the position of the centre of mass. (4 marks)
6. Draw a free body diagram, showing the forces acting upon a speed-skater accelerating forward. (4 marks)