GCE Physical Education 2016: Component guide 1: Applied anatomy and physiology

Contents

Introduction

The specification has been developed in consultation with the teaching community, higher education, learned societies and subject associations. Tutors from a range of schools and colleges – in focus groups, phone interviews and face-to-face conversations – have given feedback at each stage and have helped us to shape the specification. Physical Education academics in UK universities have helped us understand how to build on the strengths of the 2008 A level specification and advised on how progression to undergraduate study could be improved.

Component guide 1: Applied anatomy and physiology gives an overview of the new specification relating to this topic, to help you get to grips with the changes to content and assessment and to help you understand what these mean for you and your learners.

Overview of changes

From September 2016, GCE Physical Education will be a linear qualification. This means that all examinations must be sat at the end of the two-year course. From September 2016, AS level Physical Education will be a stand-alone qualification. This means that it cannot be used to contribute towards an A level Physical Education grade. More information about the changes to subject content is given later on in the guide.

Each award will have two examinations: a scientific exam and a psychological and social exam. This is a change from 2008. The science examination comprises Topic 1: Applied anatomy and physiology and Topic 2: Exercise physiology and applied movement analysis. A new topic area is biomechanical movement, which is embedded within both the anatomy and the physiology. This is a topic area that was not included in the 2008 specification.

There is an increased focus on the theoretical content, now worth 70 per cent of the grade.

The subject content includes a more detailed need to develop quantitative skills – now worth up to 5 per cent of the qualification.

Learners will need to understand the anatomical/structural and physiological/functional roles performed in the identified systems of the body. They will understand how the controlled stress of exercise will affect the systems and the way that the effect is measured. The topic will cover how different stresses/types of exercise will bring about both acute responses and chronic adaptations.

The principles of Newton's Three Laws of Motion (inertia, acceleration and action/reaction) will also be covered and are essential to a learner's understanding of how sporting technique and performance can be improved. This is a new topic area but is also covered in Component guide 3: Biomechanical movement.

Where AS differs from A level

The key content is covered in both the AS and A level. However, at A level there is an additional topic of **1.4 Energy systems: fatigue and recovery**.

This topic comprises knowledge of energy, energy systems, application of these systems to practical performance and the components of recovery. A Level topics are shown in bold type throughout the booklet.

Key content

1.1 Muscular skeletal system

Topic 1.1.1

Learners will need to know the names and locations of all the muscles and bones that are listed in the specification. They must also understand the movement that would occur at the joints and which muscle caused that movement. There are some examples of questions on this in the Sample Assessment Materials: questions 1a and 2b on the A level Scientific Principles exam.

For example, the bicep brachii and tricep brachii work together as an antagonistic pair at the elbow, when lifting a weight, through flexion and extension.

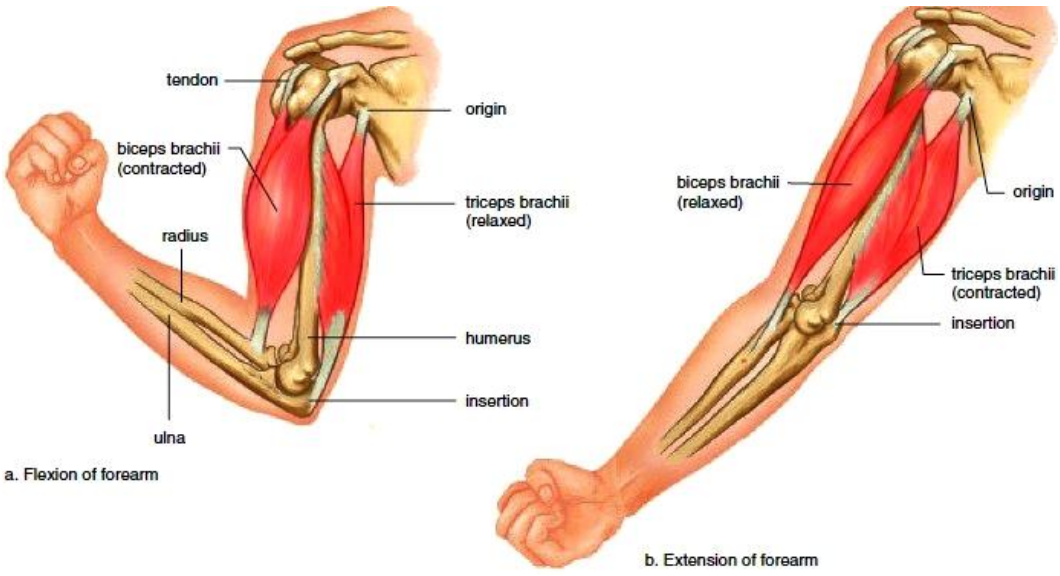


Figure from: http://shannonmcdougall.com/wp-content/uploads/2015/05/bicep.jpg

Resources include:

https://www.youtube.com/watch?v=_q-Jxj5sT0g
This has a helpful clip on the knee joint. It contains more detail than required but is also very useful for injuries. Use the specification as a guide about the level of detail required.

https://www.youtube.com/watch?v=3l3-5lj3JZ8
The start of this clip has a good introduction to the elbow joint. The detail goes beyond what is required in places but is a useful overview.

https://www.youtube.com/watch?v=qlCvKEOZtpo
This includes detail on the hip joint. Use the specification as a guide for content

Topic 1.1.2

The stretch-shortening cycle needs to be taught with the three phases; learners can refer to these as stages 1, 2 and 3 or as eccentric, amortization and concentric. They should understand what happens in each stage and how it allows movement in various physical activities.

This web link may be useful: www.davidpotach.com/stretch-shortening-cycle/.

The different types of muscle contraction will need to be known and applied to sporting examples.

- Isotonic refers to when the muscle is moving –tension remains the same but the muscle length changes, and can be further divided into concentric and eccentric.
- Concentric contractions involve the muscle shortening while contracting, as happens in the bicep during the upward phase of a bicep curl, or in the tricep during the upward phase of a push up.
- Eccentric contraction, on the other hand, involves the muscle lengthening while contracting (remember a muscle is not always relaxing while lengthening) e.g. the bicep brachii in the downward phase of the bicep curl or tricep brachii in the downward phase of the press up.
- Isometric means it stays the same length e.g. when holding a weight in a static position.

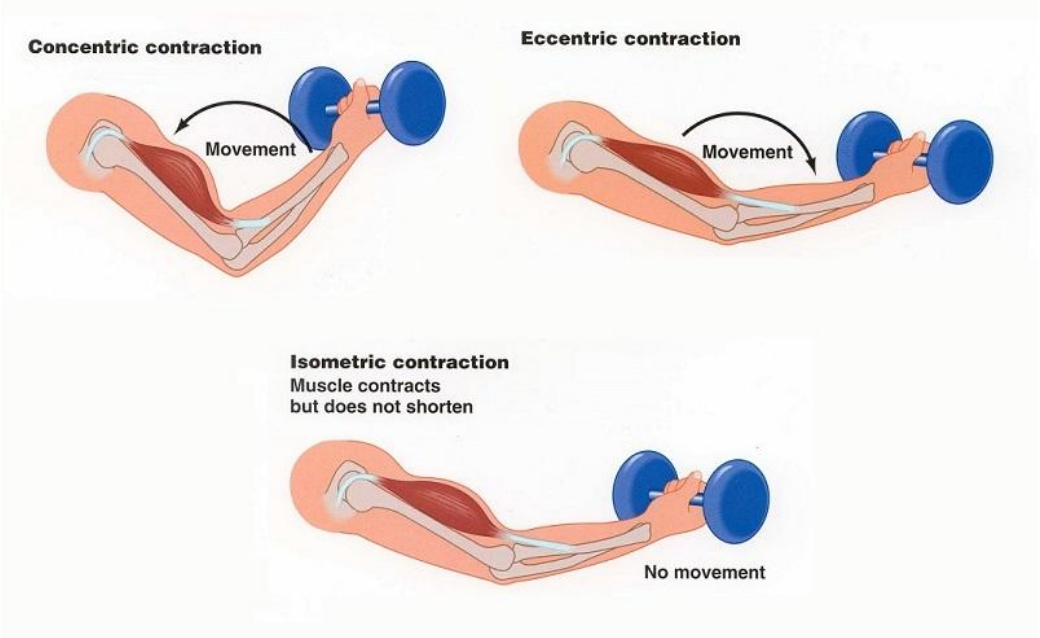


Figure from: http://www.sompare.co.uk/what-makes-muscles-grow-your-guide-to-bigger-muscles/

N.B. Students need to ensure the use of the correct language when describing movement. Muscles contract/shorten/lengthen/relax.

Resources include:

https://www.youtube.com/watch?v=HksMD73sfHU

Please scroll down to find the clip. This provides an explanation together with a practical example.

Topic 1.1.3

Learners must know which type of action is being used in different sporting examples. This links to muscles taking on the different sporting roles of agonist, prime mover, antagonist, fixator and synergist **(definitions of these can be found in the glossary in the appendix of the specification)** and how a muscle can take on these different roles when providing stability or movement in a variety of physical or sporting situations.

This website contains useful explanations of this: www.ptdirect.com/training-design/anatomy-and-physiology/skeletal-muscle-roles-and-contraction-types

The following clip provides details of the four muscle actions:

https://www.youtube.com/watch?v=PGDXXUtPw4A

Topics 1.1.4–1.1.7

The advice on biomechanics (levers, Newton's Three Laws of Motion, etc.) can be found in Component guide 3: Biomechanical movement.

Inside Track Editions 2,3 and 4 also contain useful articles on these topics.

Topic 1.1.8

Learners must understand how the muscular and skeletal systems respond, acutely, both functionally to the stress of warming up and immediate physical or sporting activity. Learners are required to understand how a warm-up will affect performance. They will need to understand how both stretching and cardiovascular exercise can affect performance; this can be positively and negatively.

Learners must understand the difference between the structures and the functions of the muscular skeletal system and be able to link the two together. The terms structural and functional must be understood.

Adaptations must also be covered in this unit. For example, to illustrate the difference between structural and functional terminology, an adaptation to training would be hypertrophy (structural), which enables the athlete to produce more power (functional).

1.2 Cardio-respiratory system and cardiovascular systems

Topic 1.2.1

Learners need a knowledge and understanding of application of the anatomy and physiology of the cardiovascular, circulatory and respiratory systems in physical activity. They must have an understanding of how they function individually and in conjunction with each other. This begins with a thorough understanding of each system first before teaching how they link together to perform activity.

Topic 1.2.2

For the respiratory system learners need to have an understanding of the anatomical structures including the larynx, pharynx, trachea, bronchus, bronchiole and alveoli. An example question is on 2019 question 4.

Resources include:

https://www.youtube.com/watch?v=CdEOQUy_FSw
Overview of the Respiratory System

Topic 1.2.3

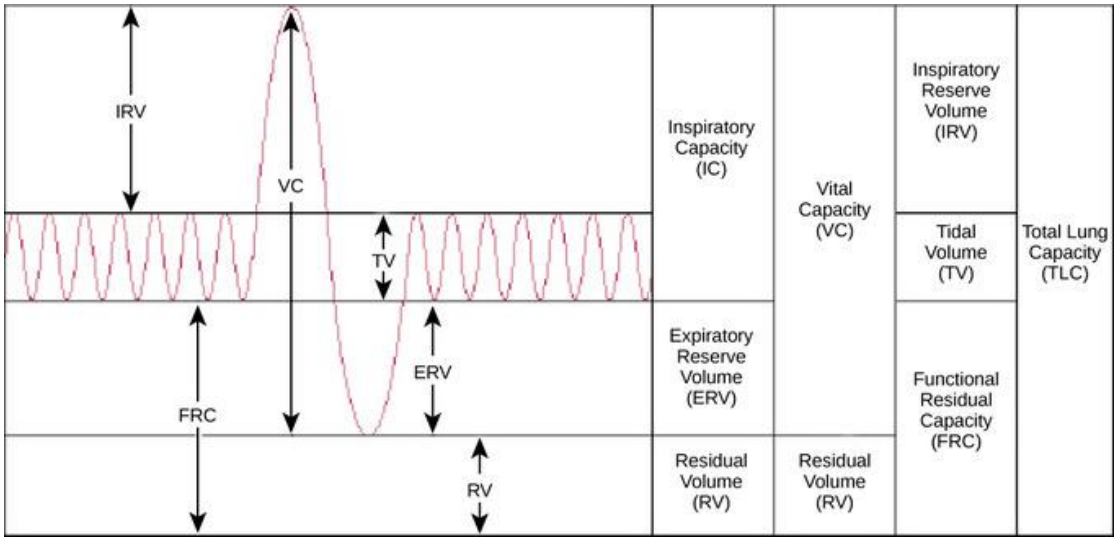
Learners must be able to understand the mechanics of breathing in and out. They must be able to understand the term 'partial pressure' (the individual pressure that a gas exerts when it occurs in a mixture of gases) and then understand what happens to the pressure of the gases as we inspire and expire. Learners must also understand the process of diffusion.

Resources include:

- Wesson, et al. (see references page at the end of this booklet)
- www.people.eku.edu/ritchisong/301notes6.htm
- https://www.youtube.com/watch?v=CdEOQUy_FSw

Topic 1.2.4

Learners must have knowledge of all the respiratory values and capacities: tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, vital capacity, inspiratory capacity, functional residual capacity and total lung capacity. **(Definitions of these can be found in the glossary in the appendix of the specification)**. Learners should be able to describe each value and be able to identify them as depicted on the graph below.



Some useful resources include:

- Wesson, et al. has a detailed section on this for tutors to support their understanding.
- www.boundless.com/biology/textbooks/boundless-biology-textbook/the-respiratory-system-39/gas-exchange-across-respiratory-surfaces-220/lung-volumes-and-capacities-834-12079/ also has clear examples of the volumes.
- https://www.youtube.com/watch?v=QJcAJHFqXZg

This clip explains lung volumes explanation, although teachers should be aware that the last two are not included on the specification.

Topic 1.2.5

Learners will need to be able to understand where all the key features of the cardio vascular system are located. They will need to be able to locate all the structures and to be able to show understanding of the structure (what it is) and function (the job it does). The anatomical components and structure of the cardiovascular system will need to include, the heart (atria, ventricles, valves, septum, atrioventricular (AV) and sinoatrial (SA) nodes, myocardia) blood, and blood vessels (arteries, veins, and capillaries). This includes the structure of the blood vessels.

Learners are expected to accurately name the structures and describe the function of each.

- https://www.youtube.com/watch?v=RYZ4daFwMa8
- https://www.youtube.com/watch?v=VWamhZ8vTL4

This resource provides an overview of the CV system parts as an introduction to the topic; especially helpful for those who did not study GCSE PE

Topic 1.2.6

Learners will also be expected to understand the physiology of the cardiovascular system with regards to the cardiac cycle, systemic and pulmonary circulation, venous return, vascular shunting, heart rates, (resting, working, maximum, heart rate reserve and recovery), stroke volume, cardiac output, end diastolic and end systolic volumes. Karvonen's theory is also included in this section as it makes sense to teach it whilst teaching about the physiology of the cardiovascular system.

Target Heart Rate = ((max HR − resting HR) × %Intensity) + resting HR example

https://www.youtube.com/watch?v=jLTdgrhpDCg

Karvonen's theory will need to be taught so that heart rate reserve is understood. Have a look at the Sample Assessment Materials A level paper, Question 9bii. The mark scheme goes through a worked example of how to calculate heart rate reserve. This also links to the exercise physiology section. Please see Topic 2.2.8.

Useful resources include:

- https://www.youtube.com/watch?v=DAXa4eR1s0M
  Physiology of the heart

- https://www.youtube.com/watch?v=3JPbpYFhNI4
  Please scroll down to find the link to this clip which covers HR, SV and Q

- https://www.youtube.com/watch?v=QIEIH6_mC1Q
  Systemic and Pulmonary Circulation

- https://www.youtube.com/watch?v=jLTdgrhpDCg
  Systole and Diastole volumes

Topic 1.2.7

Learners need to know that bradycardia is a resting heart rate of under 60 beats per minute. Trained athletes tend to have slower resting heart rates. Learners need to be able to understand why it may be beneficial and how, anatomically and physiologically, it may occur. This knowledge will need to link back to the physiology of cardiac output and heart rate.

Topic 1.2.8

Learners need to be able to understand the cardio-respiratory and cardiovascular systems and how they respond acutely, both structurally and functionally, to the stress of warming up and immediate physical or sporting activity. Learners need to discuss the anatomical change to structure and the effect it has on the function and performance.

For examples of this, please see the Sample Assessment Materials which include a question on this. The mark scheme has several examples – question 5b in the A level question paper. There is an example in 2019 paper Q07.

Topic 1.2.9

Learners need an understanding of what constitutes an unhealthy lifestyle and its effects on the cardiovascular and cardio-respiratory systems. This could include the effects of alcohol and smoking on the cardio-respiratory system, the effects of a sedentary lifestyle on the cardiovascular system e.g. high blood pressure, high cholesterol and their effect on heart and blood vessels. Diet leading to high blood pressure would also play a part in this section. There is a detailed answer on this in the Sample Assessment Materials paper and mark scheme, question 6, which shows the kind of detail required.

Useful resources include:

- https://www.youtube.com/watch?v=ll3bSP5l5KM
  Exercise and Coronary Heart disease

- https://www.youtube.com/watch?v=pJo3ouT9CKg
  The heart and smoking

1.3 Neuro-muscular system

Topic 1.3.1

Learners need a knowledge, understanding and application of the anatomy and physiology and the function of the neuro-muscular system during physical activity.

Topic 1.3.2

Learners need to understand the characteristics and anatomical make-up of the different fibre types: slow twitch (type I), fast oxidative glycolytic (IIa) and fast glycolytic (type **IIx**, formerly known as IIb). This means they need to understand what their characteristics are and which activities they are most suitable for.

See web link for a useful summary of characteristics:
https://www.google.co.uk/search?q=characteristics+of+fibre+types&biw=1366&bih=673&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMI7rng-J7PyAIVg74UCh3iAAWG#tbm=isch&q=characteristics+of+muscle+fibre+types+table&imgrc=mC-XUVcliBrRQM%3A

Some examples are:

Characteristic	Slow twitch type 1 fibre	Intermediate type 2A fibre	Fast twitch type 2X fibre
Diameter	Small	Intermediate	Large
Motor neurone size	Small	Large	Large
Nerve conduction	Slow	Fast	Fast
Contractile speed	Slow	Fast	Fast
Fatigue resistance	High	Moderately high	Low
Motor unit strength	Low	High	High
Oxidative capacity	High	Moderately high	Low
Glycolytic capacity	Low	High	High
Capillarity	Dense	Dense	Sparse
Myoglobin content	High	Intermediate	Low

Adapted from Bruton A (2002) Muscle plasticity: Response to training and detraining. Physiotherapy, 88(7): 399.

Table 12.3 | Characteristics of Muscle Fiber Types

Feature	Slow Oxidative/Type I (Red)	Fast Oxidative/Type IIA (Red)	Fast Glycolytic/Type IIX (White)
Diameter	Small	Intermediate	Large
Z-line thickness	Wide	Intermediate	Narrow
Glycogen content	Low	Intermediate	High
Resistance to fatigue	High	Intermediate	Low
Capillaries	Many	Many	Few
Myoglobin content	High	High	Low
Respiration	Aerobic	Aerobic	Anaerobic
Oxidative capacity	High	High	Low
Glycolytic ability	Low	High	High
Twitch rate	Slow	Fast	Fast
Myosin ATPase content	Low	High	High

Topic 1.3.3

Learners should understand the different structure of each fibre type: how it facilitates their physiology and affects their suitability for particular types of physical activities.

Useful resources include:

- https://www.youtube.com/watch?v=R7OyvHcKaHU

A montage of footage to generate discussion on fibre types used in different sports and how their physiology links to different activities.

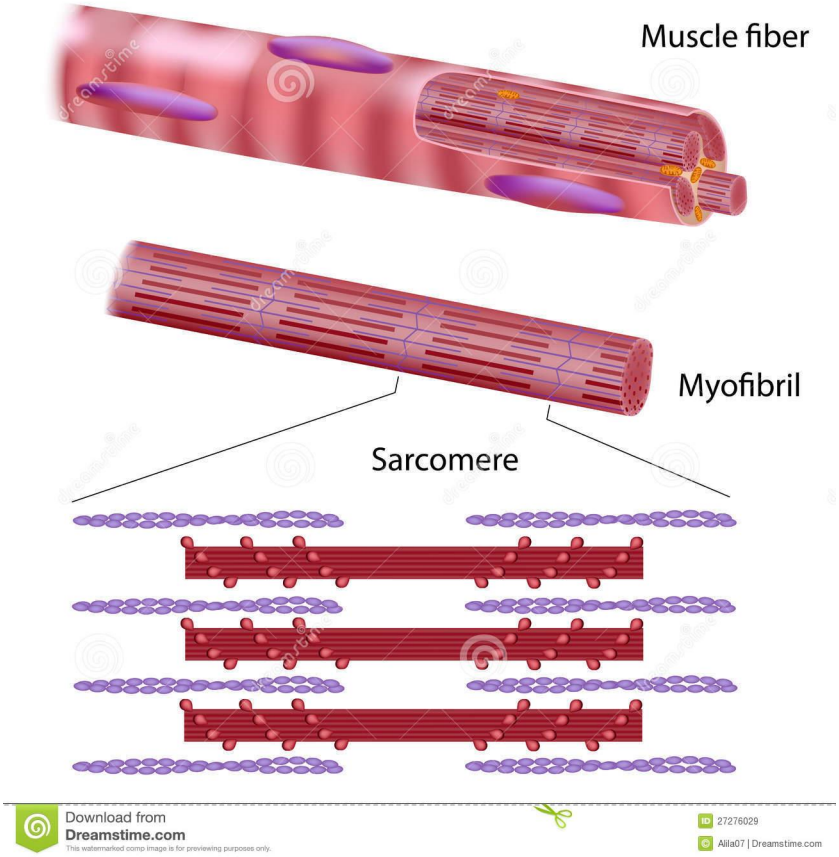
Topic 1.3.4

Learners need to have knowledge of fibre recruitment patterns for endurance and power-based events, and how specific training can enable athletes to gain control over the recruitment pattern. The patterns learners need to understand are multiple wave summation, tetanic contraction and spatial summation.

Topic 1.3.5

Learners need to understand the anatomy of the neuro-muscular system, including the central nervous system, muscle fibres, myofibrils, sarcomere, motor units, motor neurones and neuro-muscular end plates, the protein filaments of actin and myosin and the roles of globular proteins of troponin and tropomyosin.

See website for useful image: http://www.dreamstime.com/royalty-free-stock-images-structure-skeletal-muscle-fiber-image27276029



Topic 1.3.6

Learners must understand the physiology of a muscular contraction from a nervous impulse to a muscular response. This includes the neuro-muscular transfer, sliding filament theory and the all or none law.

Learners would be expected to understand all the terms on this diagram except for the junctional folds of the sarcolemma at the motor end plate.

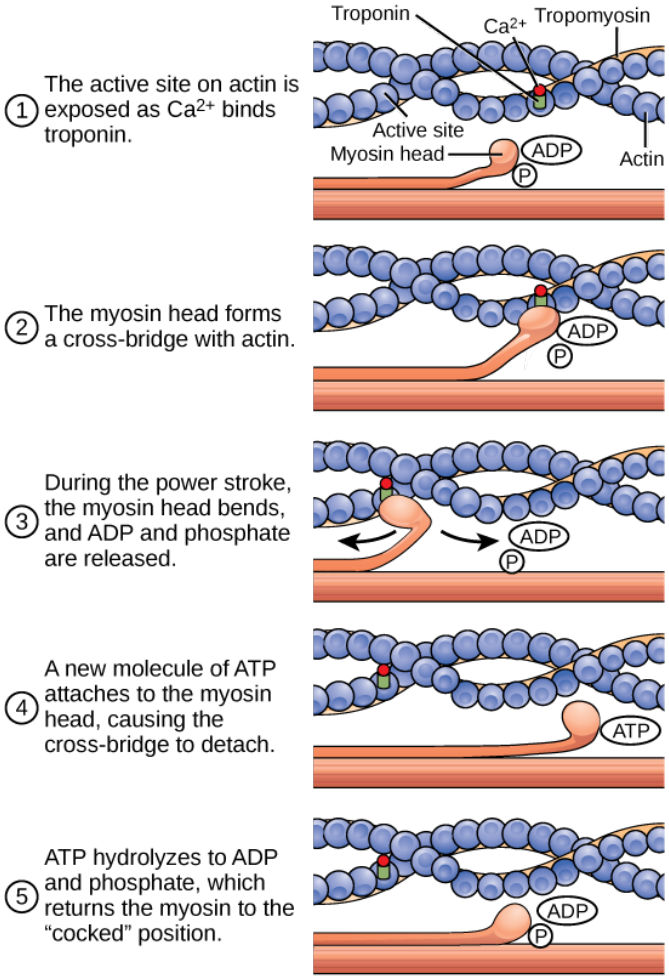
The all or none law is that 'all the muscle fibres within the unit will contract at the same time and to the maximum possible extent'.

Learners will need to understand the electrical impulse begins at the brain and are transmitted to a muscle via the spinal cord. Motor neurones (nerve cells) can only stimulate the muscle fibres attached to them (a motor unit). The point at which the nerve meets the muscle fibre is the motor end plate and forms the neuromuscular junction. An action potential travels down the nerve to the synaptic knob causing acetylcholine to be released.

This aids the spread of the impulse across the synaptic cleft. If the muscle fibre gains an action potential, this triggers the stages of muscle contraction. (This section is in the specification as 'The physiology of a muscular contraction from a nervous impulse to a muscular response'.)

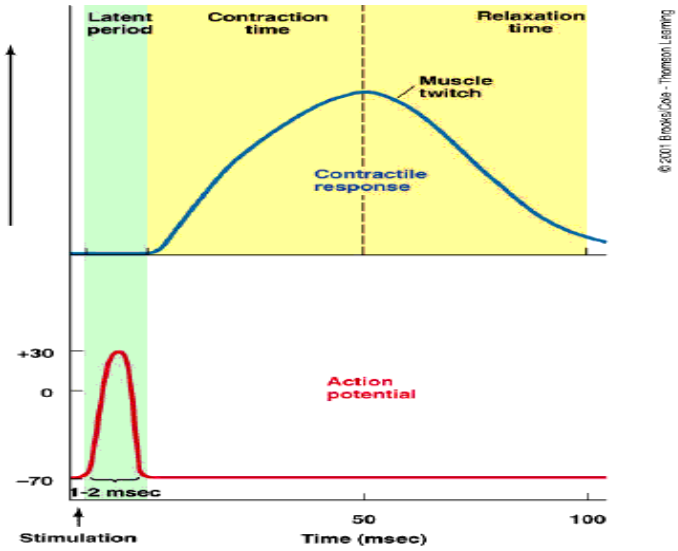
The five stages of a muscle contraction that should be taught are resting, excitation, contraction, re-charge and relaxing.

The contraction phase contains the following detail as in the image: https://courses.lumenlearning.com/boundless-biology/chapter/muscle-contraction-and-locomotion/



Learners need an understanding of wave summation and gradation of contraction. This is the idea that the frequency that impulses arrive at the muscle fibres affects the contraction force. The motor unit gives a twitch when stimulated and this causes a brief period of contraction followed by relaxation. When a second impulse is applied to the motor unit before it relaxes from the previous one this increases the contraction, known as wave summation.

Learners should be able to comment on a graphical image of these contractions if presented with one. For example:



http://csmbio.csm.jmu.edu/biology/danie2jc/muscles/muscles.htm

Useful resources include:

- https://www.youtube.com/watch?v=BVcgO4p88AA

This covers helpful information on muscle contractions.

Topic 1.3.7

Learners also need an understanding of how the neuro-muscular system responds acutely, both structurally and functionally to the stress of warming up and immediate physical or sporting activity. Structure is the anatomical make-up of the system and function is how it affects performance. For example, a slow twitch muscle fibre contains more mitochondria (structure) this allows it to fatigue less quickly in performance (function).

Topic 1.3.8

Learners need to understand the chronic adaptations of all of the cardio-respiratory, cardiovascular, muscular skeletal and neuro-muscular systems to training. This means the effects over time. It would be a good idea for learners to link this to the types of training (knowledge required under exercise physiology) and to link this to aerobic and anaerobic systems. For example, the heart undergoes hypertrophy, which could be brought about by completing interval or continuous training.

1.4 Energy systems: fatigue and recovery

Topics 1.4.1 and 1.4.2

Learners will need an understanding of energy (the capacity to perform work), the processes by which it is regenerated (the three energy systems), how depletion occurs and the recovery process (including EPOC). This all needs to be linked to sporting events, for example how fatigue occurs when using each energy system and the time taken for recovery from this fatigue.

Topic 1.4.3

Learners need to be taught the forms of energy including: mechanical, electrical, potential, chemical and kinetic, and be able to give an example of each. For example, when a message travels along a motor neurone it is electrical, and it changes to chemical as it passes through the synaptic cleft.

The role of energy as adenosine triphosphate (ATP) in muscular contraction and the use of phosphocreatine (PC), glycogen and fat as sources for ATP re-synthesis. This will include practical application of the type of activities that would utilise the different energy sources.

Topic 1.4.4

Learners will be expected to have a knowledge and understanding of the three energy pathways. The characteristics and physiology of the three energy pathways (ATP-PC, glycolytic and aerobic) will need to be taught.

Some resources with explanations of these pathways:

- www.ptdirect.com/training-design/anatomy-and-physiology/the-atp-pc-system **has a good explanation of the ATP-PC system.**
- www.ptdirect.com/training-design/anatomy-and-physiology/the-anaerobic-glycolytic-system-fast-glycolysis **looks at glycolytic system.**
- www.ptdirect.com/training-design/anatomy-and-physiology/the-aerobic-system **shows a summary of the aerobic system.**

Topic 1.4.5

As learners study each energy system they will need to consider the characteristics of the three pathways with regards to rate of ATP re-synthesis, the intensity and duration of exercise supported by each as the dominant energy provider and the regeneration of ATP

for each pathway. For example, PC stores are able to re-synthesise ADP to ATP for 8-10 seconds of maximal intensity exercise.

Topic 1.4.6

Learners will need to understand the principle of the energy continuum when based around athletic running events as performed by elite athletes. These values are different to previous specifications and old values will not be accepted. There is an article on this in inside track 5.

NB It is the duration of activity not distance covered that determines the energy sources. For example, Mo Farah will run 3000m in about 7m30s however a GCSE learner might run 1500m in that time. They would both be using a similar percent aerobic/anaerobic.

Distance	200	400	800	1500	5000	10000
Time	22	49	1m53	3m55	14m00	30m00
% aer	29	43	66	84	95	97
% an	71	56	34	16	5	3

Therefore, it is the timings of the event in this table that determine the energy system used.

Justification can be based on tactics as well as timings. There is an example of this in the Sample Assessment Material question 4b on the A level Scientific Principles paper. Please use the continuum in the table above.

Topics 1.4.7 and 1.4.8

Learners should be able to show knowledge and understanding of the use of the continuum as a medium to support understanding of the joint and collaborative role of the three energy pathways in physical activity. Use of different activities in addition to the ones in the table above can be used to support points made. Positioning of athletic events is dependent on the time it is run in – see table above for clarification. You cannot just say an event is aerobic or anaerobic; you need to know how quickly it is run. For example, a school level 1500m runner may take 5 minutes whereas an elite runner will complete it quicker. The percentage use of the systems will differ, therefore a 1500m is not always at a set point on the continuum.

Topic 1.4.9

Learners should be able to show knowledge and understanding of the concept of fatigue and factors that contribute to fatigue: energy depletion, dehydration and the build-up of waste products (which should include an exploration of the role of lactate in

performance). For example, lactate is converted back to pyruvate in the muscle, or glucose in the liver and utilised in performance. The role of lactate should include the oxidation (pyruvate or glucose), conversion to glycogen during recovery and protein. Sample question found in 2019 past paper question 12.

Topic 1.4.10

Stages of recovery (fast and slow components). Both these elements will need to be taught and an understanding of what happens in each phase. For example, the removal of lactate and restoration of muscle glycogen occur in the slow component while the restoration of PC and reloading of myoglobin with oxygen occur in the fast component. Learners should be able to describe the different stages and identify them on diagrams.

Topic 1.4.11

The fast component of recovery and re-phosphorylation: the speed and rate of phosphagen replenishment and the resaturation of myoglobin. These are all elements occurring in the fast phase. For example, it takes approximately 3 minutes to replenish the phosphagen system.

Topic 1.4.12

The slow component of recovery: the oxidation of lactate (removal of lactate and H+), replenishment of glycogen stores and the two-hour window of opportunity (re-hydration, physical cooling and thermoregulation), the 48-hour window of opportunity (re-synthesis of protein, glycogen and carbohydrate (CHO), exercise induced muscle damage (EIMD) and delayed onset muscular soreness (DOMS)). All of these elements occur in the slow component. Eating carbohydrate-based foods within 48 hours and remaking protein and glycogen all take time. The effect on training of EIMD and DOMS would need to be considered.

Useful articles on EIMD:

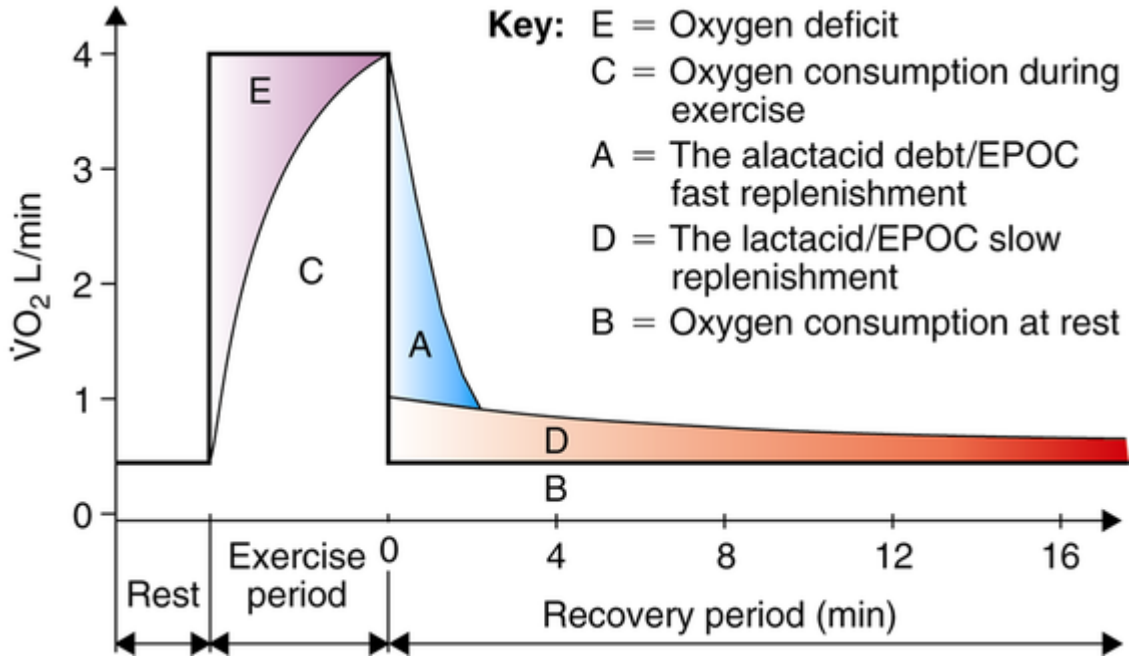
- www.bjsm.bmj.com/content/37/2/119.full
- www.ncbi.nlm.nih.gov/pubmed/18489195

These will enhance tutors understanding of the topic, but learners will only be expected to know the terms and discuss why it occurs.

Topic 1.4.13

EPOC (excess post-exercise oxygen consumption) and the fast and slow stages of recovery. Learners should understand the components of EPOC, such as restoration of the oxy-myoglobin link, and elevated heart and respiratory rates. The slow component removes lactate and the fast component restores ATP and PC.

See image: http://twynhamschoolalevelpe.weebly.com/recovery.html



Topic 1.4.14

Learners will need to be able to interpret graphs of recovery, such as that above, and to understand how the energy systems respond acutely to the stress of warming up/priming exercise (a prior bout of high intensity exercise before high intensity exercise to accelerate oxygen uptake). Priming exercise will also need to be taught under warming up.

Inside track Edition 1 contains a useful article on priming exercise.

Useful textbooks and websites are also included at the end of this guide.

Detailed content changes

The major differences between 2008 and 2016 are in the level of detail required in the topic. Theory is now worth 70 per cent so there is an increased content detail.

The 2008 specification required specific knowledge of adaptations and responses of the body systems. In understanding the adaptations of the systems, the systems had to be taught, but it was not prescribed in so much detail as it is now which elements had to be included. The 2016 specification is in a lot more detail so tutors should be able to see the depth that they need to go into. Responses and adaptations are still included in this topic area. The only big change is the inclusion of Biomechanical movement.

1.1 Muscular skeletal system

Specific muscles, bones, joints and movements must be taught but all that should be known are named in the specification to prevent any confusion.

Different types of muscle contraction must be known, as well as the roles a muscle takes on during the movement. Both of these topics were probably covered by centres before although they were not explicit in the 2008 specification.

The completely new topic in this area is Newton's Three Laws of Motion and their application to sporting contexts. This is an area where quantitative skills are likely to be addressed. This topic area also encompasses centre of mass and calculating forces. 'Calculate' is a question that can be asked in an exam, which is a change in style from 2008. There is a separate topic guide on this topic.

Note that IIX is the new name for IIB fibre types. Responses and adaptations to this system remain in the specification.

1.2 Cardio-respiratory and cardiovascular systems

The specific structure and function of named structures in the respiratory system and the process of ventilation are included. Respiratory values and capacities need to be taught.

The structure of the heart, blood and blood vessels are included, as is the physiology of the heart – this section now also includes the cardiac cycle. Again, many centres included this in 2008 to address adaptations but it is now explicit. There is an article on teaching this in inside track 6.

Responses and adaptations to the system remain in the specification.

1.3 Neuro-muscular system

Elements that were taught in 2008 to address adaptations included the fibre types, fibre recruitment, CNS and physiology of a muscle contraction. Each element is now explicit in its inclusion.

Responses and adaptations to this system remain in the specification.

At GCE level there is also **1.4 Energy systems: fatigue and recovery**. 'Forms of energy' is an addition to the 2008 specification. The three energy systems remain, as does the energy continuum, but this must be the **updated version** as in the guidance in this document (fatigue and recovery: duration of activity not distance covered as in the blue table above). This section is largely unchanged from the 2008 specification. The preferred name for the Lactic Acid system is now the Glycolytic system and candidates should refer to lactate and hydrogen ions rather than lactic acid.

Delivery approaches including ideas for practical delivery

This unit lends itself to a practical approach as much as possible.

Topic	Ideas for delivery
Muscles, bones, joints, movement	• Simon Says using muscle names and movements. • Blindfold your partner and get them to replicate your exact movement or skill using just technical terminology. • Human mannequin or use of a skeleton. • Class become a muscle and use each learner as a part of the model/act out the parts.
Newton's Three Laws of Motion	• There is more detail on this in Component guide 3: Biomechanical movement. • Trampolining as a way of demonstrating action/reaction. • Video clips of elite athletes.
Calculating forces	• There is more detail on this in Component guide 3: Biomechanical movement. • Using practical scenarios and then calculating real life examples.
Responses to all systems	• Practical investigations into the effects of warming up.

Structure and function of respiratory system	• Lung dissection. • Lung capacity practical investigations. • Use of bell jar.
Anatomy of CV system	• Heart dissection. • Practical investigation into effects of sport on heart, blood and blood vessels. • Heart rate reserve calculations. • Learners calculating their own values. • Use a flip cam to make a film to explain how the heart works to another group.
Neuro-muscular system anatomy	• Make a working model of nervous system into a muscle contraction, or make your own YouTube clip explaining how it works.
Energy systems	• Practical investigations about intensity and duration in different sports. • Create a working model of each system. • Placing sporting events on to the continuum and discussing where they are placed and why they have been put there. • Watching clips of different athletics events and discussing what happens during the event and in recovery. • You tube clips as per references

Quantitative skills guidance

There are several topics in this section that lend themselves to quantitative skill, most notably calculating forces in the biomechanical movement section. Note the inclusion of a 'calculate' question as an example of a command word that could now be used – its definition being: 'Obtain a numerical answer, showing relevant working. If the answer has a unit, this must be included.'

Any opportunity for learners to practice calculation questions and viewing information in a quantitative format to be able to interpret it should be taken, such as tables of information viewing information in a graphical format, so that they are familiar with quantitative styles of question. Examples of lessons include, for example, interpreting graphs of pressure gradients, calculation of heart rate reserve and calculating forces.

Sample questions

Regular testing of learners on the key terms in the glossary that are part of the specification is important (see Appendix 7, page 88).

When practising questions ensure that you are using the command words in the specification and that learners understand the requirements of each command word.

To ensure understanding questions could be given to learners starting:

- The muscular skeletal system responds…
- The neuro-muscular system adapts…
- A muscle contracts when…
- A warm up causes…

There are examples of questions in the sample assessment materials. In the A level SAMS these are questions from this topic: 1a, 1b, 1c, 2b, 2b, 3, 4ai, 4aii, 4b, 5a, 5b and 6. It is always section A of the Scientific Principles paper, as this is the anatomy and physiology section.

In the AS SAMs paper, again under Scientific Principles paper and Section A, the questions are 1, 2, 3, 4, 5, 7 and 8.

There are also now Past Papers, Mark Schemes and Principal Examiner Reports with exemplar answers available for both AS and A level which are also extremely useful teaching tools.

Resources and references

Useful textbooks

- Beashel, P. and Taylor, J. (1999) *Advanced studies in Physical Education and Sport*, Cheltenham: Nelson Thornes.
- Davis, R., et al. (2000) *Physical Education and the Study of Sport*, St. Louis, MO: Mosby
- Honeybourne, J., Hill, M. and Moors, H. (2004) *Advanced Physical Education and Sport for A Level (Third Edition)*, Cheltenham: Nelson Thornes.
- Kent, M. (2007) *Oxford Dictionary of Sports Science and Medicine*, Oxford: OUP
- Tortora, G. and Derrickson, B. (2012) *Essentials of Anatomy and physiology*, Chicester: John Wiley and Sons
- Wesson, K., et al.(2005) *Sport and PE: A Complete Guide to Advanced Level Study (Third Edition)*, London: Hodder Education
- Wilmore, J. and Costill, D. (2005) *Physiology of Sport and Exercise*, Champaign, IL: Human Kinetics Publishers

Useful websites

- Stretch shortening cycle: www.davidpotach.com/stretch-shortening-cycle/
- Muscle roles and contraction types: www.ptdirect.com/training-design/anatomy-and-physiology/skeletal-muscle-roles-and-contraction-types
- Respiratory system: www.people.eku.edu/ritchisong/301notes6.htm
- Lung volumes and capacities: www.boundless.com/biology/textbooks/boundless-biology-textbook/the-respiratory-system-39/gas-exchange-across-respiratory-surfaces-220/lung-volumes-and-capacities-834-12079/
- ATP system: www.ptdirect.com/training-design/anatomy-and-physiology/the-atp-pc-system
- Anaerobic glycolysis (lactic acid system): www.ptdirect.com/training-design/anatomy-and-physiology/the-anaerobic-glycolytic-system-fast-glycolysis
- Aerobic system: www.ptdirect.com/training-design/anatomy-and-physiology/the-aerobic-system
- EIMD: www.bjsm.bmj.com/content/37/2/119.full
- EIMD: www.ncbi.nlm.nih.gov/pubmed/18489195

YouTube – in more detail than required – but good background for teachers or as an overview for students.

- https://www.youtube.com/watch?v=4201SrN0WlY muscle contraction
- https://www.youtube.com/watch?v=CdEOQUy_FSw Mechanics of Breathing
- https://www.youtube.com/watch?v=RYZ4daFwMa8 Cardiovascular System
- https://www.youtube.com/watch?v=8wa04qYsaps Muscle contraction