

Unit 2: The Physiology of Fitness

Unit code:	R/502/5486
QCF Level 3:	BTEC National
Credit value:	5
Guided learning hours:	30

● Aim and purpose

This unit provides an opportunity for learners to explore the body's response to acute exercise and how the body adapts to long-term exercise participation.

● Unit introduction

You will have no doubt experienced the effects of exercise on your body; your heart beats faster and your breathing rate increases, but have you ever wondered what else is happening inside your body to allow you to perform physical activity and exercise?

The body has a number of systems that work together to allow you to take part in exercise by increasing the oxygen and energy supply to your muscles. In this unit you will learn about how these body systems respond to exercise in both the short and the long term.

Many jobs in the sports industry require a good level of understanding of how the body reacts to exercise, for example, personal trainers, football coaches and fitness instructors. This unit provides the underpinning knowledge for progression into these types of careers.

This unit explores the musculoskeletal, cardiovascular and respiratory systems responses to exercise. All three energy systems that provide energy for exercise participation are also covered together with the energy continuum. Learners will have the chance to investigate the effects of exercise on each of the body systems by taking part in practical activities and conducting physiological tests to help 'see' for themselves how each of the body systems reacts.

The unit then goes on to explore how the body adapts to long-term exercise participation to help make a person fitter and more able to cope with the stresses of exercise. Again, there will be a practical investigation into the physiology of exercise participation which will help learners to explore how the musculoskeletal, cardiovascular, respiratory and energy systems become more efficient in response to different types of exercise.

● Learning outcomes

On completion of this unit a learner should:

- 1 Know the body's response to acute exercise
- 2 Know the long-term effects of exercise on the body systems
- 3 Be able to investigate the physiological effects of exercise on the body systems.

Unit content

1 Know the body's response to acute exercise

Musculoskeletal response: increased blood supply; increase in muscle pliability; increased range of movement; muscle fibre micro tears

Energy systems: phosphocreatine; lactic acid; aerobic; energy continuum; energy requirements of different sport and exercise activities

Cardiovascular response: heart rate anticipatory response; activity response; increased blood pressure; vasoconstriction; vasodilation

Respiratory: increase in breathing rate (neural and chemical control); increased tidal volume

2 Know the long-term effects of exercise on the body systems

Cardiovascular system: cardiac hypertrophy; increase in stroke volume; increase in cardiac output, decrease in resting heart rate; capillarisation; increase in blood volume; reduction in resting blood pressure; decreased recovery time; increased aerobic fitness

Muscular system: hypertrophy; increase in tendon strength; increase in myoglobin stores; increased number of mitochondria; increased storage of glycogen and fat; increased muscle strength; increased tolerance to lactic acid

Skeletal system: increase in bone calcium stores; increased stretch in ligaments; increased thickness of hyaline cartilage; increased production of synovial fluid

Respiratory system: increased vital capacity; increase in minute ventilation; increased strength of respiratory muscles; increase in oxygen diffusion rate

Energy systems: increased aerobic and anaerobic enzymes; increased use of fats as an energy source

3 Be able to investigate the physiological effects of exercise on the body systems

Types of exercise: eg aerobic, resistance, circuit, interval

Methods of investigation: comparison of pre-exercise, exercise and post-exercise physiological readings, eg resting heart rate, exercise heart rate, percent heart rate maximum, percent heart rate reserve maximum, Rating of Perceived Exertion, blood pressure, flexibility tests, spirometry

Review: effects of exercise on the body systems (acute and long-term); pre-exercise, exercise and post-exercise physiological data; practicality of exercise activities selected; advantages and disadvantages; strengths and areas for improvement

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 describe the musculoskeletal and energy systems response to acute exercise	M1 explain the response of the musculoskeletal, cardiovascular and respiratory systems to acute exercise	
P2 describe the cardiovascular and respiratory systems responses to acute exercise		
P3 describe the long-term effects of exercise on the musculoskeletal system and energy systems	M2 explain the long-term effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems	
P4 describe the long-term effects of exercise on the cardiovascular and respiratory systems		
P5 collect physiological data to investigate the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems, with tutor support [IE2, IE4, CT5, CT6, RL3]	M3 collect physiological data to investigate the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems, with limited tutor support	D1 independently investigate the physiological effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems
P6 review physiological data collected, describing the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems. [RL3, RL5, RL6]	M4 review physiological data collected, explaining the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems.	D2 review physiological data collected, analysing the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

This is primarily a practical unit where learners will investigate how the body responds to exercise. Learners may participate or observe others performing exercises in order to assess the body's response.

It is possible to combine theory with practical investigation for exploring both the body's response to acute exercise and the long-term effects of exercise on the body systems.

A wide range of delivery methods can be used, including lectures, presentations, video, worksheets and internet research tasks. Learners can start the practical elements of the unit by taking pre-exercise physiological measurements, for example resting heart rate, resting blood pressure, resting breathing rate. Learners can then take part in different exercises and retake these measurements. An analysis of the pre-, during and post-exercise results will show learners that the body has responded to exercise in a variety of different ways. Learners can then be taught the theory behind how each body system has responded to exercise, and apply their learning to the physiological data collected.

For the long-term effects of exercise on the body systems, if time and facilities are available, learners could take part in a six-week exercise training programme. Half of the class could take part in a strength training programme and the other half could take part in an aerobic training programme. Pre- and post-programme physiological tests will need to be performed. Learners can then feedback their results to the group and average changes to the body systems for each type of training programme can be discussed. Delivery of this part of the unit could be integrated with other practical units in this programme of study.

For the investigation and review of the physiological effects of exercise on the body systems, learners can select appropriate methods of practical investigation; the exercise selection is only limited by availability of facilities and equipment. Pre-exercise, exercise and post-exercise physiological data should be collected and reviewed. Through the data review learners should be able to discuss and identify the effects that the exercise has had on the different body systems.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Tutor introduces the unit
Assignment 1: The Body's Response to Acute Exercise (P1, M1, P2).
Tutor introduces the assignment brief
Musculoskeletal system response to acute exercise – learner practical activities and theory
Cardiovascular system response to acute exercise – learner practical activities and theory
Respiratory system response to acute exercise – learner practical activities and theory
Energy systems response to acute exercise – learner practical activities and theory
Methods of investigating acute exercise – learner practical activities in small groups
Assignment 2: The Body's Response to Chronic Exercise (P3, P4, M2).
Tutor introduces the assignment brief – practical and theory
Musculoskeletal response to long-term exercise – learner practical activities and theory
Cardiovascular response to long-term exercise – learner practical activities and theory
Respiratory response to long-term exercise – learner practical activities and theory
Assignment 3: The Effects of Exercise on the Body (P5, M3, D1, P6, M4, D2).
Tutor introduces the assignment brief
Energy systems response to long-term exercise – learner practical activities and theory
Investigate the physiological effects of exercise on the body: learner practical assessments and observations – testing, data collection and results analyses
Review of unit and assessment activities

Assessment

For P1, learners need to describe the responses of the musculoskeletal and energy systems to a single bout of exercise. They will need to include how muscle responds to exercise including the increased blood supply and also the effects of resistance exercises which includes micro tears. Each of the energy systems should be described and their contribution to exercise as the exercise bout continues over a period of around 30 minutes.

For P2, learners need to describe how the cardiovascular and respiratory systems respond to a single bout of exercise. This should also include the pre-exercise effects which occur in the heart. Learners should explore the effects over an exercise period of around 30 minutes so that steady state has been attained.

For P3, learners need to describe the adaptations of the musculoskeletal system and energy systems to long-term exercise such as a six-week training programme.

For P4, learners need to describe the adaptations of the cardiovascular and respiratory systems to long-term exercise such as a six-week training programme.

For P5, learners will have received tutor support whilst setting up and collecting physiological data from an investigation. Learners should select at least two different types of exercise in order to determine how the different types of exercise result in differing adaptations. Learners should also examine the acute response to their selected exercises as well as the long-term effects of exercise. Physiological data should be recorded pre-, during and post-exercise.

For P6, learners need to examine the data collected and review the results by describing how the body responds to each type of exercise during the acute phases and also the long-term effects of the selected exercises. Learners need to review physiological data collected before, during and post-exercise. Consideration should also be given to the practicality of the exercise activities selected, and any advantages or disadvantages encountered during data collection. Learners should be able to describe the strengths and areas for improvement of their investigation.

For M1, learners need to explain the responses of the musculoskeletal, cardiovascular and respiratory systems to a single bout of exercise. They will need to include how muscle responds to exercise including the increased blood supply and also the effects of resistance exercises which includes micro tears. Cardiovascular and respiratory responses should be explained; learners should give reasons and provide the physiological evidence to clearly support their explanation.

For M2, learners need to explain the adaptations of the musculoskeletal, cardiovascular, respiratory and energy systems to long-term exercise such as a six-week training programme.

For M3, learners will have received very little tutor support whilst setting up the investigation and collecting physiological data from the investigation. Learners should select at least two different types of exercise in order to determine how the different types of exercise result in differing adaptations. Learners should also examine the acute response to their selected exercises and also the longer term effects of exercise.

For M4, learners need to examine the data collected and review the results by explaining how the body responds to each type of exercise during the acute phases and also the long-term effects of the selected exercises on the body systems. Learners will also need to explain the practicality of the exercise activities selected, and any advantages or disadvantages encountered during data collection. Learners should be able to explain the strengths and areas for improvement of their investigation.

For D1, which links to P5 and M3, learners will have independently conducted their investigation. Learners should select at least two different types of exercise in order to determine how the different types of exercise result in differing adaptations. Learners should examine both the acute response to their selected exercises and also the longer term effects of exercise.

For D2, which links to P6 and M4, learners need to examine the data collected and review the results by analysing how the body responds to each type of exercise during the acute phases and also the longer term effects of the selected exercises. The analysis will need to include the practicality of the exercise activities selected and advantages/disadvantages encountered with the way in which physiological data was collected. An analysis of the strengths and areas for improvement of the investigation will need to be included in the review.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	The Body's Response to Acute Exercise	As a health and fitness instructor you need to be able to apply your anatomical and physiological knowledge to practical activities and exercises.	Practical observation and written report
P3, P4, M2	The Body's Response to Chronic Exercise		Presentation Witness statement
P5, P6, M3, M4, D1, D2	The Effects of Exercise on the Body	Conduct practical assessments and laboratory-based work to explore how the body responds to physical activity and exercise.	Laboratory report Witness statement

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Sport sector suite. This unit has particular links with the following unit titles in the BTEC Sport suite and the BTEC Sport and Exercise Sciences suite:

Level 2 Sport	Level 3 Sport	Level 3 Sport and Exercise Sciences
Fitness Testing and Training	Principles of Anatomy and Physiology in Sport	Anatomy for Sport and Exercise
Development of Personal Fitness	Fitness Training and Programming	Sport and Exercise Physiology
	Sports Coaching	Exercise, Health and Lifestyle
	Exercise, Health and Lifestyle	Fitness Training and Programming
	Instructing Physical Activity and Exercise	Instructing Physical Activity and Exercise
	Research Investigation in Sport and Exercise Sciences	Applied Sport and Exercise Physiology
	Laboratory and Experimental Methods in Sport and Exercise Sciences	Sports Coaching
		Research Investigation in Sport and Exercise Sciences
		Laboratory and Experimental Methods in Sport and Exercise Sciences

This unit links with the National Occupational Standards (NOS) for:

- Coaching, Teaching and Instructing at Level 3
- Instructing Physical Activity and Exercise at Level 3.

Essential resources

Learners will need access to an exercise facility and equipment for taking physiological measurements including heart rate monitors, blood pressure monitors and spirometers.

Employer engagement and vocational contexts

This unit will provide learners with the background knowledge and skills needed to work in a fitness suite, leisure club or gym. Centres are encouraged to develop links with local health education professionals and health fitness instructors, so that learners can understand the importance of learning about the structure and function of the human body in order to pursue a career in the sport and fitness industry.

Indicative reading for learners

Textbooks

Adams M et al – *BTEC Level 3 National Sport (Performance and Excellence) Student Book* (Pearson, 2010) ISBN 9781846906510

Adams M et al – *BTEC Level 3 National Sport (Development, Coaching and Fitness) Student Book* (Pearson, 2010) ISBN 9781846906503

Adams M et al – *BTEC Level 3 National Sport Teaching Resource Pack* (Pearson, 2010) ISBN 9781846906541

Adams G M – *Exercise Physiology Laboratory Manual: Health and Human Performance* (McGraw Hill Higher Education, 2001) ISBN 9780072489125

Allen M B – *Sports, Exercise and Fitness: A Guide to Reference and Information Sources* (Libraries Unlimited Inc, 2005) ISBN 9781563088193

American College of Sports Medicine – *ACSM's Guidelines for Exercise Testing and Prescription, 7th Edition* (Lippincott Williams and Wilkins, 2005) ISBN 9780781745901

American College of Sports Medicine – *ACSM's Health-Related Physical Fitness Assessment Manual* (Lippincott Williams and Wilkins, 2007) ISBN 9780781775496

Coulson M – *The Fitness Instructor's Handbook: A Complete Guide to Health and Fitness – Fitness Professionals* (A&C Black, 2007) ISBN 9780713682250

Franks B D and Howley E T – *Fitness Leader's Handbook* (Human Kinetics Europe, 1998) ISBN 9780880116541

Hazeldine R – *Fitness for Sport* (The Crowood Press, 2000) ISBN 9781861263360

Heyward V H – *Advanced Fitness Assessment and Exercise Prescription* (Human Kinetics, 2006) ISBN 9780736057325

Howley E T and Franks B D – *Health Fitness Instructor's Handbook* (Human Kinetics Europe, 2003) ISBN 9780736042109

National Coaching Foundation – *Physiology and Performance – NCF Coaching Handbook No.3* (Coachwise Ltd, 1987) ISBN 9780947850241

Powers S K and Howley E T – *Exercise Physiology: Theory and Application to Fitness and Performance* (McGraw Hill Higher Education, 2006) ISBN 9780071107266

Sharkey B J – *Physiology of Fitness, 3rd Edition* (Human Kinetics, 1990) ISBN 9780873222679

Sharkey B J and Gaskill S E – *Fitness and Health* (Human Kinetics, 2006) ISBN 9780736056144

Skinner J – *Exercise Testing and Exercise Prescriptions for Special Cases: Theoretical and Clinical Applications* (Lippincott Williams and Wilkins, 2005) ISBN 9780781741132

Watson A W S – *Physical Fitness and Athletic Performance: A Guide for Students, Athletes and Coaches*
(Longman, 1996) ISBN 9780582091108

Journals

American College of Sport Medicine's Health and Fitness Journal

British Journal of Sports Medicine

Exercise and Sport Sciences Reviews

International Journal of Sports Science and Coaching

Medicine and Science in Sports and Exercise

Research Quarterly for Exercise and Sport

Websites

American College of Sports Medicine

www.acsm.org

British Association of Sport and Exercise Sciences

www.bases.org.uk

Coachwise

www.1st4sport.com

Human Kinetics

www.humankinetics.com

Sport Science

www.sportsci.org

Sports Coach UK

www.sportscoachuk.org

Top End Sports

www.topendsports.com

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	collecting physiological data to investigate the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems, with tutor support
Creative thinkers	collecting physiological data to investigate the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems, with tutor support
Reflective learners	collecting physiological data to investigate the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems, with tutor support reviewing physiological data collected, describing the effects of exercise on the musculoskeletal, cardiovascular, respiratory and energy systems.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Team workers	working in small groups to collect physiological data.

● Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Follow and understand the need for safety and security practices	saving data taken from practical investigations
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> • text and tables • images • numbers • records 	recording data from their investigation
Present information in ways that are fit for purpose and audience	compiling results from their investigations
Mathematics	
Select and apply a range of skills to find solutions	analysing data from their investigations
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching the effects of exercise on the body.