

Unit 12: Physiology of Human Regulation and Reproduction

Unit code:	J/502/5551
QCF Level 3:	BTEC National
Credit value:	10
Guided learning hours:	60

● Aim and purpose

The aim of this unit is to enable learners to understand of the physiology of human regulation and reproduction. Learners will cover the regulation of body fluids, how the nervous system functions, homeostasis and the human reproductive system.

● Unit introduction

The fascinating way that the human body works is further explored in this unit. Learners will use the experience they gained from studying the *Unit 11: Physiology of Human Body Systems* to help them understand some even more intriguing systems in the human body.

Learners will be able to understand:

- how bodily fluids are regulated, by studying the urinary system
- the structure and function of the nervous system and how we respond to changes in our internal and external environment
- the structure and function of the endocrine system and homeostasis. Homeostasis is the process that maintains the body's internal environment within optimal limits so that the body can function as effectively as possible. All learners will have studied the maintenance of the internal environment within certain physiological limits before and should be aware that a rise in body temperature of 4°C or more can have serious and even fatal results. Similarly, if glucose levels rise or fall dramatically, the body as a whole can be affected. The retention or loss of too much fluid will also have significantly adverse effects on the workings of the human body. Learners will discover the importance of homeostasis and that monitoring homeostatic functions through various tests is a major part of a medical technician's laboratory work. Learners will carry out some of these tests and will develop an understanding of how human body systems are interlinked and therefore do not function in isolation.
- how humans reproduce through studying the reproductive system and the process from fertilisation to birth.

It is important during delivery and assessment of this unit that learners take on the role of an employee and complete investigations and tasks as they would in the workplace.

At the end of this unit learners will have sufficient knowledge of human physiology to undertake further study at a higher level, or use it in employment situations, eg medical laboratories, sport fitness, health and beauty.

● Learning outcomes

On completion of this unit a learner should:

- 1 Know the importance of the regulation of body fluids in the human body
- 2 Know the organisation and function of the nervous system
- 3 Understand the homeostatic mechanisms used by the body to maintain the internal environment
- 4 Understand how the structure of the human reproductive system relates to the functions.

Unit content

1 Know the importance of the regulation of body fluids in the human body

Body fluids: intracellular and extracellular fluid; fluid balance; movement of body fluids, eg osmosis, diffusion; electrolytes and their functions; regulation of electrolytes

Acid-base balance: hydrogen ion concentration of body fluids; buffer systems, eg carbonic acid, protein, phosphate, pH; maintenance of acid-base balance

Body fluid control: sources of fluid for the body; dehydration; rehydration; maintenance of body fluid

Structure of the urinary system: main sites of re-absorption in the kidney; kidneys (nephron structure, blood supply); ureters; bladder; urethra

Functions of the urinary system: filtration; absorption; constituents of urine (normal and abnormal); urine production; urine storage and release by bladder

2 Know the organisation and function of the nervous system

Organisation of the nervous system: central nervous system (main features of the brain and spinal cord); peripheral nervous system (afferent and efferent pathways); autonomic system (sympathetic and parasympathetic pathways); synaptic structure; structure of neurones, sense organs, effector organs; sensory (afferent) and motor (efferent) neurones; somatic and autonomic (sympathetic and parasympathetic) neurones; measurement of nervous responses in a range of conditions

Functions of the nervous system: initiation and transmission of the nerve impulse; synapses and synaptic transmission; sensory (afferent) and motor (efferent) impulses; reflex arc; somatic and autonomic (sympathetic and parasympathetic) control; coordination role of nervous system; interpretation of graphical displays of a nerve impulse and EEG recordings

3 Understand the homeostatic mechanisms used by the body to maintain the internal environment

Organisation of the endocrine system: pituitary gland; hypothalamus; thyroid and parathyroid gland; pancreas; adrenal medulla; adrenal cortex; gonads and placenta; pineal; gastrointestinal tract

Functions of the endocrine system: characteristics of hormones; names and actions of principal hormones produced by each gland; hormone responses to extremes of stress and alarm, eg fight and flight; malfunctioning of endocrine system and possible correction, eg goitre, Cushing's syndrome, diabetes mellitus, pituitary dwarfism; description of the measurement of endocrine function

Principles of homeostasis: definition of homeostasis; principles of homeostatic control systems; significance of maintaining an optimum internal environment for cell function

Homeostatic systems: endocrine control and feedback in general; significance of homeostatic regulation by hormones compared with nervous system regulation; relation of digestive system to cellular homeostasis; regulation of blood glucose (insulin, glucagon, adrenaline, glucocorticoids); regulation of body fluids; measurements used in determining imbalances in homeostatic mechanisms

4 Understand how the structure of the human reproductive system relates to the functions

Structure of the reproductive system: in males (testes, epididymis, scrotum, vas deferens, penis, accessory glands); in females (ovary, oviduct, uterus, vagina, external genitalia, mammary glands); cellular structure of male and female organs (testes, ovary, oviduct, uterus)

Functions of the reproductive system: production of gametes (gametogenesis); hormonal regulation of sperm production in the male; hormonal regulation of the female ovarian and menstrual cycles; fertilisation; pregnancy and birth; lactation; environmental influences on embryonic development

Fertility: role of hormones in pregnancy; tests for pregnancy; infertility and the use of hormones in IVF

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 main sites of re-absorption in the kidney [RL3; CT3; SM3]	M1 describe how re-absorption occurs in each of the main sites	D1 explain how the body maintains the correct acid-base balance
P2 outline the importance of regulating body fluids in the body [CT2; IE1; EP2,3; RL3]		
P3 outline the organisation and function of the nervous system [CT1; IE1; EP4,5; RL5; SM2; TW1]	M2 explain the functions of the nervous system	D2 explain the interrelationship between the nervous and endocrine systems
P4 outline the organisation and function of the endocrine system [IE1,6; CT5; RL5; SM3]	M3 explain the functions of the endocrine system	
P5 describe the mechanisms of the homeostatic system [IE2,4; CT1,6; RL5; SM3; EP3]	M4 explain positive and negative feedback in homeostasis, using examples from the human body	D3 explain how malfunctions in the homeostatic mechanisms can lead to disorders
P6 explain the roles of the sex organs in production of ova and sperm [SM3; IE1; EP2]	M5 report on the common tests performed to measure fertility.	D4 evaluate data concerning the levels of sex hormones at different times in the menstrual cycle in relation to fertility.
P7 explain how the structure of the reproductive system relates to their functions. [IE2; EP5, 6; CT1; RL6; TW6; SM2]		

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 CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators
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Essential guidance for tutors

Delivery

Tutors delivering this unit have the opportunity to use a wide range of techniques. These include lectures, discussions, seminars, site visits, guest speakers, laboratory work, internet research, use of library resources and suitable workplace experience.

Work placements, if used, should be monitored regularly to ensure learners are benefiting from the experience. Before any placement, the learner and workplace supervisor must be aware of the requirements of the unit and how the placement can contribute to the evidence required to achieve the grading criteria. Learners may have the opportunity, for example, to carry out an assay of endocrine levels in the work placement. If suitably observed and recorded, this could contribute towards the requirements of this unit and others. Tutors must be aware of the integration of some subject matter with other units within the qualification.

Health and safety issues relating to laboratory work in the centre or workplace must be emphasised. Risk assessments, and COSHH and other regulations must be adhered to. The requirements of carrying out any experiments using human subjects must be followed.

Laboratory work should form a major part of the delivery of learning outcome 1. There are many established experiments regarding fluid movements and acid-base balance. Similarly, exercise and body fluid control measurements are frequently referred to in sport science manuals enabling the learners to carry out experiments. Although formal lectures relating to kidney structure and function will form part of the delivery of this unit, practical investigations are essential in helping learners to meet this learning outcome.

It is possible, through laboratory work, to measure nerve responses under different conditions for learning outcome 2. Access to EEG recordings and other graphical material showing nerve impulse transmission will help learners cope with a rather theoretical area of work. Input from tutors, and possibly guest speakers, will be needed and some areas can be covered by independent research.

Learning outcome 3 requires a grasp of how human body systems are interlinked. This learning outcome is probably best covered by formal input from the tutor and guest speakers if available. Once learners have grasped the basis of the homeostatic mechanism, including the endocrine system, then individual or group research can add more detail. The use of flow diagrams, which can be built using appropriate software packages, helps learners understand a constantly changing set of systems. Research on endocrine levels and how they are monitored will probably only be found in specialist journals or online medical sites, and learners may need tutorial help with the material. Case studies provided by the tutor will be useful here.

Learning outcome 4 covers the human reproductive systems and the wider subject area of fertility and menstruation. This learning outcome will probably involve formal lectures and learner-research and will require access to CD ROMs, photomicrographs and other material to help learners understand the complexities of the reproductive systems. Ideally, a visit to a fertility clinic or laboratory would be a good way of gathering information. A guest speaker such as a fertility technician, nurse or doctor would also be useful here. Documentaries and case studies could provide additional sources of material.

Studying blood and other bodily substances is not a banned activity (unless an employer has provided written instructions restricting the activity). A risk assessment **must** be carried out.

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
Introduction to structure of programme and assignments.
Assignment 1 – Re-absorption in the Kidney and Associated Abnormalities (P1, M1) Introduction to body fluids, urinary system and acid-base balance. Learners: <ul style="list-style-type: none">• identify different bodily fluids and electrolytes, structure and function of urinary system• do a practical on diffusion• write up practical• do a practical on osmosis• write up practical.
Assignment 2 – Maintenance of Bodily Fluids under Different Conditions (P2, D1) Learners: <ul style="list-style-type: none">• research regulation of body fluids to include acid-base balance• create a flow chart• practical for class – fluid regulation. Home study task: Evaluate and compare practical to previous studies.
Assignment 3 – The Role of the Nervous System and Reflex Arcs in the Body (P3, M2) Introduction to the structure and function of the nervous system. Learners: <ul style="list-style-type: none">• identify structures associated with the nervous system• produce models of nervous system• research functions of the nervous system• create a flow diagram• investigation in groups to include nervous response in a number of conditions• carry out the investigation. Home study task: Collate data and present results using ICT.
Assignment 4 – The Structure and Function of the Endocrine System in the Body (P4, M3, D2) Introduction to endocrine system. Learners: <ul style="list-style-type: none">• research structure and function of endocrine system and homeostasis• research interrelationship between nervous and endocrine system• complete booklet project.
Assignment 5 – Homeostatic Mechanisms and Malfunctions Leading to Disorders (P5, M4, D3) Introduction to homeostasis. Learners: <ul style="list-style-type: none">• produce flow charts on homeostatic mechanisms in different situations• research homeostasis• carry out investigation• write up investigation.

Topic and suggested assignments/activities and/assessment

Assignment 6 – Primary and Secondary Sex Organs (P6)

Introduction to structure and function of reproductive organs. Learners:

- identify structures of the male and female reproductive organs.

Assignment 7 – The Role of the Reproductive System in Fertility and Menstruation (P7, M5, D4)

- learners research reproduction in relation to fertility and menstruation
- prepare presentation using ICT
- carry out presentation.

Home study task: Case studies on infertility.

Review of unit and assignment programme.

Assessment

All the pass grade criteria must be met in order for a learner to achieve this unit.

For P1, learners may have to be guided initially. They must be able to describe the main sites of re-absorption in the kidney. For P2, it is essential that learners are able to outline the importance of regulating body fluids. They need to consider electrolytes, their functions in the body and how balances are maintained. Learners should be encouraged to use text and visual representations, (for example, flow charts can make the process more dynamic) and carry out practical investigations to demonstrate fluid regulation, diffusion and osmosis.

For M1, learners must give a detailed account of the interrelationship between the structures which make up the kidney to allow it to function effectively. A flow diagram or any other pictorial approach would allow this.

For D1, learners must explain what the acid-base mechanism is and show that they understand how it functions to maintain normal stability. They must give details about the rises and falls in acid-base levels as part of normal body functions. Only an overview, not great depth, is required.

For P3, it is not sufficient for learners to list the functions of the nervous system; the emphasis here is on considering the functions in terms of nerve impulses. A clear but succinct description is required, showing how nerve impulses are part of a control system in the body. For M2, learners may present their work in a variety of ways, but the tutor must ensure that learners can explain the function of the nervous system, for example to increase or decrease the heart rate in detail with diagrammatic representations to help with understanding.

For P4, learners need to give a clear account of how the endocrine system is organised and, through a diagram or description, show how it functions to bring about changes in the body.

For M3, learners must explain the interrelationship between different structures in the endocrine system and their related hormones to explain how the system works together. Flow diagrams are a good way of demonstrating this.

For D2, learners must use the knowledge acquired from previous criteria on the nervous and endocrine system to produce a detailed account of how they interact with each other. It would be useful for them to understand the consequences of malfunction in each system.

For P5, learners must give a clear account of the main systems involved in homeostasis and how they work. Learners must demonstrate through the clarity of their account, whether pictorial or descriptive, that they understand it is a regulatory system essential for the maintenance of a steady state in the body. For M4, learners must explain positive and negative homeostatic feedback. Annotated diagrams are an ideal way of presenting some of this material.

For D3, learners must show they understand the whole homeostatic process – the hormone and nervous systems and how they interact with each other. Leading on from this, learners must describe the possible homeostatic malfunctions and what these do to the body. Learners must consider all of the internal regulatory mechanisms, including blood glucose control, temperature and water regulation. Learners must explain how malfunctions lead to disorders in a clear, logical manner. Learners do not need to give detailed descriptions of treatment but should show a clear understanding of the effects of the disorders and how they are rectified.

For P6, learners should produce a clear account of how primary and secondary sex organs lead to production of sperm and ova. They could include a flow diagram of the process of meiosis with a clear description to enhance their understanding of the process. For P7, learners should be encouraged to use a variety of presentation methods. Learners should avoid lengthy descriptions, especially lists of hormones and contraceptive devices. Learners must identify the main hormones and describe their function and provide a pictorial and descriptive account of ovulation.

For M5, learners must research infertility using various websites and other resources. Learners must provide details about the pre-fertility tests carried out (on both males and females). Learners are not required to give details of costs or level of services (private or NHS) it is the science of the procedures which is important. Learners must include the positive and negative of effects hormone treatment. Most learners will probably produce a written account but annotated diagrams are essential in describing ovulation and hormone treatment.

For D4, much graphical data is available from various sources and learners are required to interpret this research. Learners must show their ability to analyse the data, interpret it and relate it to the physiology of reproduction in relation to fertility and the menstrual cycle. Some details are essential here because of the interrelationship of so many sex hormones, and learners must refer to males and females. Diagrams should be an integral part of the presentation, especially in demonstrating which hormones are targeting which organs and tissues.

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, M1	Re-absorption in the Kidney and Associated Abnormalities	A research worker in a medical laboratory.	Produce a scientific report.
P2, D1	Maintenance of Bodily Fluids under Different Conditions	A research worker in a medical laboratory.	Produce a scientific report.
P3, M2	The Role of the Nervous System and Reflex Arcs in the Body	A trainee biology teacher.	Produce resources for a lesson on the nervous system.
P4, M3, D2	The Structure and Function of the Endocrine System in the Body	Working as a research technician.	Report on case studies using secondary data.
P5, M4, D3	Homeostatic Mechanisms and Malfunctions Leading to Disorders	Working for a scientific journal.	Produce an article for a scientific journal.

Criteria covered	Assignment title	Scenario	Assessment method
P6	Primary and Secondary Sex Organs	Working as a fertility clinic advisor.	Produce a visual display to help patients.
P7, M5, D4	The Role of the Reproductive System in Fertility and Menstruation	A fertility clinic investigation.	Prepare a presentation and deliver it to the class posing as a trainee fertility technician.

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

This unit forms part of the BTEC Applied Science sector suite. This unit has particular links with the units shown below in the BTEC Applied Science suite of qualifications:

Level 2	Level 3
The Living Body	Scientific Investigation
	Physiology of Human Body Systems
	Chemistry for Biology Technicians

Essential resources

To deliver this unit the centre will need to provide laboratory space equipped for work at Level 3 standard. Learners will need the facilities to carry out practical work, in particular the equipment associated with investigations into how the coordinating systems function. This includes being able to carry out experiments associated with the movement of fluids (osmosis, diffusion), and the measurement of nerve responses and stimuli.

Access to anatomical models, microscopic sections/slides/photomicrographs will also be needed. It is expected that laboratory time will be a major aspect in the delivery of this unit, hence the need for suitable laboratory accommodation.

Research facilities providing access to suitable texts, computers and CD ROMs are essential. These resources are particularly important in some sections where experimental data such as EEG recordings are only available as secondary data. Suitably experienced and competent staff will be needed to assess the science skills and knowledge demonstrated by the learners.

Employer engagement and vocational contexts

Ideally, visits to relevant work areas such as a range of laboratories will help learners understand the vocational relevance of their studies. A visit to an industrial state-of-the-art laboratory is recommended. If this is not possible for all learners, then tutors are advised to take any opportunity to visit one themselves. This would give tutors an appreciation of the differences between industrial laboratories and centre-based laboratories to enable them to better deliver the unit. Differences include the clear demarcation of 'clean' and 'contaminated' areas (not only in biological and animal laboratories, but even in many chemistry laboratories), and the separate space for computers, desks etc that learners may not be aware of.

The input of guest speakers working in different aspects of human biology research would also enhance appreciation of the subject. Input from medical and nurse practitioners, laboratory technicians, and other related practitioners would also benefit learners.

Indicative reading for learners

There is a vast array of human biology material available in the form of books, journals, CD ROMs and websites. The materials available change rapidly and both tutors and learners will have their own favourite websites. The same applies to computer packages and CD ROMs where new versions are constantly produced. There are some standard textbooks and a few have been listed, but many more are available, as a search of websites such as www.amazon.co.uk will show. Scientific journals and magazines are often rather specialised and aimed at the medical profession, although many are now available online and are a useful reference source.

Textbooks

Adds J et al – *Respiration and Coordination (Nelson Advanced Science: Biology Series)* (Nelson Thornes, 2005)
ISBN 9780748774890

Boyle M et al – *Human Biology (Collins Advanced Science Series)* (Collins Educational, 2002)
ISBN 9780007135998

Johnson M D – *Human Biology: Concepts and Current Issues, 3rd Edition* (Benjamin Cummings, 2005)
ISBN 9780805372014

Pickering W R – *A-level Advanced Human Biology Through Diagrams* (Oxford University Press, 2001)
ISBN 9780199141968

Tortora G J – *Principles of Anatomy and Physiology* (John Wiley & Sons, 2005) ISBN 9780471718710

Journals

The Journal of Physiological Sciences

The Journal of Physiology – Published on behalf of the Physiological Society

Websites

www.cellsalive.co.uk	Biology site
www.hse.gov.uk/pubns/indg342.pdf	Health and safety guidance on blood borne viruses
www.innerbody.com/html/body.html	Human anatomy online
www.kidney.niddk.nih.gov/Kudiseases/pubs/yourkidneys	The kidneys and how they work
www.merck.com/mmhe/sec12/ch159/ch159a.html	Disorders of nutrition and metabolism
www.merck.com/mmhe/sec22/ch241/ch241e.html	Menstrual cycle
www.s-cool.co.uk/alevel/biology.html	Social biology revision
www.womens-health.health-cares.net/female-fertility-tests.php	Fertility tests

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	[IE1,2,4,6] identifying questions to answer; planning and carrying out research; writing up practical investigations
Creative thinkers	[CT1,2,3,5,6] generating plans and creating models and presentations
Reflective learners	[RL3,5] reflecting on experimental data following investigations to look for improvements
Team workers	[TW1] working together as a class to plan and carry out an investigation
Self-managers	[SM2,3] researching tasks and organising time and resources
Effective participators	[EP2,3] producing plans for investigations and preparing and delivering presentations.

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 ...
Independent enquirers	[IE3] exploring issues, events and problems from different perspectives using their own and other scientists' data
Creative thinkers	[CT4] questioning their own and others' assumptions in order to evaluate this and put it into a written report
Reflective learners	[RL5] evaluating their experiences with practical investigations and learning to inform future progress
Team workers	[TW5] taking responsibility, showing confidence in themselves and their contribution to group activities, ie practical work or presentations
Self-managers	[SM5] dealing with competing pressures, including personal and work-related demands to complete all tasks and assignments to specific deadlines
Effective participators	[EP4] identifying improvements that would benefit both themselves and others by evaluating practical data following investigations.

● Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	researching, preparing and delivering presentations
Troubleshoot	troubleshooting when completing assignments
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	finding information using various websites in preparation for a presentation/report
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching and selecting information which is specific to requirements
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 	producing tables and graphs from practical experiments carried out
Present information in ways that are fit for purpose and audience	producing practical assignment reports making presentations, using appropriate software
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	interpreting secondary data
Identify the situation or problem and the mathematical methods needed to tackle it	interpreting secondary data
Use appropriate checking procedures and evaluate their effectiveness at each stage	carrying out practical work
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	interpreting secondary data
Draw conclusions and provide mathematical justifications	writing up reports following investigations

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	making presentations, using appropriate software listening to tutor instruction and peer presentations and contributing to these
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	preparing presentations and seeking information to select specific requirements for each criteria
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	writing reports for practical assignments and research-based assignments.