

# Unit 21: Biomedical Science Techniques

<b>Unit code:</b>	<b>J/502/5565</b>
<b>QCF Level 3:</b>	<b>BTEC National</b>
<b>Credit value:</b>	<b>10</b>
<b>Guided learning hours:</b>	<b>60</b>

## ● Aim and purpose

The aim of this unit is to enable learners to develop the skills and techniques used in a biomedical context. Although much of the testing is now automated, doing tests manually will give access to important theory behind the modern tests.

## ● Unit introduction

This unit develops learners' understanding of topics including microbiology and explores the major groups of organisms of medical importance. It also explains the ways in which disease is spread throughout the population. Mechanisms used to control such organisms both inside and outside of the body will be examined, including the body immunological methods of defence.

Haematology and transfusion science is studied to give an understanding of how medical science uses blood in the health sector.

Cellular pathology is studied to show how disease can be diagnosed both in life and after death.

Clinical chemistry will give the learners an understanding of how the chemical make-up and balance of the body can cause disease.

All of these sections can link to the biochemistry and physiology units.

Practical applications will be used throughout this unit to reinforce theoretical aspects of biomedical science and learners will be expected to complete the practical requirement in order to develop important skills necessary for working in various applied science workplaces, particularly those in medical research and the health sector.

## ● Learning outcomes

**On completion of this unit a learner should:**

- 1 Be able to investigate the structure and characteristics of major groups of organisms of medical importance
- 2 Understand how the body defends itself against infection
- 3 Know how the principles of blood transfusion science relate to haematology
- 4 Know the importance of cell pathology as a diagnostic tool
- 5 Understand how the chemical make-up of the body influences health and disease.

## Unit content

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### 1 Be able to investigate the structure and characteristics of major groups of organisms of medical importance

*Structure and characteristics of the major groups of organisms of medical importance:* bacteria (circular DNA, cell membrane, cell wall, capsule, flagella, pili, cocci, bacilli, Gram stain); viruses (obligate intracellular parasites, DNA or RNA nucleic acid, capsid, capsomere, envelope, spikes, use of photomicrographs to view structure); fungi

*Concepts of parasitism:* symbiosis; commensalism; pathogenicity

*Sources of infection:* human reservoirs; animal reservoirs; non-living reservoirs

*Routes of transmission:* contact; vehicle; vectors

*Routes of entry into the body:* orifices; droplets; body fluids

*Antimicrobials:* asepsis; disinfection; sterilisation; antibiotics; antiviral agents; antifungal agents

*Demonstrate:* preparation and observation of heat fixed smears of Gram-positive and Gram-negative bacterial samples; determination of antibiotic sensitivity; practically demonstrate asepsis and disinfection

### 2 Understand how the body defends itself against infection

*Non-specific defences:* barriers (skin, mucous membranes, tears, commensals); non-specific cellular defences (phagocytes, inflammation)

*Specific defences:* humoral immunity; cell-mediated immunity

*Cells of the immune system and their functions:* leucocytes; lymphocytes (B lymphocytes, T-lymphocytes, large granular lymphocytes); phagocytes (mononuclear phagocytes, neutrophils, eosinophils); auxiliary cells (basophils, mast cells, platelets)

*Process of immune responses:* antigen recognition; reaction to eradicate antigen

*Mechanism of inflammation:* increased blood supply; increased capillary permeability; immune cell migration to site

### 3 Know how the principles of blood transfusion science relate to haematology

*Components of blood:* erythrocytes, leucocytes, thrombocytes, structure and functions, origins

*Diagnostic techniques:* eg blood smears, red blood cell count, reticulocyte count, mean corpuscular volume; analysis for iron deficiency, coagulation, platelet counts, tests for abnormal haemoglobin, blood volumes

*Erythrocytes:* associated diseases, eg anaemia, thalassaemia, megaloblastic anaemia, aplastic anaemia, vitamin B12 deficiency, foliate deficiency, sickle cell anaemia

*Leucocytes/white blood cells:* their role in immunity; disorders associated with leucocytes, eg lymphocytosis, infectious mononucleosis, AIDS

*Platelets:* use in treatment of diseases, eg haemophilia

*Haemostasis and thrombosis:* definitions; significance to the human body

*Associated blood diseases:* bone marrow failure; leukaemias; lymphomas, eg Hodgkin's, non-Hodgkin's disease

*Transfusions:* production of blood products; red cell compatibility; pretransfusion and transfusion procedures including screening; clinical use of blood products, eg in surgery, intensive care, haemophilia, anaemia, obstetrics, haemolytic disease of new-born infants, myasthenia gravis, neuromuscular diseases, Kawasaki disease

*Transmissible infections by transfusion:* eg hepatitis, cytomegalovirus (CMV), human parvovirus (B19), malaria, Chagas diseases; screening of blood products

### 4 Know the importance of cell pathology as a diagnostic tool

*Cell pathology:* cell injury, reversible and irreversible; causes of cell injury; cell ageing; neoplasia in identifying underlying disease, eg cancer cells in sputum, urine, fluids in chest and abdomen; identification of skin lesions, eg melanocytic lesions, inflammatory lesions, eg Lupus, allergic drug reactions; types of cell collection used for analysis, eg surgical removal, pap smear, surface cells, aspiration, use of fine needle biopsy to remove cells, post mortem investigations

### 5 Understand how the chemical make-up of the body influences health and disease

*Clinical biochemistry:* uses, eg assist diagnosis, confirm diagnosis, screen for latent disease, evaluate prognosis, monitor disease progress

*Biochemistry systems:* input, eg nutrition, drugs, digestion; control systems, eg genetic, endocrinology, water and electrolytic metabolism, control of calcium and carbohydrates; processing, eg enzymes, metabolic errors; storage and temperature; eg acid-base balance, blood gases, plasma proteins, lipid and lipoproteins; defence, eg immunoglobulins, output, kidney and liver functions

## 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:
<b>P1</b> describe the structure and characteristics of major groups of organisms of medical importance [RL2,3]	<b>M1</b> explain the sources of infection, routes of transmission and entry into the human body of micro-organisms of medical importance	<b>D1</b> assess the effectiveness of antimicrobials
<b>P2</b> carry out preparative work related to organisms of medical importance [RL2,3; TW1]		
<b>P3</b> explain how the body defends itself against infection [IE2]	<b>M2</b> explain how the cells of the immune system allow an immune response to be evoked and maintained	<b>D2</b> compare and contrast the effectiveness and efficiency of non-specific defences with specific defences
<b>P4</b> describe some of the abnormalities that diagnostic techniques used in blood analysis can identify	<b>M3</b> explain the clinical uses of different blood products used in transfusions	<b>D3</b> discuss the effectiveness of screening blood products for one transmissible disease
<b>P5</b> outline how cell pathology is used to identify underlying diseases [CT1; EP3]	<b>M4</b> describe, giving examples, the collection of cells for use in cell pathology	<b>D4</b> explain how a staining procedure (H&E) is performed on several identified tissues, drawing what can be seen
<b>P6</b> identify how the chemical make-up of the body can be measured using biochemical tests [EP3].	<b>M5</b> describe, giving examples, what test results could show about malfunctions of the body systems.	<b>D5</b> explain, using examples, how a knowledge of cell pathology and biochemistry can help in following the course of a disease.

**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

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### Delivery

A visit to an industrial state-of-the-art laboratory is strongly recommended. If this is not possible for all learners, then tutors are strongly 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. Such differences include the clear demarcation of 'clean' and 'contaminated' areas (not only in biological and animal laboratories, but even in many chemistry ones), and the separate space for computers, desks etc that learners may not be aware of.

The fundamental concepts of this unit should be delivered through tuition, guided learning, practical work and learner-centred activities. This should include exercises in data interpretation and problem solving.

Wherever possible, the theoretical aspects of this unit should be related to the learners' work-based training and experiences. The medical relevance of the *Unit content* should be emphasised to make these topics applicable to the vocational background of the learners.

It is not intended that learners should have detailed knowledge of the contents of learning outcomes 3 and 4. The intention is to make learners aware of the range of systems and procedures involved in understanding how the human body functions normally, and the procedures that identify abnormalities.

Learners should be encouraged to develop skills in primary and secondary research. There is some overlap between topics in learning outcomes 2, 3 and 4 but this is indicated so repetition can be avoided. The tutor should make sure this overlap is pointed out and used to show the links between sections.

Distinction criteria will develop learners' knowledge and understanding further.

Tutors should ensure that learners use scientific terminology correctly and consistently. Wherever possible, learners should be encouraged to work independently for D1 and D2.

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, outline scheme of work and programme of assignments.
<b>Learning outcome 1</b> Theory input on organisms of medical importance. Learner activity: Investigate the organisms of medical importance from each of the major groups. Investigate the routes of transmission and entry of organisms of medical importance. Practically assess the effectiveness of antimicrobials. <b>Assignment 1 – Effect of Antimicrobials (P1, P2, M1, D1)</b> The investigation of an outbreak of a disease in a care home.
<b>Learning outcome 2</b> Theory input on the immune system. Learner activity: Investigate the immune system and how its component parts work together to defend the body against disease. <b>Assignment 2 – Why Should We Continue with Immunisation? (P3, M2, D2)</b> Assessment of the effectiveness of immunisation.
<b>Learning outcome 3</b> Theory input on the components of blood. Learner activity: Investigate the components of blood and the abnormalities that can be shown by testing. Undertake some simple diagnostic techniques to show abnormalities in the blood. Investigate blood products used in a clinical context. Investigate the test carried out on donated blood. <b>Assignment 3 – Blood Tests and Transfusion (P4, M3, D3)</b>
<b>Learning outcome 4</b> Theory input on the uses of cellular pathology techniques in identifying disease. Learner activity: Investigate the range of samples used and their collection techniques. <b>Assignment 4 – What Happens in a Histopathology Laboratory? (P5, M4, D4)</b> Carry out staining procedures to show how tissue can be investigated for abnormalities.
<b>Learning outcome 5</b> Theory input on how disease can be diagnosed using biochemical test results. <b>Assignment 5 – Clinical Biochemistry (diagnostic tests for disease) (P6, M5, D5)</b> Investigate how the progress of diseases can be assessed using biochemical and histopathology results.
Review of unit and programme of assignments.

## Assessment

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

For P1 and P2, learners must carry out smears of Gram-positive and Gram-negative samples and describe the structure and characteristics of the range of organisms stated in the content. This may be presented as a poster, leaflet or similar, provided that the science is clearly communicated.

For P3, learners must explain the mechanisms by which the human body can defend itself against infection. Learners could produce a written assignment, verbal presentation or a poster. The tutor must ensure that learners generate evidence that clearly identifies non-specific defences and specific defences.

For P4, learners require knowledge of a number of diagnostic techniques used in blood analysis. Learners must show how these diagnostic techniques identify a specific abnormality. It is accepted that learners may not have practical experience of carrying out the diagnostic techniques, but they should observe them whenever possible.

For P5 and P6, learners must show their understanding of the importance of cell pathology and biochemistry as a diagnostic tool. Learners should use their own experience of this area of work whenever possible.

For a merit grade, all the pass grade criteria and all the merit grade criteria must be met.

For M1, learners must explain sources of infection, routes of transmission, and entry of micro-organisms into the human body. They must ensure that the following key terms are explained: human reservoirs, animal reservoirs, non-living reservoirs, contact transmission, vehicle transmission, vector transmission, entry via oral cavity, entry via droplet, and entry via body fluids.

For M2, learners must explain how the cells of the immune system evoke and maintain an immune response. It may be necessary for the tutor to provide a scenario that outlines a specific disorder, and learners explain the immunological principles involved.

For M3, learners must explain the role of blood products, administered by transfusion, in the treatment of disease.

For M4, learners must describe the techniques used in a clinical context to collect the samples required to identify underlying disease.

For M5 a number of diseases and sets of results could be matched together.

Depending on the learner's work area, it might be necessary to give a scenario detailing a disease, for learners to show how biochemistry and cell pathology work together in tracking the progress of the disease.

For a distinction grade, all the pass, merit and distinction grade criteria must be met.

For D1, learners must assess the effectiveness of antimicrobial agents. Learners must complete practical activities on the determination of antibiotic sensitivity, demonstration of asepsis and disinfection using various chemical media (eg bleach, disinfectants, antibacterial spray, sterilising solutions).

After completing this practical work, learners must write a scientific practical report. The results generated should allow learners to assess the effectiveness of antimicrobial agents.

For D2, learners must compare and contrast the effectiveness and efficiency of non-specific immune defences with specific immune defences. Learners must present their ideas logically and clearly. All non-specific and specific defences listed in the Unit content must be considered.

For D3, learners must consider the safety of the products used in blood transfusions. They must discuss, in general terms, the screening procedures used and then evaluate the effectiveness of the screening process in relation to one transmissible disease.

For D4, Either through practical work or by research, depending on facilities and the expertise of the tutor, learners should explain how staining procedures are performed on a variety of tissue types. This explanation needs to be supplemented by visual representations.

For D5, learners must understand the biochemistry of a normal functioning cell, then take an example of where the system goes wrong and examine the consequences, eg blood clotting and haemophilia. Hodgkin's disease could be an example: learners can discuss the normal functions of the lymph nodes to show what happens when uncontrolled cell division causes a malignant tumour of the lymph glands.

### 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, D1	Effect of Antimicrobials	Scientist investigating the outbreak of urinary infections in a care home.	Practical work and report.
P3, M2, D2	Why Should We Continue with Immunisation?	Article outlining the effect of the increase in some diseases linked to how the body defends itself against disease.	Article for a magazine.
P4, M3, D3	Blood Tests and Transfusion	Scientific journalist.	Article for popular science magazine.
P5, M4, D4	What Happens in a Histopathology Laboratory	Career guidance for trainee medical laboratory scientists.	Leaflet or appropriate software Presentation.
P6, M5, D5	Clinical Biochemistry (diagnostic tests for disease)	Information for junior medical staff.	Handout for use during training.



## 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 National in Applied Science suite of qualifications:

Level 1	Level 2	Level 3
Defeating Disease (FLT)	Biology and Our Environment	Fundamentals of Science
	Health Applications of Life Science	Scientific Investigation
	The Living Body	Scientific Practical Techniques
	Science in Medicine	Physiology of Human Body Systems
		Physiology of Human Regulation and Reproduction
		Genetics and Genetic Engineering
		Medical Instrumentation

### Essential resources

Relevant television programmes may be used to illustrate topics of interest. Use of any resource should be checked for permission and copyright.

- Basic laboratory glassware and general laboratory equipment.
- Light microscopes with oil immersion objective lens.
- Gram-positive and Gram-negative bacterial cultures.
- Gram stain practical apparatus.
- Microscope slides and cover slips.
- Antibiotic sensitivity testing kit.
- Nutrient agar.
- Petri dishes.
- Sterile swabs and apparatus for aseptic techniques.
- Inoculating loops.
- Prepared blood smears.
- Specialised histology equipment.
- Prepared slides for histological staining.
- Haematoxylin and Eosin stain.

### Employer engagement and vocational contexts

Learners from a biomedical workplace can gain theory enhancing the practical work carried out in their day-to-day work. Learners who are hoping to work in a biomedical field will gain an insight into the wide range of tasks involved in the work of the biomedical scientist. The importance of the biomedical scientist can be impressed upon learners.

## Indicative reading for learners

### Textbooks

A basic medical dictionary

Baker F J, Silvertown R E, Pallister C J – *Introduction to Medical Laboratory Technology* (Scion Publishing, 1998) ISBN 9780750621908

Crocker J and Murray P – *Molecular Biology in Cellular Pathology* (Wiley Blackwell, 2003) ISBN 9780470844755

Hoffbrand V and Mehta A B – *Haematology at a Glance* (Wiley Blackwell, 2005) ISBN 9781405126663

Luxton R – *Clinical Biochemistry 2nd Edition* (Scion Publishing, 2008) ISBN 978190842415

Murphy M F and Pamphilon D H – *Practical Transfusion Medicine 3rd Edition* (Wiley Blackwell, 2009) ISBN 9781405181969

National Blood Service – *Guidelines for the Blood Transfusion Services in the United Kingdom, 7th Edition* (The Stationery Office, 2005) ISBN 9780117033719

Provan D et al – *Oxford Handbook of Clinical Haematology* (Oxford University Press, 2009) ISBN 9780199227396

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

Tortora G J, Funke B R and Case C L – *Microbiology: An Introduction* (Pearson, 2006) ISBN 9780321396037

### Journals

*Biomedical Scientist*

*Journal of Epidemiology*

*New Scientist*

*Nursing Times*

Articles from newspapers, television or radio transcripts or other scientific publications will be beneficial to aid the learning process.

### Websites

[www.ase.org.uk](http://www.ase.org.uk)

The Association for Science Education

[www.glaxowellcome.co.uk](http://www.glaxowellcome.co.uk)

Glaxo Wellcome

[www.gsk.com](http://www.gsk.com)

GlaxoSmithKline

[www.ibms.org](http://www.ibms.org)

Institute of Biomedical Science

[www.pfizer.co.uk](http://www.pfizer.co.uk)

Pfizer

[www.scienceconsortium.co.uk](http://www.scienceconsortium.co.uk)

The Science Consortium

[www.sep.org.uk](http://www.sep.org.uk)

Science Enhancement Programme

[www.societyofbiology.org](http://www.societyofbiology.org)

Society of Biology

[www.york.ac.uk/org/ciec](http://www.york.ac.uk/org/ciec)

Chemical Industry Education Centre (CIEC)

## 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 ...
<b>Independent enquirers</b>	[IE2] using researching skills to obtain information about how the body defends itself against infection
<b>Creative thinkers</b>	[CT1] generating and further researching ideas about how cell pathology is used to identify diseases
<b>Reflective learners</b>	[RL2,3] using several sources to reach a conclusion; using results from practical work to draw conclusions about organisms of medical importance
<b>Team workers</b>	[TW1] working together in research, practical and presentation work
<b>Effective participators</b>	[EP3] adding ideas at planning and discussion stages; working on research, practical and presentation work

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 ...
<b>Independent enquirers</b>	[IE3] reading around a subject, not just concentrating on the topic under investigation
<b>Creative thinkers</b>	[CT3] constructing scenarios for use in other subjects
<b>Reflective learners</b>	[RL4] taking a wider view of a topic
<b>Self-managers</b>	[SM2] completing the work to the required standard and on time [SM6] knowing when to ask for help or guidance

## ● Functional Skills – Level 2

Skill	When learners are ...
<b>ICT – Use ICT systems</b>	
Manage information storage to enable efficient retrieval	saving information from different sources for later use
<b>ICT – Find and select information</b>	
Select and use a variety of sources of information independently for a complex task	using internet sources to research information on therapies and treatments
<b>ICT – Develop, present and communicate information</b>	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> <li>• text and tables</li> <li>• images</li> <li>• numbers</li> <li>• records</li> </ul>	using internet sources to research information on therapies and treatments displaying results in appropriate format, presenting reports and data displaying results in appropriate format, presenting conclusions and suggestions for improvement
Bring together information to suit content and purpose	researching information on types of therapies producing reports, posters, leaflets on religious views on medical treatments
Present information in ways that are fit for purpose and audience	producing reports, posters, leaflets on religious views on medical treatments
Evaluate the selection and use of ICT tools and facilities used to present information	selecting the best media for use in presentation
<b>English</b>	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	giving information to the group on personal experiences of treatments presenting information on a researched topic
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching from multiple sources
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	completing written work for the assessment.