Unit 20: Biomedical Science

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

This unit will help learners understand the role biomedical scientists play in identifying the causes of disease and in helping medical personnel to offer suitable treatments.

Unit introduction

This unit will help you understand three key areas of biomedical science: haematology, histology/cytology and biochemical balance. The analytical and diagnostic testing carried out in these three areas supports other health professionals in screening, diagnosing, monitoring disease progression and treatment.

In this unit you will concentrate on biomedical science in relation to the human body, but many of the same techniques are used in veterinary science. Similar techniques are also valuable in the pharmaceutical industry, the blood and tissue transfusion and transplant service, forensic science and food technology.

You will have opportunities to investigate and understand blood and its importance, and how it can be used to diagnose and treat disease. Analysis of blood biochemistry provides important information to medical practitioners about the functions of the human body. You will consider the importance of maintaining 'norms' within the body and how deviations from these levels provide clues as to what is happening in the body to enable conditions to be diagnosed and treated.

Having completed this unit, you will be in a position to know which branch of biomedical science interests you and what further courses you can pursue to enter the profession. This may be entering as a trainee technician or after completing a biomedical science-related degree course.

Learning aims

In this unit you will:

A Understand the principles of haematology and its use in medical diagnosis
B Examine the use of histology and cytology in medicine
C Examine the use of urinalysis as an analytical and diagnostic tool.
### Summary of unit

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<th>Learning aim</th>
<th>Key content areas</th>
<th>Recommended assessment approach</th>
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<tr>
<td><strong>A</strong> Understand the principles of haematology and its use in medical diagnosis</td>
<td>A1 The components of blood</td>
<td>Practical work to investigate microscopically the components of blood and use of diagnostic techniques to identify disease. Observation records will be required. A report explaining blood component structure and function along with causes and consequences of dysfunction. Analysis of the use of diagnostic blood tests for different diseases.</td>
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<td>A2 Changes to blood components and composition</td>
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<td>A3 Diagnostic techniques used in haematology</td>
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<tr>
<td><strong>B</strong> Examine the use of histology and cytology in medicine</td>
<td>B1 Tissue investigation and consequences of diagnosis</td>
<td>A report/presentation on the implications for society, the health service and individual patients of using histology and cytology in detecting and diagnosing disease occurrence, including how information is used and communicated to key stakeholders.</td>
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<td></td>
<td>B2 Role of informatics and record keeping</td>
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<tr>
<td><strong>C</strong> Examine the use of urinalysis as an analytical and diagnostic tool</td>
<td>C1 Urine composition</td>
<td>Practical work and a report on the use of urinalysis in diagnosing changes to health status.</td>
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<td>C2 Urinalysis</td>
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Content

Learning aim A: Understand the principles of haematology and its use in medical diagnosis

A1 The components of blood
Structure and function of the following blood components:
- erythrocytes
- leucocytes
- thrombocytes (platelets)
- plasma and serum.

A2 Changes to blood components and composition
The effects of diseases and disorders on the overall composition of blood, including the effects on the structure and function of key blood components:
- erythrocytic diseases associated with types of anaemia, thalassaemia, vitamin B12 and foliate deficiency, sickle cell anaemia
- leucocytes (white blood cell) diseases associated with lymphocytosis, AIDS, infectious mononucleosis
- bone marrow failure
- leukaemia
- lymphomas such as Hodgkin’s, non-Hodgkin’s diseases
- haemostasis and thrombosis, and their significance to the body
- hepatitis B and C
- syphilis
- HIV.

A3 Diagnostic techniques used in haematology
The principles behind haematological diagnostic techniques, including the practical application of these techniques as appropriate:
- counts of red blood cells and platelets
- mean corpuscular and blood volumes
- analysis for iron deficiency
- coagulation/clotting
- haemoglobin tests
- blood grouping (typing).

Learning aim B: Examine the use of histology and cytology in medicine

B1 Tissue investigation and consequences of diagnosis
- Types and methods of sample removal, preservation and examination, including consideration of appearance of normal and abnormal results, methods of recording these and the implications of the results on patients, their families, the health service and society in general.
- Cell and tissue specimen analysis:
  - screening (bowel cancer)
  - aspirates (cerebrospinal fluid, amniocentesis)
  - surgical removal of tissues for disease identification (cervical, breast, prostate tissue)
  - allergic reactions tested by skin tests
  - tissue typing for bone marrow transplantation
  - purposes of specimens taken in autopsies to establish causes of death.
• Implications of disease diagnosis to individuals, the health service and society:
  o importance of correct and timely diagnosis and treatment
  o prognosis and quality of life for individuals and their families
  o financial implications of screening costs for early diagnosis as opposed to cost of treatment when disease is diagnosed later
  o confirmation of diseases likely to cause epidemics and resulting plans for prevention.

B2 Role of informatics and record keeping
Consideration of how information regarding diagnostic tests is recorded, stored and disseminated:
• right information to right person at right time
• processing and reporting, correct results matched with correct sample
• medical records – accurate and complete
• confidentiality.

Learning aim C: Examine the use of urinalysis as an analytical and diagnostic tool

C1 Urine composition
Main constituents of urine, including their biochemical sources in the body and how these vary in relation to healthy renal function:
• water
• organic solutes, e.g. urea, hormones, carbohydrates
• inorganic ions, e.g. sodium, chloride and potassium.

C2 Urinalysis
• Urine sampling to prevent misleading results in urinalysis:
  o why cleanliness of genitalia and sterility of collection vessels before sample collection is important
  o the purpose of mid-stream sample collection
  o why specific times of day for sample collection are sometimes recommended
  o length of time between sample collection and testing, and preservation methods of samples that will not be tested immediately.
• For each of the key indicators present in urine, the following must be considered:
  o normal ranges (as appropriate)
  o when each kind of test (visual, chemical or microscope) is considered appropriate
  o problems presented in result interpretation and steps to counter this, e.g. use of optical readers in digital pregnancy tests and automation of result reading
  o the mechanisms each analysis uses
  o health implications of changes in these levels, to include how and why the changes are brought about.
• Key indicators used in urinalysis:
  o visual – colour and clarity
  o chemical tests using test strips: specific gravity for determining concentration, pH, blood, protein, glucose, bilirubin, urobilirubin, ketones, nitrite, human chorionic gonadotropin (HCG)
  o under the microscope: crystalline structures, trichomonads, blood cells, microorganisms, epithelial cells, casts.
### Assessment criteria

<table>
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<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
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<tr>
<td><strong>Learning aim A: Understand the principles of haematology and its use in medical diagnosis</strong></td>
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<tr>
<td><strong>A.P1</strong> Explain the structure and function of the main components of blood.</td>
<td><strong>A.M1</strong> Discuss the basis of diagnostic tests for different diseases.</td>
<td><strong>A.D1</strong> Evaluate the use of diagnostic testing of blood in relation to the detection of diseases.</td>
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<td><strong>A.P2</strong> Explain how diseases affect the composition of blood.</td>
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<td><strong>A.P3</strong> Correctly carry out diagnostic testing of blood.</td>
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<td><strong>Learning aim B: Examine the use of histology and cytology in medicine</strong></td>
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<td><strong>B.P4</strong> Explain the use of analytical investigation in disease screening.</td>
<td><strong>B.M2</strong> Analyse how the interpretation and informatics of diagnostic test results are used as a tool for planning appropriate treatment.</td>
<td><strong>B.D2</strong> Evaluate the implications of screening and early disease diagnosis for the individual and for the health service and society.</td>
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<td><strong>B.P5</strong> Explain the use of analytical investigations of tissue samples.</td>
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<td><strong>B.P6</strong> Explain the use of informatics and data handling in biomedical science.</td>
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<td><strong>Learning aim C: Examine the use of urinalysis as an analytical and diagnostic tool</strong></td>
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<td><strong>C.P7</strong> Explain how urine composition may vary in relation to health.</td>
<td><strong>C.M3</strong> Analyse how the results of urinalysis are used in diagnoses of health status changes.</td>
<td><strong>C.D3</strong> Evaluate the use of urinalysis in domestic and clinical settings.</td>
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<td><strong>C.P8</strong> Correctly carry out simple urinalysis.</td>
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Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. **Section 6** gives information on setting assignments and there is further information on our website.

There is a maximum number of three summative assignments for this unit. The relationship of the learning aims and criteria is:

- **Learning aim: A** (A.P1, A.P2, A.P3, A.M1, A.D1)
- **Learning aim: B** (B.P4, B.P5, B.P6, B.M2, B.D2)
- **Learning aim: C** (C.P7, C.P8, C.M3, C.D3)
Further information for teachers and assessors

Resource requirements
For this unit, learners must have access to:
• a well-equipped laboratory
• research facilities.

Essential information for assessment decisions

Learning aim A
For distinction standard, learners must clearly link the disease and blood composition, and make judgements about the appropriate selection, implementation and interpretation of diagnostic tests by medical workers. They will give a detailed consideration of the implications of misdiagnosis of disease, with the accurate use of appropriate scientific terminology throughout.

For merit standard, learners must consider how diagnostic testing of blood relates to accurate identification of two diseases. They must discuss changes to the composition of blood with reference to normal ranges in humans. Learners will make reference to required equipment and techniques used in each diagnostic test. They must give sustained lines of reasoning, free of fundamental errors.

For pass standard, learners must link the structure and function of each of the main components of blood. They must select two diseases associated with dysfunction or abnormality of blood components, and clearly state the cause of each disease and its effect on blood composition with reference to key indicators in blood composition. Observation records will be required to validate learners’ practical work. At this level, learners must be able to follow instructions, work methodically and demonstrate awareness of good health and safety practice. Evidence of this should be identified in the write-up and records of the practical work produced by the learners should have a good level of accuracy in results/observations obtained.

Learning aim B
For distinction standard, learners must demonstrate an understanding of the value of screening for disease and how the early detection of disease can impact on prognosis and quality of life. They must evaluate the importance of early diagnosis leading to treatment and the implications of this, including a consideration of the associated emotional, economic and financial costs to the individual, the health service and society. Learners must demonstrate an understanding of the importance of accurately sampling and reporting diagnostic results, along with accurate medical records being available to the right people at the right time. It is expected that learners will access secondary data to support their conclusions about prevention and early treatment.

For merit standard, learners must provide a methodical and detailed examination of how the accuracy of testing and reporting of results to other health professionals is important in the treatment of the patient. They must consider how informatics are managed to ensure the prompt and accurate recording and dissemination of diagnostic test results. This will include an awareness of monitoring methods in automated sample analysis.

For pass standard, learners should consider the dual role of screening for disease and for detecting early signs of disease. They will describe different screening techniques and explain their role in early detection of disease. Learners should discuss the analysis of tissue samples removed surgically for examination in relation to how this can relate to the type of treatment that may be required. Learners must explain the use of informatics in biomedical science, including the management of data to maintain confidentiality while ensuring key personnel involved with the treatment of a patient have essential information in a timely and accessible format.
Learning aim C

For distinction standard, learners must demonstrate their understanding and knowledge of the normal biochemical functioning of body systems. They will need to be able to access and quote data identifying normal ranges of values for substances present in urine samples. Learners must evaluate the role of the biomedical scientist in providing the data requested by other health professionals to ensure effective monitoring of the progression and treatment of a patient in at least three cases. Learners will need to explain the issues related to sample collection, preservation and analysis in domestic and clinical settings, including a consideration of the implications of inaccurate interpretation of results and how errors can be reduced.

For merit standard, learners must identify and discuss how screening compares test results indicating abnormal values with normal values when attempting a diagnosis for particular diseases. They will make reference to how changes in health status along with contamination when collecting or preserving urine samples can cause abnormal levels of substances in three or more cases.

For pass standard, learners will provide clear details about how normal biochemical values are maintained in the body in relation to urine production, and why these are among the first tests ordered when diagnosing and treating patients.

Learners will carry out simple urinalysis tests, accurately identifying the changes in three or more substances in samples of urine and suggesting what these changes indicate in relation to health. They must specify how the samples of urine should be obtained in order to prevent misleading results.

Links to other units

This unit links to:

- Unit 1: Principles and Applications of Science I
- Unit 2: Practical Scientific Procedures and Techniques
- Unit 4: Laboratory Techniques and their Applications
- Unit 5: Principles and Applications of Science II
- Unit 8: Physiology of Human Body Systems
- Unit 10: Biological Molecules and Metabolic Pathways
- Unit 17: Microbiology and Microbiological Techniques.

Employer involvement

Centres may involve employers in the delivery of this unit if there are local opportunities. Visiting speakers from health centres, the blood transfusion service, doctors’ surgeries and pathology laboratories can give a valuable insight into their work.

All large hospitals have laboratories where blood products, cells and so on are dealt with. Since health and safety regulations may make it difficult to gain access, it is possibly best to approach the head of the medical services at a local hospital or the blood transfusion service to find out what access, speakers or other facilities are available to a centre teaching this unit.