Unit 15: Biochemistry for Health

Unit code: F/600/8970

QCF Level 3: BTEC Nationals

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to enable learners to gain knowledge of biochemical principles such as the structure of molecules of life, and the structure and function of enzymes, and to understand disorders related to metabolism.

Unit introduction

The study of biochemistry has been associated with the great expansion of knowledge that has taken place in the recent past. Its importance lies in that it covers the fundamental knowledge that relates to physiology – the way in which body systems work. This has direct relevance to for example the healthcare, nutrition and pharmaceutical industries. Studying this unit will support learners who plan to progress to further or higher level studies in the health sector.

Initially, the unit examines atomic and molecular structure, focusing on the relationship between structure and properties, with reference to biological molecules and the support and maintenance of life. Learners will gain an understanding of a range of inorganic and organic molecules.

The unit examines the principles of metabolism, considering certain metabolic pathways and the role of enzymes in metabolism. Learners will use the principles of the scientific method to carry out practical investigations involving enzymes. They will then consider metabolic disorders, the nature of these and their causes and effects.

Learning outcomes

On completion of this unit a learner should:

1 Know the structure of the molecules of life

2 Understand the principles of metabolism

3 Be able to demonstrate the factors affecting enzyme activity

4 Understand disorders of metabolism.

Unit content

1 Know the structure of the molecules of life

Atoms: nucleus (neutrons, protons); electrons; electronic configuration of hydrogen, carbon, oxygen, nitrogen atoms and the relevance to biological molecules

Inorganic molecules: water – configuration, properties – eg as a solvent, surface tension, importance of hydrogen bonds; carbon dioxide – configuration, covalent bonds; sodium chloride, ionic bonds; ions, eg hydrogen carbonate, phosphate

Organic molecules: condensation in building polymers and configuration structure hydrolysis in breaking them down; proteins (primary, secondary, tertiary and quarternary structure, peptides, amino acids); carbohydrates (polysaccharides – starch, glycogen, cellulose); disaccharides (sucrose, maltose, lactose); monosaccharides (glucose, fructose, galactose); lipids (fatty acids – saturated, monounsaturated, polyunsaturated; glycerol, triglycerides, phospholipids and their role in cell membranes and as surfactants in the lungs, cholesterol); nucleic acids (nucleotides – base, pentose sugar, phosphate group; DNA, double helix, complementary base pairing, RNA, mRNA, tRNA, role in protein); synthesis; mitosis – cell replication in growth and repair, prophase, metaphase, anaphase, telophase

Food analysis: practicals, eg for starch, reducing sugar, non-reducing sugar, protein; health and safety; structured scientific report

2 Understand the principles of metabolism

Metabolism: anabolism, eg protein synthesis; catabolism, eg respiration; role of glucose and ATP

Metabolic pathways: cellular respiration – glycolysis, Krebs cycle, oxidative phosphorylation, generation of ATP, anaerobic respiration, lactic acid, oxygen debt and recovery

3 Be able to demonstrate the factors affecting enzyme activity

Enzymes: role in metabolism; structure; properties, denaturation, active site, specificity, theories of enzyme action; co-enzymes, co-factors, inhibitors; effects of substrate and enzyme concentrations, temperature and pH on rate of reaction

Investigation: principles of the scientific method; any two factors affecting enzyme activity; health and safety; structured scientific report

4 Understand disorders of metabolism

Metabolic disorders: resulting from inborn errors of metabolism, resulting from disorders of the endocrine system; cause; effects; screening/diagnosis; treatment/management

Inborn errors of metabolism: genetic defects, eg phenylketonuria, homocystinuria, galactosaemia, glycogen storage disease, inherited fructose intolerance

Disorders: of the endocrine system, eg diabetes mellitus, hyper/hypo-thyroidism, hyper/hypo-parathyroidism

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 structure of hydrogen, carbon, oxygen and nitrogen and relate these to the structure of biological molecules [IE1; SM2; SM3]	**M1** explain the relevance of the electronic configuration of hydrogen, carbon, oxygen and nitrogen to biological molecules	
P2 describe the structure of water and carbon dioxide with reference to different types of bonding [SM2; SM3]		
P3 describe the structure and function of organic molecules [SM2; SM3]	**M2** explain the relationship between the structure and function of organic molecules	**D1** analyse the behaviour of molecules in relation to the functioning of animal cells
P4 explain the processes of aerobic and anaerobic respiration [SM2; SM3]		
P5 demonstrate the factors that affect enzyme activity [IE4; TW2; EP3]	**M3** use data from experimental work to explain the role of enzymes in the body.	**D2** analyse the role of enzymes in metabolism.
P6 explain the causes of different types of metabolic disorders. [IE4; SM2]		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills which are embedded in the assessment of this unit. By achieving the criteria, learners will have demonstrated 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 unit should be delivered by a tutor who is appropriately qualified in chemical/biochemical sciences. Access to laboratory facilities will be necessary for the assessment of the unit.

Tutors will need to introduce the unit, but learners could use resources in class and research atomic structure in relation to the elements listed in the unit contents. They could then explain the relevance of the electronic configuration, with regard to biological molecules, to their peers.

A similar approach could be used for the molecular configuration of water, carbon dioxide and sodium chloride, with reference to the different types of bonding. This approach could aid learner understanding and provide a good foundation for this and other units in the programme, encouraging learners to relate structure at an atomic and molecular level to the functioning of compounds.

The structure and functions of organic molecules could be delivered through a combination of tutor input, individual research, posters and presentations, with the emphasis again being on the functions of molecules as conferred by their configuration.

The principles of metabolism can be delivered in a similar way, encouraging active learning through a combination of approaches. Practical work can be used to break up theory sessions, including undertaking practical food analysis or enzyme investigations (which are required for assessment purposes).

Metabolic disorders could be introduced through the use of relevant television documentaries, or other DVD/video materials. Learners may have experience of individuals with metabolic disorders either through their work-placement experiences or personal lives, and presentations could be used as a means of sharing this and other information about a range of metabolic disorders with peers.

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
Unit introduction.
Learning outcome 1 Tutor input/models: atomic structure and the molecular structure of inorganic molecules should build on work studied for GCSE. Learner research/models: different types of bonding. Tutor input/models: organic molecules. DVD/demonstration/discussion: structure of organic molecules; models could also be used to demonstrate structure; function of organic molecules should be limited to those relevant to human biology.
Practical work: basic identification of biochemicals using standard tests on standard solutions, including reducing and non-reducing sugars, starch, lipids and proteins. Common foods such as bread, egg white, milk, fruits, oil should then be tested. This could be carried out in small groups and the results shared. Group discussion: comparing with expected results and explaining discrepancies.

Topic and suggested assignments/activities and/assessment
Assignment 1: Molecules of life (P1, P2, P3, M1, M2, D1)
Learning outcome 2 Tutor input: general introduction to metabolism. Tutor input: cellular respiration (for example, running a race). Practical activity: learners could carry out exercise activity such as the Sargent jump or a 50 metre dash to calculate anaerobic power. Learner research: determine the dominant type of respiration for different track and field events or the change of respiration type during a marathon. (There is a lot of information on this topic in sport and fitness books and journals.)
Assignment 2: Cellular respiration (P4)
Learning outcome 3 This could follow on from work on the structure and function of proteins. Tutor input/models: properties of enzymes. Learner research/data sheets: different factors affecting enzyme activity and produce posters or presentations to the rest of the group.
Practical activity: learners should carry out simple experiments to show factors affecting enzyme activity. Many learners will have already carried out experiments on the effects of temperature and pH on the activity of starch and, if possible, replication of these should be kept to a minimum although some practical techniques may need revising. There are examples of alternative experiments on, for example, the effects of enzyme and substrate concentration. Learners could make their own dilutions of enzyme and/or substrate and draw graphs of their results. If classes are large enough, and there are suitable facilities, different groups could carry our different experiments. The results of these experiments should be related to the structure of enzymes to enable learners to achieve the higher grades.
Assignment 3: Enzymes (P5)
Practical work: writing up the food test experiments and the experiments on the factors affecting enzyme activity. (Some tutor input may be required to explain the conventional format of a scientific report.)
Learning outcome 4 Tutor input: introduce learners to metabolic disorders; use of case studies to lead into learner research. Learner research: metabolic disorders.
Assignment 4: Metabolism (P6, M3, D2)
Unit review and assessment.

Assessment

Four assignments could be used to assess this unit, although they could also be broken down into smaller units of assessment, as appropriate for learners.

The first assignment could provide the assessment vehicle for P1, P2, P3, M1, M2 and D1. Evidence could take the form of a combination of written work, diagrams, posters and presentation records. Care needs to be taken to ensure that evidence is authentic, in particular with regard to visual images and explanations downloaded from the internet or taken from textbooks. Evidence needs to be in the learner's own words, relating specifically to the assessment task, and referenced appropriately. Visual images need to be either annotated by learners, or explanations should be included in learners' own words.

For M1 and M2, clear explanations of the relationship between structure and function are required, whilst D1 links to and extends all other criteria in this assignment as it requires an analysis of the behaviour of the different molecules in animal cells in relation to their structure and composition. Evidence should be presented clearly with good use of scientific language and demonstrating thorough understanding of the subject.

P4 could be assessed in a separate assignment covering cellular respiration and a third assignment could then be used as the basis of evidence for P5. P6, M3 and D2 being assessed in a fourth assignment. Evidence could be presented in the form of descriptive work supported by images, diagrams and posters, and a scientific report based on the laboratory work. For M3, learners should assess the data they obtain through their practical work and use it to support an explanation of the role of enzymes in the body. This should be extended to a more detailed analysis for D2. For example, learners could take a specific metabolic pathway and analyse the role of the enzymes in that pathway, linking this to metabolic disorders metabolism and the potential consequences.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the 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, P3, M1, M2, D1	Molecules of life	A basic knowledge of biochemistry is essential for those working in the health sector. It is the basis of physiological processes and the pharmaceutical industry. You need to demonstrate your knowledge of the atomic structure of simple elements and molecules.	Posters, presentations, annotated diagrams, practical report.
P4	Cellular respiration	Cellular respiration is an example of a metabolic pathway. Using a marathon as an example, describe the different processes that take place throughout the race. This could be through a series of annotated diagrams.	Report, essay, annotated diagrams.

Criteria covered	Assignment title	Scenario	Assessment method
P5	Enzymes	Metabolism is the sum of all the different chemical reactions in the body. Most of these reactions are controlled by enzymes which allow them to occur at relatively low temperatures. You need to carry out two experiments which demonstrate how two factors affect enzyme activity.	Practical scientific report.
P6, M3, D2	Metabolism	Choose two types of metabolic disorder and describe their causes, effects and management.	

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

This unit forms part of the BTEC Health and Social Care sector suite (see *Appendix A*) and has links with units from other qualifications in that suite. See *Appendix E* for NOS links and *Appendix G* for a mapping of the NHS Knowledge and Skills Framework against particular units in this qualification.

Essential resources

The following resources are essential for delivery of this unit:

- an appropriately qualified tutor
- library resources with key texts and other reference materials
- access to laboratories for practical experimentation
- equipment for the practical tasks.

In addition, videos/DVDs are considered to be highly valuable.

Employer engagement and vocational contexts

- Hospital placements.
- Visit to biochemical department of a hospital.
- Visit to a pharmaceutical company.

Indicative reading for learners

Textbooks

Adds J, Larkcom E and Miller R – *Molecules and Cells* (Nelson Thornes, 2003) ISBN 9780748774845

Clancy J and McVicar A – *Physiology and Anatomy: A Homeostatic Approach, Second Edition* (Hodder Arnold, 2002) ISBN 9780340762394

Clegg C J and Mackean D G – *Advanced Biology Principles and Applications* (John Murray, 2000) ISBN 9780719576706

Green N P O, Stout G W and Taylor D J – *Biological Science 1 Organisms, Energy and Environment* (Cambridge University Press, 1997) ISBN 9780521567213

Jones M and Jones G – *AS Biology: Molecules and Cells* (Collins, 2000) ISBN 9780003277128

Kent M – *Advanced Biology (Advanced Science)* (Oxford University Press, 2000) ISBN 9780199141951

Myers B – *The Natural Sciences* (Nelson Thornes, 2004) ISBN 9780748785834

Shaw L – *Anatomy and Physiology* (Nelson Thornes, 2004) ISBN 9780748785841

Stretch B and Whitehouse M – *BTEC Level 3 Nationals in Health and Social Care Student Book 1* (Pearson, 2010) ISBN 9781846907663

Stretch B and Whitehouse M – *BTEC Level 3 Nationals in Health and Social Care Student Book 2* (Pearson, 2010) ISBN 9781846907470

Toole G and Toole S – *Understanding Biology for Advanced Level* (Nelson Thornes, 1999) ISBN 9780748739646

Journals and magazines

Biological Science

New Scientist

Nursing Times

Website

www.bbc.co.uk/science/humanbody	BBC resource on human mind and body

Delivery of personal, learning and thinking skills

The following table 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] asking questions when researching the atomic structure of molecules [IE4] considering the results of their practical work and evaluating information for its relevance when researching metabolic disorders
Team workers	[TW2] working together to carry out their practicals to reach agreement as to who does what
Self-managers	[SM2] planning time to complete assignments, working towards deadlines, showing commitment and perseverance [SM3] organising themselves when conducting experiments as well as planning time to complete assignments in a timely fashion, prioritising actions
Effective participators	[EP3] planning their practical work and breaking down the method into manageable steps.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching for assessments, selecting information from a variety of sources
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching for assessments, using search engines and assessing the relevance of the information
ICT – Develop, present and communicate information	
Bring together information to suit content and purpose	producing annotated diagrams, bringing together and organising components of images and text
Present information in ways that are fit for purpose and audience	producing written work, proofreading to ensure accuracy producing practical reports on experiments using an accepted convention
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	researching different metabolic disorders, presenting and contributing to group discussions researching different aspects of enzyme function and the different molecules
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching different disorders of the nervous and endocrine systems
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	communicating ideas in a concise, clear and logical manner using an appropriate style of writing when producing their practical reports presenting work with accurate spelling, punctuation and grammar.