Unit 13: Biological Molecules and Metabolic Pathways

Delivery guidance

Your learners will have come across respiration and photosynthesis and other biological systems in plants and animals. In this unit, you will be helping them to look at and appreciate the biological molecules that are the basis of the many biological systems in plants and animals. Therefore, most of this unit will be new to your learners especially in terms of the approach taken.

Your learners will need access to a suitable laboratory where they can carry out experiments concerning respiration and photosynthesis. They will also be required to research information about biological molecules and relate them to living organisms. A different emphasis concerning the fundamental molecules that are so important to all living organisms, is being studied in this unit. You will need to guide and discuss with your learners the role of the building blocks (biological molecules) that underpin all the systems in a living organism.

Approaching the unit

You may decide to do **learning aims A and B** together as they deal with structure and function and are assessed together. Four basic molecules: water, carbohydrates, proteins and lipids are the subject of learning aim A in terms of their structure. You will need to use 3D molecular models and any other visual representations such as computer-generated models so your learners can see the structure of these molecules. This will be very important in the proteins where your learners will find the 4-dimensional (4D) structures difficult to visualise. Understanding these structures is vital if your learners are to appreciate their functions in the next learning aim.

If your learners are thoroughly familiar with the 3-dimensional (3D) structure of the molecules in learning aim A, then their functions at a molecular level within living organisms will be made much easier for learning aim B. You will need to consider each of the groups mentioned in learning aim A in terms of how it functions in normal systems. This subject matter is very detailed and a mixture of research, class discussions, problem solving (such as matching a series of cards with functions written on them to the correct molecule) and the use of spider diagrams will show how their functions interact or in other cases are very specific.

The last part of this aim considers what happens if the molecular set-up is disrupted. A list of possible examples is given in the specifications but you could use other ones. Research could be a starting point and then use case studies or card games such as matching a particular disease with the associated biomolecular disruption. You must remember to include plants. The use of photomicrographs, videos and access to a website showing various diseases of living organisms resulting from biochemical malfunctions will make the subject more interesting to your learners. It is worth directing your learners to certain sites or giving them specific words to use in a search engine.

Your learners will be familiar with a more simplistic version of the respiratory pathways and equations compared with the ones they will now meet. You may decide to remind them of the work done previously in respiration and then start the practical work on the effect of activity on respiration.

If done in this order, then the results of their experiments can be the starting point for a discussion on the biochemistry of respiration. Your input as a tutor will be needed plus visual aids such as computer-simulated models of the stages of aerobic respiration. Using as much visual material as possible such as flow charts, diagrams etc. will help your learners follow a complicated biochemical pathway.

Your learners can find out what factors other than exercise can affect respiration by doing their own research and taking part in class/group discussions. You could give them secondary data and case studies that focus on the factors affecting respiration.

Plants and photosynthesis are not usually of much interest to your learners, as they often prefer human-related topics. For **learning aim C**, you may decide to do some practical work in the laboratory based on what factors affect photosynthesis. You could do an introduction by getting your learners to think about food chains and how they all begin with plants. Use this to start your learners thinking about the role of photosynthesis and what may affect it. You will need to guide your learners regarding what practical work they do and plan it carefully because some tasks are quite time consuming and reliant on the time of year.

The theory work on the pathways in science will initially have to be tutor-led as well as using visual aids such as computer-simulated models of the light and dark stages. Use as much visual material as possible such as flow charts, diagrams etc. as these will help your learners follow a complicated biochemical pathway. You will need to have secondary data available as part of a class discussion.

Be aware of all health and safety regulations when doing practical work and make sure that you and your learners carry out risk assessments for all practical work.

Input from speakers or visits to sports training laboratories where the effects of exercise on athletes are measured would give the topic a vocational aspect.

Assessment Model

Learning aim	Key content areas	Recommended assessment approach
A Understand the structure and function of biological molecules and their importance in maintaining biochemical processes	**A1** Water **A2** Carbohydrates **A3** Proteins and nucleic acids **A4** Lipids **A5** Disruption of biochemical processes in living organisms	A report or a visual display with explanations, that include: • the molecular structure of proteins and the basic biochemical properties they show. • links between molecular structure, their properties and role and importance in the importance in the human body, including the effect of disruption of biochemical processes in humans and plants.
B Explore the effect of activity on respiration in humans and factors that can affect respiratory pathways	**B1** Respiration **B2** Effect of activity on respiration **B3** Effect of activity on requirements for oxygen and output of CO_2	A portfolio of evidence to include: • practical work and results, which can be recorded in lab notebooks, signed off by the tutor/observer. • record of analysis, conclusions, evaluation and any research work can be by a written essay, diagrams, flow charts.
C Explore the factors that can affect the pathways and the rate of photosynthesis in plants	**C1** Pathways in photosynthesis **C2** Factors that can affect pathways in photosynthesis	A portfolio of evidence, to include: • practical work and results which can be recorded in lab notebooks, signed off by the tutor/observer. • record of analysis, conclusions, evaluation and any research work can be by a written essay, diagrams, flow charts

Assessment guidance

The assignments are a mixture of research and practical work. All practical work is done in a laboratory equipped for Level 3 work (A level). Your learners should be given instructions about each piece of practical work; they are not expected to devise their own methods. Your learners should be made aware that they will be observed and assessed as to how competently they carry out the practical work. You should ideally allow them to do non-assessed practical work before a final assessment is done. All assessed practical work must be recorded in their laboratory notebooks, as this will be the basis of further assessment criteria.

For learning aim A, you will need to supply learners with a lot of information before they begin their research. You will need to remind them about molecular structures and how to represent them visually. Once you are sure about their understanding of structure, your learners can then begin their research on the functions of the molecules. Encourage your learners to present their work in a visual way using annotated diagrams and using the accepted notation for representing molecular structures. You will need to guide their research on the effects of disruption to biological molecules and use class discussion or some case studies to help your learners evaluate the effects of disruption.

A portfolio of evidence will be required for learning aim B, including your learners' practical notebooks in which are recorded the results of their experiments. These experiments will be observed and your learners must be made aware of what is being looked for. You will need to give secondary data to use in analysis and help learners to evaluate the harmful effects of some substances on respiration. The harmful substances may have been the subject of a research project at any time during this unit.

A portfolio of evidence will be required for learning aim C, including your learners' practical notebooks in which are recorded the results of their experiments. These experiments will be observed and your learners must be made aware of what is being looked for. The key word in the *Essential Information for Assessment Decisions* is 'competently' so results may not be as expected but you are observing how competently they carried out their work. You will need to give secondary data to use in analysis and help learners to evaluate the factors that affect the efficiency of photosynthesis. Encourage your learners to present their theory work in the most appropriate way, for instance, the stages of photosynthesis lend themselves to annotated flow charts.

Getting started

This provides you with a starting place for one way of delivering the unit, based around the recommended assessment approach in the specification.

Unit 13: Biological Molecules and Metabolic Pathways

Introduction

Your aim in this unit is to introduce both background knowledge and practical skills that learners can transfer to other situations when the unit is complete. You should engage your learners actively with the practical work. As your learners may find some parts of this work difficult, some input via tutorials/lessons will be required. You will need to direct their research work and encourage the exchange of information by group and class discussions.

You may decide for instance, to do the practical work regarding respiratory activity and use the results along with secondary data as a discussion point. This can lead into the structure and role of biological molecules. This same idea applies to learning aim C.

Learning aim A – Understand the structure and function of biological molecules and their importance in maintaining biochemical processes

- Give tutor input, reminding your learners of their knowledge of molecules in terms of structure, and how to represent them diagrammatically.
- Learners should undertake individual activity practicing the diagrammatical representation of biological molecules.
- Lead a discussion/research on comparing biological structures: how similar/ dissimilar are they in structure and what are the implications, in terms of their activity?
- You should give learners a list of the functions of biological molecules and they must match the function against the biological molecules (water, carbohydrates, proteins, lipids).
- Group or individual research about what the effects of disruption are on the functions of biological molecules. You may need to give each group one or two factors to investigate, such as, what is the cause of lactose intolerance? Do not forget that plants are included in this work.

Learning aim B – Explore the effect of activity on respiration in humans and factors that can affect respiratory pathways

You can do this suggested assignment in two ways, either by doing the practical work first and following up with theory or vice versa.

- You could give an introduction/encourage a discussion looking at the effects of exercise on respiration.
- Practical work on the effects of respiratory rates and exercise:
    - Find out the respiratory rates before and after exercise.
    - Find out the recovery rates after exercise.
    - What effect does exercise have on carbon dioxide output?
- Arrange an observation of your learners by a suitably qualified person as to their competency in doing the experiments.

- Learners could carry out individual research on the factors that affect respiration.
- Encourage a class discussion about the factors that affect respiration rates –use your learners' results, secondary data you give them and their own research on factors such as smoking, drugs, pollutants, disease etc.
- You could give input on the stages in aerobic respiration.
- Discuss with class how is the best way to represent these stages when they explain them to meet the criteria.
- Lead a discussion about the most appropriate way to present the information.

Learning aim C – Explore the factors that can affect the pathways and the rate of photosynthesis in plants

You can do this suggested assignment in two ways, either by doing the practical work first and following up with theory or vice versa.

- Encourage a discussion about how plants can make their own food molecules as opposed to ingesting and converting molecules to ones they can deal with, as in animals. This will need to include a reminder about the basic processes of photosynthesis, i.e. revision of Level 2 work (GCSE or iGCSE).
- Arrange for learners to carry out practical work on the factors that affect photosynthesis:
    - light intensity
    - CO_2 concentrations
    - water
    - temperature
    - plant pigments
    - wavelengths of light.
- You should arrange observation of your learners by a suitably qualified person as to their competency in doing the experiments.
- You could ask learners to carry out individual research on the factors that affect photosynthesis.
- Class discussion about the factors that affect photosynthetic rates – use your learners' results, secondary data you give them and their own research.
- Give input on the stages in photosynthesis.
- Discuss with class how is the best way to represent these stages when they explain them to meet the criteria.
- You could lead a discussion about the most appropriate way to present the information.

Details of links to other BTEC units and qualifications, and to other relevant units/qualifications

This unit links to:

- *Unit 1: Principles and Applications of Biology l*
- *Unit 5: Principles and Applications of Biology ll*
- *Unit 9: Biomedical Science*
- *Unit 11: Functional Physiology of Human Body Systems*
- *Unit 12: Human Regulation and Reproduction*
- *Unit 14: Genetics and Genetic Engineering.*

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC International qualification in Applied Science. Check the Pearson website (http://qualifications.pearson.com/endorsed-resources) for more information as titles achieve endorsement.

Textbooks

Blankenship, Robert E., *Molecular Mechanisms of Photosynthesis*, 2nd edition, Wiley-Blackwell, 2014 (ISBN: 978-1405189750).
A useful reference book.

Ferrier, Denise R., *Biochemistry (Lippincott's Illustrated Reviews Series)*, 6th edition, Lippincott Williams and Wilkins, 2013 (ISBN: 978-1451187533).
An illustrated book to help the learner – written expressly for advance level learners.

Tortora, Gerard J. and Derrickson, Bryan H., *Principles of Anatomy and Physiology*, John Wiley & Sons, 2011 (ISBN: 978-0470565100).
A very well-known book which covers in detail all the information required for human biology – a standard reference book for learners.

Williams, Andrew, *Photosynthesis – Advanced Biology Study Notes: For Teachers and Students* (includes a mock exam), 1.2 edition, CreateSpace Independent Publishing, 2013 (ISBN: 978-1493588855).
This is helpful for learners to use and test their knowledge.

Journals

Using your search engine and typing in 'Biology journals' will give you access to a wide range of journals most of which are suitable for science tutors to refer to. Other journals such as this is useful for reference:

New Scientist Scientific American

Websites

http://www.bing.com/images/search?q=photosynthesis&qpvt=photosynthesis&qpvt=photosynthesis&FORM=IGRE
Hundreds of diagrams illustrating photosynthesis at various levels – good discussion points and eye-catching images for your learners.

https://www.youtube.com/watch?v=Rh6JaCj5cz8

Video on human respiration.

http://www.bing.com/images/search?q=biological+molecules&qpvt=biological+molecules&qpvt=biological+molecules&FORM=IGRE

Lots of coloured images of molecules which make a good discussion starting point.

Good visual starting point for discussion on biological.

http://chemistry.tutorvista.com

Pearson is not responsible for the content of any external internet sites. It is essential for tutors to preview each website before using it in class so as to ensure that the URL is still accurate, relevant and appropriate. We suggest that tutors bookmark useful websites and consider enabling learners to access them through the school/college intranet.