Unit 19: Microbiology and Microbiological Techniques

Delivery guidance

Approaching the unit

The emphasis for this unit is on assessed practical work that learners will use to meet the criteria. Your learners will have some experience of this practical work, but you should aim to extend their skills to ensure they have competencies that are transferable to the workplace.

You will need access to a suitable laboratory, and equipment for using microscopes and dealing with microbes. As the teacher, you will be involved in ensuring your learners work within health and safety regulations. Your learners must be fully aware they will be observed and assessed during the practical work. Your learners will be expected to present the outcomes of their practical work in an accepted format.

Ideally, work placements will help your learners develop laboratory skills in microbiology, but if this is not possible, then visits or talks from staff involved in the work will help give a vocational context to this unit. This is an exciting unit because of the emphasis on practical work and the development of microbiological skills.

As they do this unit, your learners will be increasingly aware of the role played by microbes in recent outbreaks of very serious epidemics originating abroad and how easily they can be transmitted globally.

This unit will help your learners to appreciate the opportunities available in not only local health services, but in the many laboratories that supply microbiological services. Using visiting speakers, such as a doctor, public health official, infection control nurse or environmental protection officer, or a visit to a diagnostic laboratory, etc. will help learners understand the vocational nature of the programme and unit.

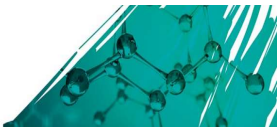
Your learners will need to be aware that a number of jobs require degree level qualifications, but this unit gives a foundation so they can make an informed choice of career.

There are many training posts available for technicians who work under the supervision of qualified microbiologists, so job progress is a feature of microbiology. There is also the challenge of working in an environment where microbe mutation, and therefore resistance to antibiotics, is a constant possibility.

Delivering the learning aims

Learning aim A is assessed along with learning aim B, so you may decide to do the practical work on microbes by using microscopes and then research their structure, etc. Whichever approach you use, your learners can work in groups to research the structure, characteristics, classification and replication of microorganisms. Make sure your learners look at a variety of microorganisms, as suggested in the specification. You might suggest each group concentrates on a particular group of microorganisms, but you will then have to arrange for the exchange of information between groups. The learners' final reports must be their own individual work, in order to cover all the assessment criteria.

Learning aim B, although assessed with learning aim A, is focused on practical work. The setting up and use of light microscopes and different lenses requires observation to ensure the learners undertake the procedures correctly. This will also include the preparation of slides and mounting of samples using different techniques. The structure of microorganisms is explored using a light microscope and an oil immersion lens. Your learners may need reminding about using microscopes. Your aim is to observe them setting up and using microscopes safely and competently in order to



demonstrate transferable skills.

Your learners will need to research other types of microscopes so they are aware of the capacity of these microscopes, plus the advantages and disadvantages in their use. If visits to laboratories with, for instance, an electron microscope are possible, this would aid your learners in their understanding of such machines.

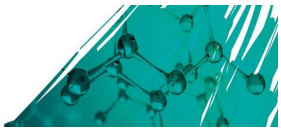
You may decide to do **learning aim C** prior to learning aims A and B so your learners are familiar with aseptic techniques prior to working with microbes. For learning aim C, which will be assessed alongside learning aim D, your learners will be demonstrating their competences in aseptic techniques in order to culture microorganisms. This is practical work and you should try to make the laboratory as near to a workplace scenario as you can. For instance, you should insist on laboratory coats being worn and not being removed from the laboratory, and instruct learners that only essential writing materials should be taken into the laboratory, with all bags/coats, etc. being left outside. Strict hygiene rules are applied prior to entry. Within the laboratory, the same COSHH rules must be applied with learners wearing gloves, eye protection, etc. The usual disinfectant sprays should be used for work benches, prior to and after work, with frequent changes of gloves as needed, which are then disposed of in safety bins. Obviously, work placement in a microbiological laboratory would be ideal, but wherever the work is carried out, your learners must be observed doing practical work in order to meet the criteria.

Your learners will need to research how commercial laboratories deal with microorganisms in terms of biocontainment. It will be interesting for them to compare different situations including those in their own laboratories and perhaps also at a local university.

Learning aim D is based on assessment of your learners' work carried out in a laboratory. Group work will be the most efficient and effective way of approaching growth requirement and inhibitors. It would be very time consuming to expect your learners to carry out all the possible experiments. You will probably have to delegate certain practical work to your groups, and then hold feedback sessions. In this way, all your learners will have enough knowledge to meet the criteria.

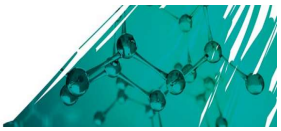
Again, this learning aim is based on observation of your learners as they carry out practical work so you must ensure that, even if they work in groups, each learner does demonstrate the skills being assessed in the criteria. Class discussions will be important if your learners are to analyse their data. You will need to give some case studies involving secondary data so your learners can be involved in coming to conclusions about growth factors and their effects.

For this unit, it is expected that practical guidance on what to do will be given to your learners, so there is no need to for methods to be written up. The criteria are focused on your learners competently carrying out the practical work you have set, being able to report their findings, and undertaking analysis, evaluation and justification.



Summary of the unit

Learning aim	Key content areas	Recommended assessment approach
A Understand the importance of microbial classification to medicine and industry	**A1** Microorganisms and infectious agents **A2** Classification **A3** Microorganisms in medicine and industry	A research report using any appropriate format that covers four of the listed microorganisms. Practical work setting up and using light microscopes and oil immersion lenses to look at the structure of microorganisms. Scientific drawings of specimens, laboratory notebooks and practical write-ups supported by teacher observations. A presentation of their work, which also outlines the uses and limitations of the instruments used when compared to other types of microscopy, including specimen preparation and imaging.
B Undertake microscopy for specimen examination in laboratories	**B1** Microscopes **B2** Specimen and slide preparation **B3** Setting up and using a compound light microscope	
C Undertake aseptic techniques to culture microorganisms	**C1** Safety and prevention of contamination in microbial culturing **C2** Growth media **C3** Inoculation and incubation	Laboratory notebooks recording the practical work done plus observations of practical work by suitably qualified staff. Any parts not covered in practical work can be addressed by research reports.
D Explore factors controlling microbial growth in industrial, medical and domestic applications	**D1** Growth requirements **D2** Growth inhibitors **D3** Measuring microbial growth	



Assessment guidance

Assessment is based on practical work carried out in a laboratory with facilities and equipment for advanced level work. There must be access to microscopes and suitable equipment for working with microorganisms. The laboratory must comply with all health and safety requirements and risk assessments must be done for every experiment both by the teacher and learner.

For learning aims A and B, the research report must cover four of the microorganisms listed. Your learners can present the report in a number of forms, such as using annotated diagrams that will cut out long descriptive passages. This same technique could be used for classifying the microorganisms and detailing their methods of reproduction..

The second part of this assignment focuses on practical work with microscopes and the observation of microorganisms. These parts of the assignment are assessed by observation of your learners setting up and working with a microscope, along with the illustrations produced. Observation records of them carrying out practical work will be required for B.P2. To access higher grades, learners will then need to follow this up with a comparison and evaluation of the use of microscopy techniques to observe structures and classify microorganisms.

Learning aims C and D are assessed together in the second assignment. is assessed, as far as possible, by observation of practical work... Your learners will be following instructions given to them so, as the assessor, you will be concentrating on the competence shown by your learners in preparing growth media, inoculating it and carrying out growth counts (C.P4/C.M3) and investigating which factors affect growth in microorganisms (D.P6) .

Accompanying the practical work in the second assignment, learners will also need to explain and compare biocontainment procedures used in the centre's own laboratory and industrial laboratories (C.P5/C.M4). In relation to growth, they will need to explain how growth inhibitors affect microorganisms (D.P7) and analyse the effects of environmental factors on their growth (D.M5). Finally they should evaluate their own aseptic techniques used to culture microorganisms with specific reference to the type of media, methods of inoculation chosen and the biocontainment procedures carried out. You will need to give learners some secondary data, perhaps set out as a case study, on other research about the factors that affect growth in microorganisms.

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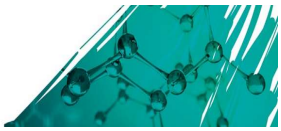


Getting started

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

Unit 19: Microbiology and Microbiological Techniques

Introduction

Start with a class discussion of what learners understand microbes to be. Are they useful or harmful? Where are they found and what do they look like? Use a spider diagram or flow chart to summarise these first thoughts. You may prefer to start with learning aim B, which is more practically based, before tackling learning aim A.

Learning aim A – Understand the importance of microbial classification to medicine and industry

A1/A2

- Group research and discussion to come up with the main classifications of microbes, the characteristics of each of the groups (bacteria, fungi, protozoa, viruses, viroids and prions) and their methods of replication.
- Groups should feed back to the whole class by presenting their work on a whiteboard, for example, so everybody can note it.
- Encourage class discussion to get a consensus about classifications and their characteristics, and how replication helps in this classification.
- Discuss with your learners the best methods of presenting this information – flow charts/diagrams/verbal presentation (assess content, not presentation skills, and you will need to have some form of written notes to back up a presentation).

A3

- A class discussion about the discovery of Penicillin could stimulate learners to research other antibiotics from microorganisms.
- Learners could produce a poster to show how microorganisms are useful in the field of medicine, food and drink production, biowaste processing, agriculture and in the digestive tract of humans.

Learning aim B – Undertake microscopy for specimen examination in laboratories

B1

- Ask your learners or groups to research light, phase contrast and electron microscopes and draw up a table of their characteristics, advantages and disadvantages.
- Use these tables as a discussion point with the whole class, making sure they understand the different techniques and consequent implications associated with each type of microscope. Details of the structure and workings of microscopes are not required unless they are needed in order to meet the criteria.

B2

- Learners should practise specimen and slide preparation.
- Carry out assessment observation of specimen and slide preparation.
- Learners should practise observation of slides of microorganisms and recording what is

seen using appropriate diagrams.

B3

- Give a demonstration of the parts of a microscope and the correct way to set one up, and use it with prepared slides. You could give them a suitable handout to refer to as they practise the skills before an actual observation.
- Encourage learners to practise the correct setting up and use of a microscope, including using an oil immersion lens.

Learning aim C – Undertake aseptic techniques to culture microorganisms

C1/C2/C3

- Give a demonstration on the preparation and inoculation of different growth media.
- Emphasise safety procedures, and as part of the class discussion after the demonstration, build up a visual representation of safety procedures that learners must follow.
- Learners should carry out research on classifications in biosafety and safety procedures, including levels of safety and biosafety cabinets.
- They should then research different growth media used in microbiology.
- Organise group/individual work, following procedures given to your learners, to: prepare growth media; inoculate media following regulations; and incubate the media following regulations.
- Carry out an assessment of preparation and inoculation of growth media using aseptic techniques.
- Carry out an assessment of measuring microbial growth. This may be done after your learners' own media have shown growth, or you may prefer to have more standardised media prepared with growths for your learners to measure.
- Encourage group/class discussions about the practical work done and the outcomes. Summarise these outcomes.
- Encourage group/class discussions about their understanding of biocontainment prior to carrying out research.
- Visits to microbiology laboratories/work placement/visiting speakers can be used at any time during the assignment.

Learning aim D – Explore factors controlling microbial growth in industrial, medical and domestic applications

D1

You should give a demonstration/discussion on the following:

Growth requirements

- Nutrients could include carbon, hydrogen, oxygen, nitrogen, sulfur, phosphorus, water, minerals, trace elements.
- The need for light, temperature preferences.
- Ability to thrive in carbon dioxide-loaded atmospheres.
- Growth surfaces.
- pH level preferences, such as acid/alkaline or neutral.

- You will need to guide learners to the practical experiments that need to be done. There will not be time for every learner to do every experiment. You will need to discuss with your learners how the work will be divided up and the use of class discussions to summarise the outcomes.

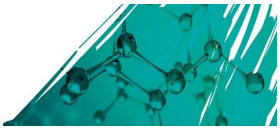
D2

Growth inhibitors

- Irradiation – set this as theory research for your learners and for class discussion.
    - Antimicrobials – antibiotics, antivirals set as a research project, or learners can use household products that claim to be antimicrobial products.
    - Antifungals – set this as a research project or learners can use household products which claim to be antifungal products.
- Disinfectants, such as household products.
- Sterilisation procedures: ask the groups to do research on this topic and relate it to procedures used in food preparation, operating theatres, etc.
- Osmotic potentials in strong salt/sugar solutions as preservatives: use class discussion in addition to practical work to relate this to the use in preserving foodstuffs, etc. in industry.
- Controlled atmosphere for food preparation.
    - You will need to guide learners to the practical experiments that need to be done. There will not be time for every learner to do every experiment. You will need to discuss with your learners how the work will be divided up; use class discussions to summarise the outcomes. Observation of the learners' practical work is part of the assessment criteria.

D3

- Give demonstrations on:
    - colorimetry for fungal, bacterial and viral growth showing turbidity
    - haemocytometer, such as in yeast cell counts
    - mycelial discs measured as increase in diameter or dry mass
    - counting bacterial colonies and use of serial dilution.
- Learners should carry out group/individual work, following procedures given to them, to practise some of the techniques shown in your demonstration.
- Group work on case studies can be set around the topics mentioned above. This will help your learners to apply the knowledge gained from their practical work.
- Give case studies that include secondary data about growth inhibitors for your learners, to discuss in relation to their own findings.
- Give guidance to your learners about the presentation of their work. Where instructions about practical work were given to your learners, they should not need to submit them as part of the assessment



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 I
- Unit 5: Principles and Applications of Biology II
- Unit 9: Biomedical Science
- Unit 11: Functional Physiology of Human Body Systems
- Unit 14: Genetics and Genetic Engineering
- Unit 15: Diseases and Infections

Resources

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

Textbooks

Alexander, SK and Strete, D *Microbiology: A Photographic Atlas for the Laboratory*, Pearson, 2000 (ISBN: 9780805327328).

Deacon, JW *Fungal Biology*, 4th edition, Wiley-VCH, 2005 (ISBN: 9781405130660).

Lammert, JM *Techniques for Microbiology: A Student Handbook*, Pearson, 2006 (ISBN: 9780132240116).

Madigan, MT, Martinko, JM, Bender, KS, Buckley, DH and Stahl, DA *Brock Biology of Microorganisms*, 14th edition, Pearson, 2014 (ISBN: 9781292018317).

Taylor, J *Bath Advanced Science – Micro-organisms and Biotechnology*, 2nd edition, Nelson Thornes, 2001 (ISBN: 9780174482550).

Waites, MJ, Morgan, NL, Rockey, JS and Higton, G *Industrial Microbiology – An Introduction*, Wiley-Blackwell, 2001 (ISBN: 9780632053070).

Websites

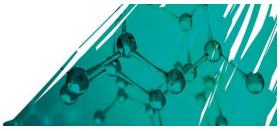
Visit the "Biotechnology and Biological Sciences Research Council" website. This is a UK Research Council and NDPB, and is the largest UK public funder of non-medical bioscience. It predominantly funds scientific research institutes and university research.

Visit "The British Mycological Society" website which gives useful educational resources on fungi.

The "Microbe World" website explores the world of microbes with vivid images and descriptions. Learn about microbiology, what microbiologists do, how they do it, and current topics.

Visit the "Microbiology Society" website; this is a membership organisation for scientists who work in all areas of microbiology. For teachers and technicians to refer to.

Visit the "Microbiology Online" website, for the Microbiology Society's online teaching resources.



Visit “virology.net” for an online catalogue of virus pictures and links to other virology websites.

Visit the “PubMed” website and search “antimicrobial activity of home disinfectants and natural products against potential human pathogens” for an abstract of an article on antimicrobial activity of home disinfectants.

“BBC Bitesize” offers good classroom resources, with links to BBC Science, BBC Lab UK and BBC Nature.

You can also use search engines, entering the following terms:

- antibacterial efficacy of disinfectants
- agar-disc diffusion method
- disinfectant efficacy testing procedures
- surface effectiveness test.

Pearson is not responsible for the content of any external Internet sites. It is essential for teachers 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 teachers bookmark useful websites and consider enabling students to access them through the school/college intranet.