

Cambridge TECHNICALS LEVEL 3

# APPLIED SCIENCE

Cambridge  
TECHNICALS  
2016

Unit 18

Microbiology

D/507/6165

Guided learning hours: 60

Version 3 - September 2016 - black line indicates updated content

## LEVEL 3

### UNIT 18: Microbiology

H/507/6166

**Guided learning hours:** 60

**Essential resources required for this unit:** Pre-irradiated plastic Petri dishes; pipettes and syringes; inoculating loops and spreaders; culture bottles; incubator; colorimeter; microscopes (oil immersion). Use of laminar-flow cabinets is desirable, but not essential.

**This unit is internally assessed and externally moderated by OCR.**

#### UNIT AIM

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Microbiology is the study of microorganisms. Microorganisms affect every aspect of life on Earth. Some microorganisms cause disease but the vast majority are completely harmless.

The beneficial uses of microorganisms have been recognised and exploited for thousands of years in brewing, bread making and yogurt production. Bacteria occupy every habitat on Earth and form a biomass that exceeds that of all plants and animals. We now make use of bacterial ecology and metabolism in the production of natural fertilizers, pesticides and herbicides. Recent developments also include industrial applications such as cleaning up pollution and mining, and the production of important chemical and pharmaceutical products using genetically-engineered microorganisms.

Microorganisms are also responsible for various diseases, however, which affect millions of people worldwide every year. As new antimicrobial therapies have been developed, microorganisms have developed resistance to them, and without the development of new drugs and other therapies, we face the possibility of unstoppable infectious diseases, as in the pre-antibiotic era.

In this unit you will learn about the commercial use of microorganisms in food production and in medical microbiology. You will also develop a range of practical manipulative skills, including aseptic technique and those used in bacterial identification, which will enable you to work safely and competently in a microbiology laboratory.

## TEACHING CONTENT

The teaching content in every unit states what has to be taught to ensure that learners are able to access the highest grades.

Anything which follows an i.e. details what must be taught as part of that area of content. Anything which follows an e.g. is illustrative, it should be noted that where e.g. is used, learners must know and be able to apply relevant examples in their work, although these do not need to be the same ones specified in the unit content.

For internally assessed units you need to ensure that any assignments you create, or any modifications you make to an assignment, do not expect the learner to do more than they have been taught, but must enable them to access the full range of grades as described in the grading criteria.

Learning outcomes	Teaching content
The Learner will:	Learners must be taught:
1 Be able to classify and identify microorganisms	1.1 Groups of microorganisms, i.e.: <ul style="list-style-type: none"> <li>• viruses</li> <li>• archaeans</li> <li>• bacteria</li> <li>• microscopical invertebrates</li> </ul> 1.2 Classification of bacteria <ul style="list-style-type: none"> <li>• cocci</li> <li>• bacilli</li> <li>• spirilla</li> <li>• vibrios</li> </ul> 1.3 Techniques used to identify bacteria <ul style="list-style-type: none"> <li>• basic aseptic technique</li> <li>• colony morphology, i.e. shapes, colony margins, surface characteristics</li> <li>• gram staining</li> <li>• use of specialised growth media, i.e.:               <ul style="list-style-type: none"> <li>○ selective and differential media, i.e. MacConkey's, Mannitol Salt Agar (MSA)</li> <li>○ differential medium, i.e. blood agar</li> </ul> </li> <li>• serological and genetic methods</li> </ul>
2 Understand the use of microorganisms in agriculture	2.1 How microorganisms are used in sustainable agricultural practice i.e: <ul style="list-style-type: none"> <li>• natural fermentation, e.g. silage</li> <li>• biofertilizers</li> <li>• biopesticides</li> <li>• bioherbicides</li> </ul> 2.2 Energy production for agriculture, i.e.: <ul style="list-style-type: none"> <li>• anaerobic digestion (AD or biogas)</li> <li>• feedstocks</li> <li>• microorganisms involved</li> <li>• environmental benefits</li> </ul>

Learning outcomes	Teaching content
The Learner will:	Learners must be taught:
	<p>2.3 Genetic engineering of crops i.e.:</p> <ul style="list-style-type: none"> <li>• mechanism <ul style="list-style-type: none"> <li>○ Insertion of genes using vectors</li> </ul> </li> <li>• use in human food supply and animal feed</li> <li>• characteristics developed <ul style="list-style-type: none"> <li>○ nutritional characteristics</li> <li>○ insecticide resistance using <i>Bacillus thuringiensis</i> gene</li> <li>○ herbicide resistance</li> </ul> </li> </ul> <p>2.4 Evaluate the development of genetically-modified (GM) crops, i.e.:</p> <ul style="list-style-type: none"> <li>• scientific, ecological, safety and ethical implications</li> </ul>
3 Be able to use microbiology in food production	<p>3.1 Food industries that use microorganisms in production i.e.:</p> <ul style="list-style-type: none"> <li>• dairy industry</li> <li>• bread industry</li> <li>• brewing industry</li> <li>• wine industry</li> </ul> <p>3.2 Biochemistry of fermentation i.e.:</p> <ul style="list-style-type: none"> <li>• carbon and nitrogen sources for biosynthesis</li> <li>• energy source is organic substrate</li> <li>• glycolysis</li> <li>• an organic compound as the terminal electron acceptor in fermentation</li> <li>• optimum fermenter conditions <ul style="list-style-type: none"> <li>○ hygiene</li> <li>○ nutrients</li> <li>○ pH</li> <li>○ oxygen concentration</li> <li>○ duration of fermentation</li> <li>○ separation of product, if required</li> </ul> </li> <li>• chemical and physical nature of the product</li> </ul>
4 Understand the action of antimicrobials on microorganisms	<p>4.1 Types of antimicrobial, i.e.:</p> <ul style="list-style-type: none"> <li>• antibiotic</li> <li>• antiviral</li> <li>• antifungal</li> </ul> <p>4.2 Major classes of antibiotics, i.e.:</p> <ul style="list-style-type: none"> <li>• penicillins</li> <li>• sulfonamides</li> <li>• aminoglycosides</li> <li>• cephalosporins</li> <li>• tetracyclines</li> <li>• macrolides</li> <li>• glycopeptides</li> <li>• quinolones</li> <li>• monobactams</li> <li>• carbapenems</li> <li>• oxazolidinones</li> </ul>

Learning outcomes	Teaching content
The Learner will:	Learners must be taught:
	<p>4.3 Mode of action of antibiotics, i.e. affect:</p> <ul style="list-style-type: none"><li>• cell wall biosynthesis</li><li>• protein synthesis</li><li>• DNA synthesis</li></ul> <p>4.4 Antimicrobial resistance (AMR) i.e.:</p> <ul style="list-style-type: none"><li>• mechanism</li><li>• trends in and projected models for AMR</li><li>• implications for hospitals, nursing and care homes</li><li>• solutions to AMR<ul style="list-style-type: none"><li>○ more restricted use of antimicrobials; use according to prescription</li><li>○ combined use of antibiotics, i.e.: amoxicillin and clavulanic acid</li><li>○ development of new antibiotics and other therapies</li></ul></li></ul>

## GRADING CRITERIA

LO	Pass	Merit	Distinction
	The assessment criteria are the Pass requirements for this unit.	To achieve a Merit the evidence must show that, in addition to the Pass criteria, the candidate is able to:	To achieve a Distinction the evidence must show that, in addition to the pass and merit criteria, the candidate is able to:
1. Be able to classify and identify microorganisms	*P1: Identify the main groups of microorganisms	M1: Use techniques to identify microorganisms	D1: Evaluate the use of techniques used to identify microorganisms
2. Understand the use of microorganisms in agriculture	*P2: Describe the use of microorganisms in sustainable agriculture		
	*P3: Describe how GM crops are produced	M2: Describe the advantages of GM crops	D2: Evaluate the consequences of the introduction of GM crops
3. Be able to use microbiology in food production	*P4: Describe the use of microbes in food production	M3: Explain the optimum conditions for growth of microorganisms during a fermentation process	
	*P5: Produce a microbiological food product under optimum conditions	M4: Describe the biochemical processes involved in the production of a food from microorganisms	
4. Understand the action of antimicrobials on microorganisms	*P6: Identify the types of antimicrobial used in medicine	M5: Describe current and projected trends in AMR	D3: Evaluate measures to prevent future consequences of AMR
	*P7: Describe the mode of action of antibiotics		
	*P8: Describe the mechanism of antimicrobial resistance (AMR)		

## ASSESSMENT GUIDANCE

### LO1: Be able to classify and identify microorganisms

Learners should be able to identify microorganisms from samples of photographs applying identification techniques appropriately.

### LO2: Understand the use of microorganisms in agriculture

Rather than use chemicals to optimise crop production, microbes are used to lessen the impact on the environment.

Breeding programmes are used to improve animal and plant species. More recently genetically modified crops have been used in agriculture, in most cases the aim is to introduce a new trait to

the plant which does not occur naturally in the species. Learners should discuss the ethics of the use of microbiology in crop production.

### LO3: Be able to use microbiology in food production

For many years microbes have been used to produce food but they also have the potential to produce harmful pathogens that are harmful to animals and people. Learners will describe the use of microbes in food production and produce a microbiological food product under optimum conditions and describe the preservation processes to keep food safe from microbes and evaluate their effectiveness.

### LO4: Understand the action of antimicrobials on microorganisms

Bacterial infections can cause many symptoms but in most cases can be treated.

Learners should be able to describe a range of bacterial infections and explain in detail how an infection can be treated, emphasising the benefits of the treatment. Learners should safely carry out, using aseptic technique, an investigation to identify a bacteria, they will need to identify the susceptibility of a range of bacteria to arrange of antibiotics.

Feedback to learners: you can discuss work-in-progress towards summative assessment with learners to make sure it's being done in a planned and timely manner. It also provides an opportunity for you to check the authenticity of the work. You must intervene if you feel there's a health and safety risk.

Learners should use their own words when producing evidence of their knowledge and understanding. When learners use their own words it reduces the possibility of learners' work being identified as plagiarised. If a learner does use someone else's words and ideas in their work, they must acknowledge it, and this is done through referencing. Just quoting and referencing someone else's work will not show that the learner knows or understands it. It has to be clear in the work how the learner is using the material they have referenced to inform their thoughts, ideas or conclusions.

For more information about internal assessment, including feedback, authentication and plagiarism, see the centre handbook. Information about how to reference is in the OCR Guide to Referencing available on our website: <http://www.ocr.org.uk/i-want-to/skills-guides/>.

## SYNOPTIC LEARNING AND ASSESSMENT

It will be possible for learners to make connections between other units over and above the unit containing the key tasks for synoptic assessment. Please see Section 6 of the Qualification Handbook for more details. We have indicated in the unit where these links are with an asterisk.

Name of other unit and related LO	This unit:
<p><b>Unit 1 Science fundamentals</b></p> <p>LO1 Understand the chemical structures of elements and compounds</p> <p>LO2 Understand reactions in chemical and biological systems.</p> <p>LO3 Understand cell organisation and structures</p> <p>LO4 Understand the principles of carbon chemistry</p> <p>LO5 Understand the importance of inorganic chemistry in living systems</p>	<p>LO1 Be able to classify and identify microorganisms (P1)</p> <p>LO2 Understand the use of microorganisms in agriculture (P2, P3)</p> <p>LO3 Be able to use microbiology in food production (P4, P5)</p> <p>LO4 Understand the action of antimicrobials on microorganisms (P6, P7, P8)</p>

Name of other unit and related LO	This unit:
<p><b>Unit 2 Laboratory techniques</b></p> <p>LO1 Understand the importance of health and safety and quality systems to industry</p> <p>LO2 Be able to separate, identify and quantify the amount of substances present in a mixture</p> <p>LO3 Be able to determine the concentration of an acid or base using titration</p> <p>LO4 Be able to examine and record features of biological samples</p> <p>LO5 Be able to identify cations and anions in samples</p> <p>LO6 Be able to use aseptic technique</p>	<p>LO1 Be able to classify and identify microorganisms (P1)</p> <p>LO2 Understand the use of microorganisms in agriculture (P2, P3)</p> <p>LO3 Be able to use microbiology in food production (P4, P5)</p> <p>LO4 Understand the action of antimicrobials on microorganisms (P6, P7, P8)</p>
<p><b>Unit 3 Scientific analysis and reporting</b></p> <p>LO1 Be able to use mathematical techniques to analyse data</p> <p>LO2 Be able to use graphical techniques to analyse data</p> <p>LO4 Be able to analyse and evaluate the quality of data</p> <p>LO5 Be able to draw justified conclusions from data</p> <p>LO6 Be able to use modified, extended or combined laboratory techniques in analytical procedures</p> <p>LO7 Be able to record, report on and review scientific analyses</p>	<p>LO3 Be able to use microbiology in food production (P4, P5)</p> <p>Learners will describe the use of microbes in food production and produce a microbiological food product under optimum conditions and describe the preservation processes to keep food safe from microbes and evaluate their effectiveness.</p>
<p><b>Unit 5 Genetics</b></p> <p>LO1. Understand the importance of meiosis</p> <p>LO2. Be able to apply techniques used in genetics crosses</p> <p>LO3. Understand the techniques of DNA mapping and genomics</p> <p>LO4. Understand the impact of an innovation in an application of genomics</p>	<p>LO2 Understand the use of microorganisms in agriculture (P2, P3)</p> <p>LO3 Be able to use microbiology in food production (P4, P5)</p>

Name of other unit and related LO	This unit:
<p><b>Unit 6 Control of hazards in the laboratory</b></p> <p>LO1 Understand the types of hazard that may be encountered in a laboratory</p> <p>LO2 Be able to use health and safety procedures to minimise the risk presented by hazards in a laboratory</p> <p>LO3 Be able to design a safe functioning laboratory to manage the risk presented by hazards</p>	<p>LO3 Be able to use microbiology in food production (P4, P5)</p> <p>LO4 Understand the action of antimicrobials on microorganisms (P6, P7, P8)</p>
<p><b>Unit 8 Cell biology</b></p> <p>LO1 Understand the functions of the plasma membrane and endomembrane systems</p> <p>LO2 Be able to use key cytological techniques</p> <p>LO3 Understand the cell cycle and the importance of mitosis</p> <p>LO4 Understand the process and significance of differentiation</p> <p>LO5 Understand the potential of stem cells in medical therapies</p>	<p>LO1 Be able to classify and identify microorganisms (P1)</p> <p>LO2 Understand the use of microorganisms in agriculture (P2, P3)</p>
<p><b>Unit 10 Testing consumer products</b></p> <p>LO1 Understand the influence of regulatory bodies on development of consumer products</p> <p>LO2 Understand how product testing determines the development of consumer products</p> <p>LO3 Be able to use quantitative titration techniques on consumer products</p> <p>LO4 Be able to use extraction and separation techniques on consumer products</p> <p>LO5 Be able to test the effectiveness of consumer product tests</p>	<p>LO3 Be able to use microbiology in food production (P4, P5)</p> <p>LO4 Understand the action of antimicrobials on microorganisms (P6, P7, P8)</p>
<p><b>Unit 17 Food technology</b></p> <p>LO1 Understand the main features of food manufacturing operations</p> <p>LO2 Understand the importance of food safety in food manufacture</p> <p>LO3 Understand the importance of quality control in food manufacture</p> <p>LO4 Be able to test product samples</p>	<p>LO2 Understand the use of microorganisms in agriculture (P2, P3)</p> <p>LO3 Be able to use microbiology in food production (P4, P5)</p> <p>LO4 Understand the action of antimicrobials on microorganisms (P6, P7, P8)</p>

Name of other unit and related LO	This unit:
<p><b>Unit 19 Crop production and soil science</b></p> <p>LO1 Understand how common crops are grown for commercial production in the UK</p> <p>LO2 Understand factors affecting the growth of crops</p> <p>LO3 Be able to monitor the growth of a crop plant species</p> <p>LO4 Be able to carry out soil testing</p>	<p>LO1 Be able to classify and identify microorganisms (P1)</p> <p>LO2 Understand the use of microorganisms in agriculture (P2, P3)</p>

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