

Model Assignment Assessment Material

OCR Level 1/2 Cambridge National Certificate in Science

R073: How scientists test their ideas - Antimicrobials

Please note:

This OCR model assignment is to be used to provide evidence for the unit identified above. Alternatively, centres may 'tailor' or modify the assignment within permitted parameters (see Information for Teachers). It is the centre's responsibility to ensure that any modifications made to this assignment allow learners to show that they can meet all of the learning outcomes and provide sufficient opportunity for learners to demonstrate achievement across the full range of marks.

INSTRUCTIONS TO TEACHERS

The OCR administrative codes associated with this unit are:

- unit entry code R073
- certification codes J815

The accreditation numbers associated with this unit are:

- unit reference number M/503/6267
- qualification reference(s) 600/4790/2

Duration: Approximately 6 hours

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Model Assignment: Information for Learners

OCR Level 1/2 Cambridge National Certificate in Science

R073: How scientists test their ideas - Antimicrobials

Assignment for the learner

Antimicrobials

Some bacteria, including antibiotic-resistant *Staphylococcus aureus* (MRSA) cause infections in hospital patients. It is important that health practitioners reduce infection rates in hospitals.

Antimicrobials can prevent the growth and transfer of bacteria and other microorganisms.

- Disinfectants are intended for use on surfaces such as floors.
- Antiseptics are intended for use on or in patients' bodies.
- Antibiotics are used to limit the growth of bacteria in the human body.

You are going to carry out an investigation on the effectiveness of different concentrations of antimicrobials in preventing the growth of bacteria.

Read through all of the tasks carefully, so that you know what you will need to do to complete this assignment.

Your Task

Part 1 – Research and planning

You are going to carry out an investigation on the effectiveness of different concentrations of antimicrobials in preventing the growth of bacteria.

The first step is to carry out suitable research to collect some information about antimicrobials. You should find out about:

The different types of antimicrobials and how these affect the growth of bacteria.

The active ingredients found in antimicrobials.

The effectiveness of antimicrobials.

You should record your research.

To carry out your investigation, your teacher will provide you with agar plates containing cultures of bacteria. These bacteria do not cause disease in humans, but all microorganisms must be treated with care. You will also be provided with a range of antiseptics and disinfectants.

You should produce a plan to collect high quality, valid data, and minimise measurement errors.

Part 2 – Collecting primary data

Prepare a full risk assessment before you begin any practical work.

Carry out your investigation and record your results to use in Part 3.

Part 3 – Analysis

In your analysis, you should:

- Process the data you have collected and either:
 - plot a graph to show the results of your investigation, **or**
 - carry out a mathematical or statistical analysis of your results.
- Describe any patterns or trends in your results.

Part 4 – Evaluation and conclusion

In your evaluation and conclusion, you should:

- comment on any unexpected results
- evaluate your results, the method you used, and how well you managed the risks
- relate the information on antimicrobials from your research (Part 1) to the results of your own investigation (Part 2).

Information for Teachers

OCR Level 1/2 Cambridge National Certificate in Science

R073: How scientists test their ideas - Antimicrobials

Guidance on using this assignment

1 General

- 1.1 OCR assignments are available to download free of charge from our website:
www.ocr.org.uk
- 1.2 OCR assignments are intended to be used for summative assessment of learners and assessment must be conducted under supervision. The OCR specification for this qualification gives more information on the arrangements for assessing internally assessed units. There is also guidance on what supervision and authenticity mean in the context.
- 1.3 This assignment has been designed to meet the full assessment requirements of the unit. Learners will need to take part in a planned learning programme that covers the underpinning knowledge, understanding and skills of the unit.
- 1.4 This assignment requires learners to:
 - plan practical ways to answer scientific questions
 - devise appropriate methods for the collection of numerical and other data
 - assess and manage risks when carrying out practical work
 - collect, process, analyse and interpret primary and secondary data including the use of appropriate technology
 - draw evidence-based conclusions
 - evaluate methods of data collection and the quality of the resulting data.
- 1.5 This assignment consists of one task divided into four parts. The task is centred on a particular idea that antimicrobials work by killing microorganisms or inhibiting their growth. This idea is investigated through Parts 1, 2, 3 and 4. The parts should be taken in this order.

2 Before carrying out the assignment

- 2.1 Learners should be provided with a copy of the *Information for Learners* section of this assignment.
- 2.2 Learners will not need to carry out any preparations prior to undertaking the assessment tasks, such as collating resources to use in the assessment.
- 2.3 We have estimated that it will take approximately 6 hours to complete this assignment. This is the recommended time but centres can decide how the time can be allocated between each part or individual task in the assessment. Centres are also permitted to spread the overall assessment time across several sessions and therefore it is permissible for evidence to be produced over several sessions.
- 2.4 It is expected that before learners attempt this assignment task they will have received general preparation in their lessons. The details of practical techniques, the development of skills associated with these techniques, and the methods and choice of equipment for the task should be covered when teaching the particular part(s) of the specification which the assignment relates to, and should be completed prior to undertaking the task.

From their work in R071 (LO4) learners should understand qualitatively and quantitatively the concept of the prevention and treatment of disease and will be familiar with the techniques for *in vitro* testing of antibiotics. They should be familiar with the use of aseptic technique when inoculating and examining bacterial cultures and know how to dispose of cultures safely.

From their work in R073, learners should be able to plan a scientific investigation (LO1), collect scientific data (LO2), analyse, evaluate and communicate scientific information (LO3-5).

- 2.5 Learners should be made aware of the: health and safety issues associated with this task; need to provide a quantitative evaluation of the data collected; sources of experimental errors.
- 2.6 Learners working at higher levels will need to be made familiar with the principles and use of statistics when assessing the significance of their results.
- 2.7 Learners should also be made aware of the marking criteria for this task.

3 When completing the assignment and producing evidence

3.1 Centre staff may give support and guidance to learners. This support and guidance should focus on checking that learners understand what is expected of them and giving general feedback that enables the learner to take the initiative in making improvements, rather than detailing what amendments should be made. However, where more specific support is provided so that learners are able to make progress with the task or to ensure safety, this must be reflected in the marks awarded. It is not acceptable for teachers/deliverers to provide answers or to work through answers in detail.

3.2

Part 1 – Research and planning

You are going to carry out an investigation on the effectiveness of different concentrations of antimicrobials in preventing the growth of bacteria.

The first step is to carry out suitable research to collect some information about antimicrobials. You should find out about:

The different types of antimicrobials and how these affect the growth of bacteria.

The active ingredients found in antimicrobials.

The effectiveness of antimicrobials.

You should record your research.

To carry out your investigation, your teacher will provide you with agar plates containing cultures of bacteria. These bacteria do not cause disease in humans, but all microorganisms must be treated with care. You will also be provided with a range of antiseptics and disinfectants.

You should produce a plan to collect high quality, valid data, and minimise measurement errors.

Part 1 requires learners to carry out research using books/internet/surveys. Learners must be guided on the use of information from sources. They will need to plan how they are going to carry out the research and collect their results for use in Parts 2 - 4. The research may be carried out during lessons or as a homework exercise. Learners should be made aware of the time allowed for carrying out this part of the task. Their access to resources is determined by those available to the centre and/or to learners at home.

Learners' work and research should be available for Parts 2 and 3.

Part 1 is expected to take 1.5 – 2 hours.

3.3

Part 2 – Collecting primary data

Prepare a full risk assessment before you begin any practical work.

Carry out your investigation and record your results to use in Part 3.

Part 2 requires learners to plan and carry out an investigation to collect primary data. Learners need access to their individual work and research from Part 1.

Learners may work in groups of no more than 3 (2 is recommended) and may collaborate in the development of the plan and the conduct of the investigation. During planning learners may wish to trial procedures they plan to use, at the discretion of the centre. They should provide a risk assessment of the procedures they have planned. Learners must record their plan and results individually. The investigation should be planned and conducted in supervised lessons.

Teachers are responsible for ensuring appropriate health and safety procedures (in particular, risks of handling microorganisms will be understood) and all appropriate steps taken to reduce risks are carried out, including a risk assessment for the task, prior to learners attempting the practical work. It is the centre's responsibility to ensure the safety of all learners involved in any investigation.

The work of individual learners may be informed by working with others but each must provide an individual response. Learners should be made aware of the time allowed for carrying out this part of the task. Learners' access to resources is determined by those available to the centre.

In their investigations, learners will need to make choices about the possible methods to investigate the inhibition of growth of bacteria by antimicrobial agents (disc diffusion techniques or use of 'wells' in agar plates); choices about the range of antimicrobial agents and concentrations to be used; how to make up solutions of different concentrations; the number of replicates; methods of measuring the inhibition of growth; the time period of incubation; temperature of incubation; and the accuracy of measurements made of the dependent variable. Learners must not be instructed or advised in these areas except where they affect safety, use of resources or timescale.

Learners' work should be available for Part 3.

Part 2 is expected to take 2 hours.

3.4

Part 3 – Analysis

In your analysis, you should:

- Process the data you have collected and either:
 - plot a graph to show the results of your investigation, **or**
 - carry out a mathematical or statistical analysis of your results.
- Describe any patterns or trends in your results.

In Part 3, learners will process and analyse the results of their research and the investigation.

Learners will need access to their individual responses from Part 1 and Part 2.

Learners must complete all work independently. Learners should be made aware of the time allowed for carrying out this part of the task.

In processing data, learners will have opportunities to use mathematical and graphical skills: calculation of concentrations of antimicrobials; mean diameters or areas of zones of inhibition; quantitative treatment of spread of data and thus level of uncertainty; graphs drawn with correct scales and accurate plotting to show the relationship between concentration of antimicrobial and size of zone of inhibition; a mathematical analysis of the relationship between type of antimicrobial and size of zone of inhibition (in which case, this could be a simple quantitative relationship or a statistical analysis of comparisons of means, eg the student's t-test. Learners must not be instructed whilst carrying out these analyses.

Part 3 is expected to take 1 - 1.5 hours.

3.5

Part 4 – Evaluation and conclusion

In your evaluation and conclusion, you should:

- comment on any unexpected results
- evaluate your results, the method you used, and how well you managed the risks
- relate the information on antimicrobials from your research (Part 1) to the results of your own investigation (Part 2).

In Part 4, learners will evaluate their data and the methods used to collect it. They will then draw and justify a conclusion. They will be asked to comment on any issues of safety within the practical work.

Learners will need access to their individual responses from Parts 1 - 3.

Learners must complete all work independently. Learners should be made aware of the time allowed for carrying out this part of the task.

In evaluating their investigation, learners will assess the quality and validity of the evidence, identify conflicting evidence, or weaknesses in the evidence, which lead to different interpretations. Learners will link the data to scientific explanations, using ideas of correlation and cause. Learners will suggest how improvements in methods of data collection would improve the quality of the data, and suggest what further evidence would help to make a conclusion more secure.

Learners must not be instructed whilst carrying out the evaluation.

Part 4 is expected to take 1-1.5 hours.

- 3.6 We have specified what evidence the learner is expected to produce, but it is important to note that if it is possible to generate the evidence in a variety of formats, then the learner is free to use the format that is most appropriate for them. The section *Evidence Summary* at the back of this document will guide you on evidence and formats for evidence. Centres must advise learners as to the most appropriate format of evidence. Format must not be confused with the content or the type of datafile to be produced. Guidance on suitable formats of the evidence is provided in the section *Evidence Summary*.

4 Presentation of work for marking and moderation

- 4.1 Centres wishing to produce digital evidence in the form of an e-portfolio should refer to the appendix in the specification on guidance for the production of electronic assessment.
- 4.2 Centres may wish to discourage learners from excessive use of plastic wallets for presentation of their evidence as this may hinder the assessment process. Instead centres may wish to encourage learners to present their work so that it is easily accessible, eg spiral bound, stapled booklet, treasury tag.

5 Scope of permitted model assignment modification

The model assignment is very self-contained in its present form. The set of tasks form a coherent whole addressing all the learning outcomes and allowing access to the full range of marks.

You **must not** change the following:

- the learning outcomes
- the marking criteria
- the requirements for supervision and authentication as described in the specification (section 'The internally assessed units').

Permitted changes:

The model assignment can be modified in terms of the areas described below at the permission of OCR but centres must be sure that learners still have the opportunity to cover all of the learning outcomes and to access the full range of marks:

- The learner's assignment, which can be contextualised or amended to suit local needs.
- To allow for differences in the materials, equipment and facilities at different centres. For example, Bunsen burners may not be available, but alternative methods of sterilising equipment may be used.

OCR has ensured that in the language used and the tasks and scenario provided we have avoided discrimination, bias and stereotyping and support equality and diversity. In the development of qualifications and assessments we use the guidance given in the Ofqual publication *Fair access by design*, notably this includes:

- using language and layout in assessment materials that does not present barriers to learners
- using stimulus and source materials in assessment materials (where appropriate) that do not present barriers to learners.

If centres wish to adapt the model assignment we strongly advise that staff responsible for modifying the model assignment and quality assuring it refer to the publication *Fair access by design*.

If modifications are made to the model assignment, whether to just the scenario or to both the scenario and individual tasks, it is up to the centre to ensure that all learning outcomes can be met and that learners can access the full range of marks.

Evidence summary

When completing this assignment it may be possible to generate evidence for completing a task in a variety of formats. This list is not exhaustive.

Part number	What do learners need to produce (evidence)
Part 1	Evidence is likely to be in the form of a written report, with associated tables of data. Sources will be referenced using standard formats.
Part 2	Evidence is likely to be in the form of a written report with associated diagrams, pictures or flowcharts, to include an account of the problem to be investigated and the methods used to collect the data (including a risk assessment for the practical work involved). Data collected will be tabulated in appropriate formats. There will be opportunities to use ICT in the collection of data. Witness statements will be required for the practical elements of LO2.
Part 3	Evidence is likely to be in the form of a written report. Data will be analysed using appropriate mathematical and graphical techniques. There will be opportunities to use ICT in the analysis of data.
Part 4	Evidence is likely to be in the form of a written report. There will be opportunities to use ICT in the presentation of conclusions.

Apparatus and materials

- Stock solutions or bottles of antimicrobials (Note 1)
- Access to deionised water
- Access to digital balances

For each learner or group of learners:

- Nutrient agar plates, **pre-inoculated** with a bacterium of very low pathogenicity (Note 3)
- Pasteur pipettes or micropipettes
- Antiseptics (Note 1); disinfectants (Note 1)
- Measuring cylinders, including 50 cm³
- Graduated pipettes with fillers
- Beakers
- Forceps
- Filter paper
- Hole punch
- Scissors
- Bunsen burner
- Heat proof mat
- Incubators

Learners plan their own investigation and may therefore require access to other apparatus at the discretion of the centre.

Note 1: Antiseptics, eg, ethanol; iodine solution; tincture of iodine; Savlon, TCP, hexetidine (use Oraldene), etc.; disinfectants, eg, hydrogen peroxide; phenolic disinfectants; sodium chlorate(I) (sodium hypochlorite), etc.

These may be obtained from normal retail suppliers and must have appropriate hazard labels. Learners should be provided with stock solutions of known concentrations and should be required to produce their own range of different concentrations.

Note 2: Suitable bacteria include *Bacillus subtilis*, *Escherichia coli*, *Micrococcus luteus*, *Staphylococcus albus*, etc.

Notes to help teachers and technicians with this assignment

If possible, use recently bought or prepared cultures of the bacteria.

For disc diffusion techniques:

- Nutrient agar plates should be poured with identical volumes of agar, to minimise error resulting from plates with different depths of agar.

- Nutrient agar plates should be inoculated with the bacteria by inoculating loop or pipette. Use a flamed ethanol-sterilised glass or metal spreader to distribute the bacteria evenly. **Ensure that the spreader is cooled before use.**
- The inoculated plates should be stored in a refrigerator prior to use.
- Antimicrobials can be introduced using discs of filter paper, or by pipetting the antimicrobials into wells bored into the agar.
- Care should be taken with the handling of bacterial cultures (though the bacteria cited are of very low pathogenicity), and incubated plates should be autoclaved after use.
- Inoculated plates should be incubated at 25 °C until sufficient growth of bacteria and zones of inhibition are observed.
- It is important that disinfectants are handled with care; many are irritant, harmful and even corrosive or toxic. Eye protection and gloves are essential when preparing and using disinfectants with such hazard classifications. (Note that Lysol and other cresolics are toxic and caustic; they should not be used in schools).

References

To ensure safe working when using bacterial cultures and disinfectants please consult:

<http://www.practicalbiology.org/areas/intermediate/bio-molecules/bacterial-enzymes/incubating-and-viewing-plates,100,EXP.html>

<http://www.microbiologyonline.org.uk/teachers/resources>

<http://www.microbiologyonline.org.uk/teachers/safety-information>

<http://www.microbiologyonline.org.uk/teachers/preparation-of-media-and-cultures>

<http://www.cleapss.org.uk> - see the Laboratory Handbook, Mainly Biology (Section 15.2)