Science Stage 5 (Year 9) – sample assessment task

Disease

**Creation date:** 12 August 2024

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# About this assessment task

## Purpose of the resource

This assessment task is linked to the learning in the Stage 5 Disease program of learning for Year 9 students. This task is designed to assess students’ understanding of the components of the scientific method and skills in communicating in a formal scientific report. Students will conduct an investigation on the antiseptic properties of various substances. Their investigation will form the basis of a scientific report that will be assessed.

## When and how to use

This assessment task can be conducted in class after students have completed the learning on infectious diseases. It is recommended that the teacher demonstrate the investigation. Students then collect the results and complete the remaining components of the scientific report.

[Appendix A](#_Appendix_A_Teacher) and [Appendix B](#_Appendix_B_Lab_1) contain additional teacher instructions for this task and lab technician instructions for preparing the investigation.

This task is designed to be flexible in its implementation, providing teachers with the option to adapt the task to meet the needs of staff and students, as well as the resources available at school. All implementation modes provide students with the same opportunities to complete the assessment task and demonstrate their knowledge and understanding of the topic. Other modes include:

**Non-practical delivery:** if your school does not have the capacity to run this investigation as a demonstration, sample results have been provided for the students to measure the zone of inhibition. Students then complete the remaining components of the scientific report. This can be found in [Appendix C Investigation data](#_Appendix_C_Investigation).

**Depth study practical investigation alternative:** there is also an opportunity to turn this into a depth study and work with local Aboriginal and Torres Strait Islander Peoples to identify and test some local plants as antiseptics. This information can be found in [Appendix D Depth study alternative](#_Appendix_D_Depth).

The [Common Grade Scale](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/understanding-the-curriculum/awarding-grades/common-grade-scale) can be used to report student achievement in primary and junior secondary schools in NSW.

When grading students’ level of achievement in Stage 5, refer to the [course performance descriptors](https://curriculum.nsw.edu.au/learning-areas/science/science-7-10-2023/assessment#course-performance-descriptors-science_7_10_2023). Course performance descriptors provide holistic descriptions of typical achievement at different grade levels in a specific course.

# Assessment task notification

**Name of task**: investigating the use of antiseptics in preventing disease

**Type of task: investigation and s**cientific report

**Weighting**: [the weight of the assessment task is a school-based decision].

**Due date:** [school-based decision]

**Submission details:** [school-based decision – include any important details about submission, the format of the task, and submission procedures]

**Outcomes being assessed**:

A student:

* explains how an understanding of the causes of disease can be used to prevent and manage the spread of disease **SC5-DIS-01**
* selects and uses a range of tools to process and represent data **SC5-WS-05 (Processing data and information)**
* analyses data from investigations to identify trends, patterns and relationships, and draws conclusions **SC5-WS-06 (Analysing data and information)**
* communicates scientific arguments with evidence, using scientific language and terminology in a range of communication forms **SC5-WS-08 (Communicating)**

[Science 7–10 Syllabus](https://curriculum.nsw.edu.au/learning-areas/science/science-7-10-2023/overview) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2023.

## Task description

Imagine you are working for Lewtin Dermacare, a company that makes skin creams that can be applied to a graze to prevent skin infection. Experiments have been done to determine how well different antiseptic substances prevent bacterial growth. You now need to analyse the results of the experiment and explain them to the company’s chief scientist in a scientific report.

In this task, you will present the results from an experiment in an appropriate table and graph, then analyse the results to write a discussion and conclusion. You will be provided with the report's inquiry question, aim, introduction, method and risk assessment sections, which you will unpack in class. These do not need to be included in your report.

**In your scientific report, you should include the following:**

**Results**

* Use a ruler to measure each antiseptic substance's **zone of inhibition** (clear area around the discs).
* Create a **table** to display the measurements. The table should also include the mean data for each antiseptic substance.
* Create a **graph** of the mean data. Your graph can be hand drawn on graph paper or produced in Microsoft Excel.

**Discussion**

In your discussion, you should:

* identify which substances had antiseptic properties
* discuss which antiseptic substance(s) were most effective in preventing the growth of the skin pathogen
* discuss the reliability of the results and suggest relevant improvements
* consider the validity of the experiment and suggest any relevant improvements
* propose any further experiments or research that could be conducted to build on your findings.

**Conclusion**

Referring to the evidence collected, write a conclusion that addresses the inquiry question.

## Marking rubric

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Criteria | Not achieved | Level 1 | Level 2 | Level 3 |
| Results table  **SC5-WS-05** | Data is not presented in a table. | Data is displayed in a table.  The mean has not been used to summarise data.  Key information may be missing, such as descriptive headings and units. | Clear and descriptive title.  Data is displayed in an organised table with correct headings.  Units may be missing in column headings and placed in the body of the table.  The table includes all relevant data and may include unnecessary information (for example, units are entered in data cells).  The mean is correctly calculated for each treatment. | Clear, descriptive and concise title that accurately reflects the content.  The table is well-organised (for example, borders) and easy to read. All columns and rows are clearly labelled with appropriate units.  Data is accurate and correctly entered.  The table includes all relevant data and excludes unnecessary information (for example, units are not entered in data cells).  The mean is correctly calculated for each treatment. |
| Graph  **SC5-WS-05** | A graph has not been included, or the graph may contain significant omissions or errors, such as incorrect plotting of data or scale. | The results are presented in a graph; however, some major components may be missing, such as an axis scale or key, making it difficult to interpret the results. | The results are presented in an appropriate graph; however, some minor components may be missing, such as the axis label and heading. | The results are accurately presented in an appropriate graph that is easy to understand.  The graph has correctly labelled axes, headings, units and a key if relevant. |
| Discussion – analysis of results  **SC5-WS-06** | Results are repeated in the discussion. Ideas are not clearly expressed, or an incorrect interpretation of the results is provided. | A basic interpretation of the results is provided. Correctly identifies the order of susceptibility of the bacteria to the different antiseptics. | Results are correctly interpreted. Correctly explains the susceptibility of the bacteria to the different antiseptics. | Results are correctly interpreted. Correctly explains the susceptibility of the bacteria to the different antiseptics and supports this with evidence. |
| Discussion – sources of error and improvements  **SC5-WS-05**  **SC5-WS-06** | Sources of error have not been identified, and there are no suggestions for improving the investigation. | A source of error has been identified. Inadequate or no improvements have been suggested. | Some sources of error have been identified, and improvements have been suggested. | Sources of error and limitations have been identified, and adequate ways of improving the reliability and validity of the investigation have been suggested. |
| Conclusion  **SC5-WS-06** | No clear conclusion is presented, or the conclusion is not based on the results of the experiment. | The conclusion is somewhat disconnected from the results or lacks detail in answering the inquiry question. | The conclusion answers the inquiry question and is consistent with the data and information gathered. | The conclusion uses data to provide evidence to respond to the inquiry question and provides justification for inferences and conclusions. |
| Communicating  **SC5-WS-08**  **SC5-DIS-01** | Components of the report do not contain relevant scientific language.  The report is not presented coherently and does not provide evidence to support arguments. | Demonstrates a basic understanding of disease cause and prevention.  Scientific ideas are communicated using some scientific language and terminology. | Demonstrates a sound understanding of disease cause and prevention.  Scientific ideas are communicated coherently, using appropriate scientific language and terminology, with some evidence and reasoning provided to support arguments. | Demonstrates a thorough understanding of disease cause and prevention.  Arguments are communicated succinctly and coherently, using correct scientific language, terminology and evidence as appropriate to the identified audience. |

## Student support material

### Glossary

Use the information in this table to help you understand keywords in the assessment task. You can also use it to help you include scientific language in your report.

|  |  |
| --- | --- |
| Term | Definition |
| Agar plates | A sterile Petri dish filled with a jelly-like substance called agar is used to grow microorganisms such as bacteria. |
| Antimicrobial [substance] | A substance that kills microorganisms or stops them from growing and causing disease. |
| Antiseptic | A substance that stops or slows down the growth of microorganisms. |
| Disc diffusion assay | This test determines if microorganisms are susceptible to various antiseptic substances. The antiseptic substances being tested are added to small paper discs, which are then placed on the surface of agar plates containing the microorganism. As the substances diffuse from the discs, they interact with the microorganisms. The microorganisms are killed or stop growing if they are susceptible to the substance. This leads to the formation of inhibition zones. The diameter of the zone of inhibition is related to the sensitivity of the microorganisms to the antiseptic substance. |
| Exposure | When there has been some sort of contact between an individual and a pathogen, toxin or chemical. |
| Extract | The process of removing a substance of interest or active ingredient from something else. For example, removing tea tree oil from crushed tea tree leaves. |
| Infection | The entry and growth of pathogens in the body. |
| Mean | The sum of values in a data set divided by the total number of values in the data set. It is also called the average. |
| Melaleuca alternifolia | Commonly known as tea tree. It is a small native Australian tree whose leaves are used for medicinal properties. |
| Microorganism | A living thing that can only be seen through a microscope. For example, bacteria and fungi. |
| Pathogen | Any organism or agent that can cause disease or illness to its host. |
| Reliability | The extent to which repeated observations and/or measurements taken under identical circumstances will yield similar results. |
| Staphylococcus epidermidis | A type of bacteria found on the skin that causes infections in some people. |
| Sterile | Free from bacteria or other living microorganisms. |
| Susceptible | Easily influenced or harmed by something. In the context of this investigation, being susceptible means that the microbe is affected by the antiseptic substance. |
| Validity | The extent to which the processes and resultant data measure what was intended. |
| Zone of inhibition | The area on an agar plate where bacteria cannot grow due to the presence of a substance that stops its growth. |

### Effectiveness of antiseptic substances on *Staphylococcus epidermidis*

#### Inquiry question

How do antiseptic substances – eucalyptus oil, tea tree oil, Betadine, and Dettol – compare in preventing the growth of Staphylococcus epidermidis?

#### Aim

To find out how well Betadine, Dettol, eucalyptus oil and tea tree oil prevent the growth of the bacteria, Staphylococcus epidermidis, indicated by the zones of inhibition on agar plates.

#### Introduction

Antiseptics are substances that stop the growth of microorganisms. They are important for preventing infections in wounds and cuts. They are commonly used in healthcare and at home to maintain hygiene and prevent the spread of infections. This study examines how well 4 antiseptics, eucalyptus oil, tea tree oil, Betadine, and Dettol, reduce bacterial growth. These antiseptics could be used in new skin creams to treat small cuts and grazes.

* Eucalyptus oil comes from the leaves of the eucalyptus tree and is believed to kill bacteria (Bachir and Benali 2012). Eucalyptus plants have been used by Aboriginal communities for various purposes, including traditional medicinal uses (Vecchio et al. 2016).
* Tea tree oil is extracted from the leaves of the Melaleuca alternifolia tree and is known for its antimicrobial effects (Carson et al. 2006). The Bundjalung people from the coast of New South Wales crushed tea tree leaves into a paste and applied it to wounds as an antiseptic (Kamenev 2011).
* Betadine is a common antiseptic containing iodine that is often used for cleaning skin and wounds because it quickly kills bacteria that can cause infections (Health Direct 2024a).
* Dettol is used to clean and disinfect minor skin wounds like cuts and scratches. Its antimicrobial properties help prevent infections (Health Direct 2024b).

The disc diffusion method is used to test these antiseptics. This involves placing paper discs soaked in each antiseptic onto agar plates with Staphylococcus epidermidis bacteria spread on them. The agar plates are incubated for 24 hours. The clear areas around the discs, known as the zones of inhibition, are measured to see how well each antiseptic prevents the bacteria from growing.

#### Risk assessment

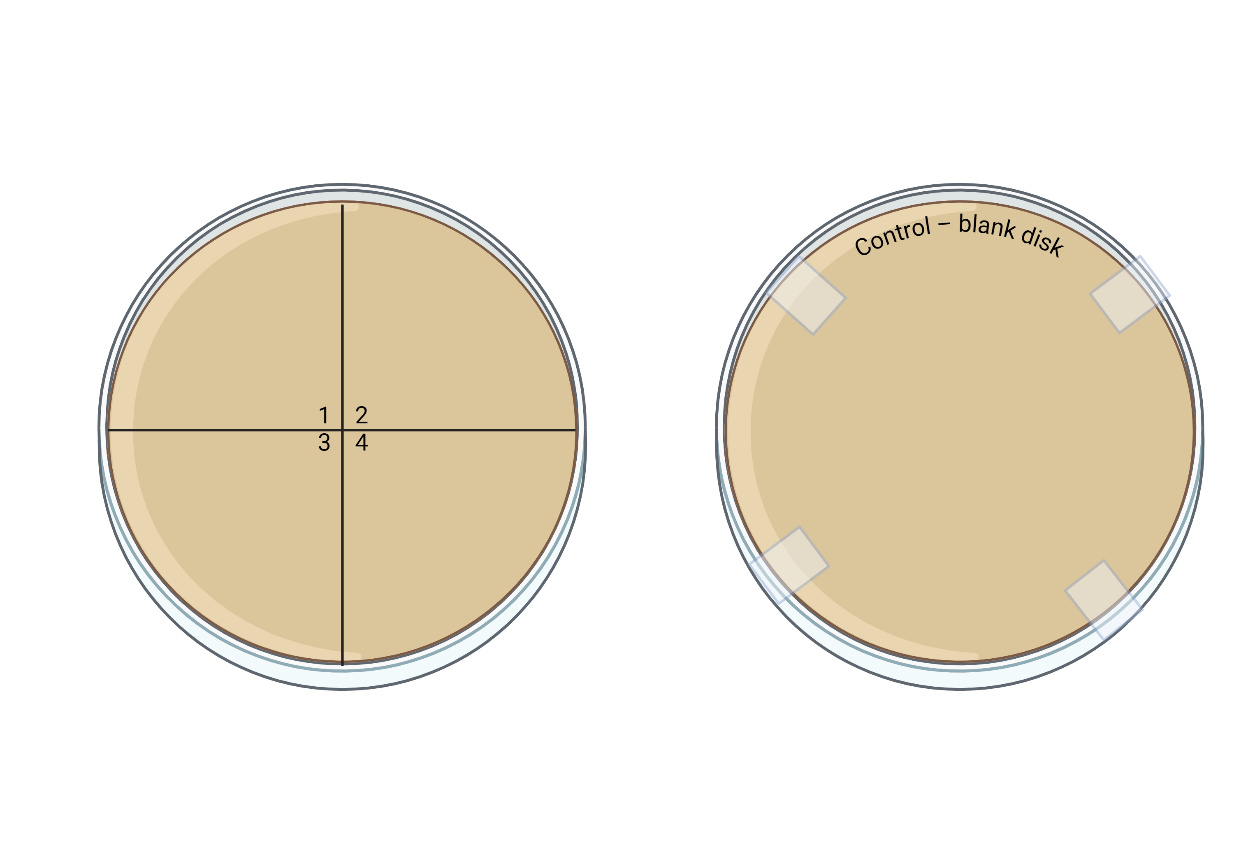
|  |  |  |  |
| --- | --- | --- | --- |
| Hazard | Risk | Risk rating\* | Control measures |
| Exposure to bacteria | Illness or infection | 6 | * Wearing personal protective equipment such as gloves, lab coat and safety goggles. * A commercial pure bacterial culture is used for the experiment. * Agar plates are taped closed, so they are not accidentally opened. * Plates are incubated at no higher than 30°C for 24 hours. This helps reduce the risk of growing human pathogenic organisms. * Agar plates remain sealed once incubated. * Used agar plates are sterilised before disposing of the general waste. * Hands are washed with antibacterial handwash after handling the agar plates and other equipment. |
| Ethanol too close to Bunsen burner | Fire or burns | 6 | * Keep the ethanol a safe distance from the Bunsen burner so it does not ignite. * Use ethanol in controlled amounts to minimise the potential for spills or splashes that could ignite near the Bunsen burner. * When spraying the bench surface with ethanol for cleaning, allow time for ethanol to evaporate before lighting the Bunsen burner. * Ensure appropriate fire safety equipment such as fire extinguishers or fire blankets are readily accessible to respond quickly. * When flaming the forceps, hold them so that the ethanol does not flow towards the hand. |
| Working too close to the Bunsen burner | Burns | 6 | * Work a safe distance from the Bunsen burner flame, ensuring you do not lean over it at any point. * Long hair should be tied back. * Turn off the Bunsen burner when not in use to avoid burns. |

\*Risk rating is based on the NSW Department of Education’s WHS risk matrix. According to this risk matrix, the most severe rating is 25 and 1 is the least severe.

#### Method

1. A sterile work environment was prepared by disinfecting the workbench with 70% ethanol.
2. All necessary materials were gathered, and a Bunsen burner was lit to create an updraft and sterile work environment.
3. The paper discs were soaked in the antiseptic substances, allowed to dry and stored in a sterile Petri dish (no agar).
4. Five nutrient agar plates were divided into 4 labelled sections, one for each antiseptic substance, as shown in Figure 1. An additional plate was labelled as the control – blank disk.

Figure 1 – agar plate divided into sections for each treatment and an agar plate with a blank disc as a control.



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1. A nutrient agar plate was placed on the sterilised bench. The bacterial culture was mixed gently with a sterile cotton swab (the swab was carefully removed from the packaging, ensuring that it did not touch anything else), as shown in Figure 2. Working close to the Bunsen flame, the swab was dipped into the Staphylococcus epidermidis broth to moisten the tip (shown in Figure 3).

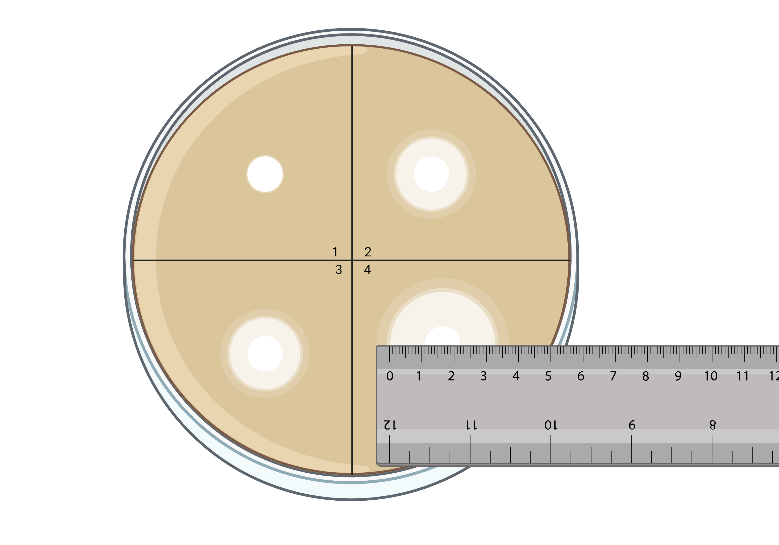
|  |  |
| --- | --- |
| Figure 2 – how to aseptically open and handle the sterile swab  A person in gloves aseptically removing a sterile swab from its packaging. | Figure 3 – inserting the swab into the bacteria culture aseptically  A gloved hand adding a sterile cotton swab tip into the bacterial culture tube near a Bunsen burner to maintain aseptic technique. |

1. After stirring the bacterial culture, the swab was removed, and the neck of the tube was flamed before the lid was replaced, as shown in Figure 4. The lid of the agar plate was lifted to expose the agar. The cotton swab containing the bacterial culture was moved across the entire surface in a rolling motion, turning the plate 3 times to distribute the bacteria evenly and create a bacteria lawn (seen in Figures 5 and 6). This was repeated for the remaining 5 agar plates with new cotton swabs.

|  |  |
| --- | --- |
| Figure 4 – the neck of the bacterial culture tube being flamed before replacing its lid | Figure 5 – creating the bacterial lawn on the agar plate |
| A person holding a bacterial culture tube mouth near the Bunsen burner flame to show aseptic technique. | A person with gloves aseptically swabbing the agar on an agar plate to create a bacterial lawn. |
|  |  |
| Figure 6 – diagram demonstrating the streaking of the agar plates | Figure 7 – control agar plate showing how to use tape to ensure the plate is closed |
| An agar plate with lines across it demonstrating how to streak the surface of the plate to ensure coverage. | Diagram of an agar plate labelled as Control - blank disk. |
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1. Forceps were sterilised by dipping them in a solution of 70% ethanol and then flamed. The sterilised forceps were used to add a blank disc to the control plate and the antiseptic discs to the correct section of each remaining plate.
2. The plates were taped closed and incubated upside down at 30°C for 24 hours.
3. After incubation, the zone of inhibition for each antiseptic substance was measured using a clear 15 cm plastic ruler.

Figure 8 – measuring the zone of inhibition



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#### Results

|  |
| --- |
| [Student to insert results table and graph here] |

#### Discussion

|  |
| --- |
| [Student to insert discussion here] |

#### Conclusion

|  |
| --- |
| [Student to insert conclusion here] |

#### Reference list

Bachir RG and Benali M (2012) ['Antibacterial activity of the essential oils from the leaves of *Eucalyptus globulus* against *Escherichia coli* and *Staphylococcus aureus*'](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3609378/), Asian Pacific Journal of Tropical Biomedicine, 2(9):739-42, doi: 10.1016/S2221-1691(12)60220-2.

Carson CF, Hammer KA and Riley TV (2006) ['*Melaleuca alternifolia* (tea tree) oil: a review of antimicrobial and other medicinal properties'](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1360273/), Clinical Microbiology Reviews, 19(1):50–62, doi:10.1128/CMR.19.1.50-62.2006.

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Health Direct (2024b) [Brand name: Dettol Antiseptic Liquid](https://www.healthdirect.gov.au/medicines/brand/amt,65186011000036101/dettol-antiseptic-liquid), Health Direct, accessed 01 July 2024.

Kamenev M (8 February 2011) [Top 10 Indigenous bush medicines](https://www.australiangeographic.com.au/topics/history-culture/2011/02/top-10-aboriginal-bush-medicines/), *Australian Geographic*, accessed 28 July 2024.

Vecchio M, Loganes C and Minto C (2016) ['Beneficial and Healthy Properties of Eucalyptus Plants: A Great Potential Use'](https://openagriculturejournal.com/VOLUME/10/PAGE/52/). *The Open Agriculture Journal*, 10, 52–57, doi:10.2174/1874331501610010052.

# Appendix A – teacher instructions

Appendix A contains the following teacher information:

* [Unpacking the assessment task with students](#_Unpacking_the_assessment)
* [Teacher demonstration instructions](#_Teacher_demonstration_instructions)
* [Equipment requirements](#_Equipment_requirements)
* [Risk assessment](#_Risk_Assessment)
* [Aseptic technique](#_Aseptic_technique)
* [Experiment procedure](#_Experiment_procedure)
* [Links to the National Literacy Learning Progressions](#_Links_to_the).

## Unpacking the assessment task with students

**Note:** students will need to have the following pages printed:

* Assessment task notification and Task description
* Student support material.

This should also be accessible to students online so they can digitally complete the results, discussion and conclusion sections.

**Differentiation**

The glossary is provided as a universal support to build students' understanding of key terms.

An alternative introduction has been provided in [Appendix E](#_Appendix_E_Alternative_1). It contains a higher level of tier 2 and tier 3 language. It would be suitable to extend students with well-developed vocabulary.

1. Read through the notification with students, asking them to highlight key components such as the due date. When reading over the ‘Type of task’, clarify that the practical component itself is not assessable.
2. Read the task description with students. **Emphasise the components that must be completed and submitted for assessment: results, discussion, and conclusion**. When reading through the individual points in those sections, remind students they have learnt these skills throughout the different activities covered in this unit of work.
3. Unpack the key features of the scientific report that have been provided to the students (Table 1 below). This will help them deepen their understanding of the investigation.
4. As you discuss the components of the report that the students must complete, unpack the relevant section of the marking rubric so that they understand the requirements for a high-level (level 3 in the rubric) response. For example, as shown in Table 2 below, note the corresponding criteria in the marking rubric when discussing how to measure the zone of inhibition and recording the results in a table.

Table 1 – supporting students understanding of the completed components of the scientific report

|  |  |
| --- | --- |
| Component | Supporting student understanding |
| Title | * Outline that the title clearly and concisely describes the experiment. Read the report's title, Effectiveness of antiseptic substances on Staphylococcus epidermidis, to students and show them how to unpack its meaning using the glossary of terms. * Tell students that Staphylococcus epidermidis is thescientific name of the specific bacteria being investigated. Staphylococcus is the genus, and epidermidis is the species (students learnt about biological classification in Stage 4, so they should understand the binomial naming system). |
| Inquiry question | * The inquiry question guides and focuses the research for the experiment, setting a clear direction for what the investigation aims to explore and determine. * Looking at this inquiry question, this investigation focuses on comparing antiseptic substances in preventing the growth of Staphylococcus epidermidis. * A hypothesis and prediction have not been provided in this report, so students must address the inquiry question in their conclusion. Inquiry questions allow for a broad investigation when not enough is known to make a hypothesis or prediction. In the early stages of scientific inquiry, researchers (or students) may lack sufficient background information to predict specific outcomes. An inquiry question helps gather relevant data and observations, which can later be used to formulate a more specific hypothesis that can be tested in future investigations. |
| Aim | * Teach that the aim states the purpose of the experiment. It identifies what is being investigated, and the independent and dependent variables can usually be identified when reading the aim. * Ask students to identify the independent and dependent variables by reading the aim. * Show students images of the antiseptic substances that are being tested (see **DIS PPT**). Ask if they know what the substances are used for (the term antiseptic substance should give a clue about some of their uses). |
| Introduction | * Introduce the relevant background information from [secondary-source research](#_Introduction) necessary to understand the experiment. This section explains the context of the study and outlines the problem or question being investigated. * Read through the introduction with the class. Ask students to identify what they do not understand on the initial read-through. Prompt the students to look for the unknown terms in the glossary and then re-read the sentence to see if it makes sense. Provide additional explanations to students where required. * Check students understanding by asking: * What is the experiment about? * What background information has been provided? * What are antiseptic substances, and why are they used? * Which part of the introduction tells us a little about how the experiment is conducted? * Point out the in-text referencing in the [introduction](#_Introduction) and explain that background research was used to find the information. Explain that the information used should always be referenced. The full citation appears in the reference list at the end, which students can access for more information. * Unpack the last paragraph with students. The **DIS PPT** contains a diagram showing how the discs were prepared and the zone of inhibition. The method section explains this further. |
| Risk assessment | **Note:** you could remove parts of the risk assessment and co-construct it with the students.   * Outline that a risk assessment is not usually included in a scientific report. However, it is undertaken before scientists begin an experiment. An abbreviated version has been included to help the students understand some of the hazards and risks in this investigation. * Distinguish between hazard and risk * A hazard is anything that could cause harm, for example, exposure to a pathogen (disease-causing microorganism) * The risk is what might happen or the consequence. For example, the pathogen causes someone to become ill * Risk rating refers to the likelihood that risk will actually occur. The level of risk (risk rating) can be reduced by implementing control measures to minimise its occurrence. The WHS risk matrix is used for this. * Read the risk assessment and discuss each hazard and its corresponding control measures. |
| Method | * Read the method with the class. The method summarises how the experiment was conducted. Point out that in scientific reports, the method is written in the past tense rather than as a procedure like in a recipe. * Revise the terms, reliability and validity, with the students (included in the glossary). Ask the students to re-read the method and identify features that help them assess the reliability and validity of the experiment. Some question prompts are outlined below * Validity * Does the method align with the aim and the inquiry question? * Are the independent and dependent variables appropriate for this aim? * What variables are controlled? * Are the techniques used in this investigation appropriate? (**Note:** students likely will not know this, but you can explain their suitability.) * Reliability * Is the method detailed enough to be repeated by someone else? * Is there replication (repeated trials)? * Do the standard procedures outlined ensure consistency across the different trials? For example, the use of aseptic techniques, the way the bacterial lawn was made, and the disk treatments.   **Note:** you can demonstrate each step of the method and facilitate a discussion about reliability, validity and errors as the students observe each step. |
| Reference list | Ask students to look at the reference list and tell you what they observe about its arrangement, and the features of each reference.   * It is in alphabetical order of the surname of the first author/name of the organisation. This makes it easy to identify specific references in the reference list. * Year published is written in brackets. * Reliable sources are used. For example, journal articles and government websites. Blogs, personal websites or chat forums should not be referenced. * Access date is given for websites. This can be used to determine the currency of information if you access the website later because online sources can change.   Discuss the importance of using reputable sources and referencing them. |

Table 2 – example of the alignment between the task description and the marking rubric

|  |  |
| --- | --- |
| Task description | Marking rubric |
| Results   * Use a ruler to measure each antiseptic substance’s zone of inhibition (clear area around the discs). * Create a table to display the measurements. The table should also include the mean result for each antiseptic substance. | **Level 3**   * Clear, descriptive and concise title that accurately reflects the content. * The table is well-organised (for example, borders) and easy to read. All columns and rows are clearly labelled with appropriate units. * Data is accurate and correctly entered. * The table includes all relevant data and excludes unnecessary information (for example, units are not entered in data cells). * The mean is correctly calculated for each treatment. |

## Teacher demonstration instructions

Chemical safety in schools [3.2.6: Safe use of biological materials/organism/tissues](https://education.nsw.gov.au/inside-the-department/facilities-assets-and-equipment/school-infrastructure-nsw/knowledge/directorates/operations/technical-services/compliance-and-environment/chemical-safety-in-schools/section-3--curriculum-support-documents/3-2-6--safe-use-of-biological-materials-organism-tissues). This page outlines procedures related to microbiology in schools.

The benefits of demonstrating this investigation include:

* students can observe the method first-hand, which helps them identify potential sources of error in the discussion
* students are exposed to microbiology techniques they may not have seen before
* students learn about aseptic techniques and the importance of carefully following a procedure and risk assessment.

### Equipment requirements

The equipment below will allow 5 plates for testing the antiseptic substances (5 repeats) and one plate as a control.

**Some specialist items will need to be ordered in advance.**

* 10 mL Staphylococcus epidermidis broth\*
* 6 × sterile nutrient agar plates\*\*
* 6 × sterile cotton swabs (individually wrapped)
* 21 × blank sterile discs or filter paper that has been hole punched\*\*\*
* Hole punch (if using filter paper)
* Pure eucalyptus oil (a very small quantity will be used)
* Pure tea tree oil (a very small quantity will be used)
* Dettol (a very small quantity will be used)
* Betadine (a very small quantity will be used)
* 15 cm clear plastic ruler
* 4 × sterile syringes/Pasteur pipettes/micropipettes (for adding each of the substances to the discs)
* 5 × sterile Petri dishes (to store the disc treatments)
* Parafilm or sticky tape
* 1 × permanent marker
* 1 × Bunsen burner
* 1 × box of matches
* Incubator
* 1 x sterile forceps
* Gloves
* 70% v/v ethanol in a spray bottle
* 50 mL 1% sodium hypochlorite (bleach)
* Paper towel
* Safety goggles
* 2 × 250 mL beakers (one for ethanol to flame forceps, one to add bleach solution for contaminated swabs)

**Notes:**

**\*The minimum volume of bacterial culture that you can purchase from a biological supply company is** 10 mL.This goes a long way, so if handled appropriately, it should be enough for several demonstrations of the investigation. The culture can last 3 to 4 weeks in the refrigerator if stored appropriately.

**\*\***Sterile nutrient agar plates can be purchased in packs of 20 from a biological supplier or made at school. You will require nutrient agar powder, sterile Petri dishes with lids, distilled water, a hotplate with a magnetic stirrer, Schott bottles and an autoclave (see Appendix B for instructions).

**\*\*\***Blank sterile discs can be purchased from biological suppliers. They usually come in sets of 50 discs. Discs made from filter paper can be used instead, although care should be taken to ensure that they are not contaminated.

### Risk assessment

**Information related to** [Risk management procedures](https://education.nsw.gov.au/inside-the-department/health-and-safety/risk-management/whs-risk-management-procedure) **can be found on the department’s website.**

The risk matrix in Table 3 was used to determine the risk for the student risk assessment. Schools should conduct a comprehensive independent risk assessment before conducting this investigation.

Table 3 ­– the WHS Risk Matrix

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | CONSEQUENCE (Severity) | | | | | |
| LIKELIHOOD (Probability) | | **Insignificant**  **1** | **Minor**  **2** | **Moderate**  **3** | **Major**  **4** | Critical  5 |
| No treatment is required. | Injury/illness requiring first aid treatment only. | Injury/illness requiring hospitalisation or ongoing treatment. | Life-threatening injury/illness or multiple hospitalisations. | Death or multiple life-threatening injuries. |
| Almost certain  5 | Expected to occur in most circumstances. | **MEDIUM**  **5** | **HIGH**  **10** | **EXTREME**  **15** | **EXTREME**  **20** | EXTREME  25 |
| Likely  4 | High probability of occurring in most circumstances. | **MEDIUM**  **4** | **MEDIUM**  **8** | **HIGH**  **12** | **EXTREME**  **16** | EXTREME  20 |
| Possible  3 | Might occur occasionally. | **LOW**  **3** | **MEDIUM**  **6** | **HIGH**  **9** | **HIGH**  **12** | EXTREME  15 |
| Unlikely  2 | Could occur at some time, doubtful. | **LOW**  **2** | **MEDIUM**  **4** | **MEDIUM**  **6** | **MEDIUM**  **8** | HIGH  10 |
| Rare  1 | May occur but only in exceptional circumstances. | LOW  1 | LOW  2 | LOW  3 | MEDIUM  4 | MEDIUM  5 |

### Aseptic technique

It is important to use aseptic techniques when conducting this investigation. This ensures the validity of the experiment and prevents contamination of the specific microorganism, the room and the people who are working with it.

The first 3 minutes of the [‘Aseptic Technique’ (6:00)](https://www.youtube.com/watch?v=bRadiLXkqoU) video provides a guide for **some** of the techniques listed below.

**Aseptic practices** [**(Science ASSIST 2019)**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1360273/)

* Wash hands with soap and water before and after working with microorganisms.
* Cover any cuts or wounds on the hands with a waterproof dressing.
* Close windows and doors to reduce draughts and prevent sudden movements which may disturb the air.
* Wear sterile disposable gloves.
* Keep hands away from the mouth, nose, eyes and face during and after the activity.
* Decontaminate work surfaces before and after working with microorganisms with 70% v/v ethanol.
* Flame the neck of all test tubes or bottles containing sterile water, microbial culture broth, and liquid agar media when the cap is removed and replaced.
* Work close to a Bunsen burner flame as it provides an updraught, which reduces contamination from the surrounding air.
* All equipment that has come into contact with microorganisms, such as forceps, must be sterilised before and after each use.
* Only open Petri dishes, tubes and bottles for the minimum amount of time.

### Experiment procedure

**Procedure for making the antiseptic disc treatments**

1. Disinfect the workbench with 70% v/v ethanol and a paper towel. Allow the ethanol to evaporate and ensure all alcohol vapours have dissipated before lighting the Bunsen burner.
2. Light the Bunsen burner to create an updraught and sterile area.
3. Collect 4 sterilised Petri dishes with lids, forceps, 50 mL ethanol in a beaker (for flaming forceps), blank paper discs, filter paper, hole punch, and the antiseptic substances (Betadine, Dettol, eucalyptus oil, tea tree oil).
4. Prepare the Dettol solution as per the manufacturer’s instructions.
5. Label the Petri dish with the antiseptic substance being used. Place 5 sterilised discs into the Petri dish and use a sterile syringe to place a drop of the antiseptic substance on each disc.
6. Repeat for remaining treatments in separate Petri dishes. Ensure you use a new sterile syringe for each antiseptic substance.

**Procedure for the experiment**

1. Disinfect the workbench with 70% v/v ethanol and a paper towel. Allow the ethanol to evaporate and ensure all alcohol vapours have dissipated before lighting Bunsen burners.
2. Light the Bunsen burner to create a hot blue flame.
3. Using a permanent marker, divide the base of 5 nutrient agar plates into 4 equal-sized sections. Label the edge of each section as the 4 selected antiseptic substances. Label a separate agar plate as control.
4. Mix the Staphylococcus epidermidis broth culture gently, then loosen the lid (do not remove the lid).
5. Place a nutrient agar plate upside down on the sterilised bench so that the lid is on the bench.
6. Tear the swab packaging at the handle end to expose the handle slightly.
7. Remove the sterile cotton swab from the packaging or beaker without touching the cotton tip to anything. Hold it in one hand.
8. Working close to the Bunsen burner flame, hold the well-mixed broth culture and remove and hold the lid (do not place this on the bench). Pass the opening of the broth culture container through the flame.

|  |  |  |
| --- | --- | --- |
| Figure 1 – opening the lid of the bacterial culture tube  Gloved hands holding a bacterial culture tube in one hand and the lid of the tube in the other hand with a swab. | Figure 2 – passing the neck of the tube through the Bunsen burner flame  A person holding a tube and passing the mouth of the tube through the blue flame of the Bunsen burner to flame the mouth of the tube. | Figure 3 – closing the lid of the tube after flaming  A person holding a tube of bacteria with gloved hands. |

1. Dip the end of the sterilised swab into the Staphylococcus epidermidis broth to moisten the tip. Remove the swab, flame the neck of the tube as before, and replace the lid.
2. Working close to the Bunsen burner, lift the base of the agar plate and turn it so the agar surface is facing you. Streak the agar surface with the cotton swab in a rolling motion over the entire surface, turning the plate 3 times to distribute the bacteria evenly across it (do this gently to prevent breaking the agar surface).
3. Immediately replace the culture plate onto the lid of the agar plate.
4. Place the used swab into the waste beaker containing bleach.
5. Repeat steps 11 to 18 with the remaining 5 plates.
6. Place the plate labelled ‘control’ near the Bunsen flame. With the sterilised forceps, pick up an untreated disc. Lift the lid of the agar plate and place the blank disc on the inoculated control plate.

**Note**: to sterilise the forceps, dip them in ethanol and pass them through the Bunsen burner flame. To avoid burns, do not let the ethanol run up the handle of the forceps.

1. Place one of the remaining nutrient agar plates near the Bunsen burner flame. Lift the lid of the agar plate and use sterile forceps to place the antiseptic disc on the inoculated agar plate in the appropriately labelled section, ensuring you immediately put the lid back onto the agar plate.
2. Repeat step 21 with a new sterile pair of forceps for the other antiseptic agents.
3. Repeat steps 21 and 22 with the remaining plates. You should now have 6 inoculated plates: 5 with the treatment discs added and one plate with a blank disc (no antiseptic).
4. Tape the agar plates closed with one strip of parafilm wrapped once around the circumference of the agar plate or using 4 strips of tape.

**Note:** four strips of sticky tape can be used instead of parafilm. Since sticky tape is not permeable to gases, it should not completely seal the plate.

1. Incubate the agar plates upside down for 24 hours at 30°C in an incubator.
2. Students measure the diameter of the zone of inhibition using one of the methods outlined below.

**Measuring the zone of inhibition**

To facilitate the recording of the results, decide on one of these 2 methods:

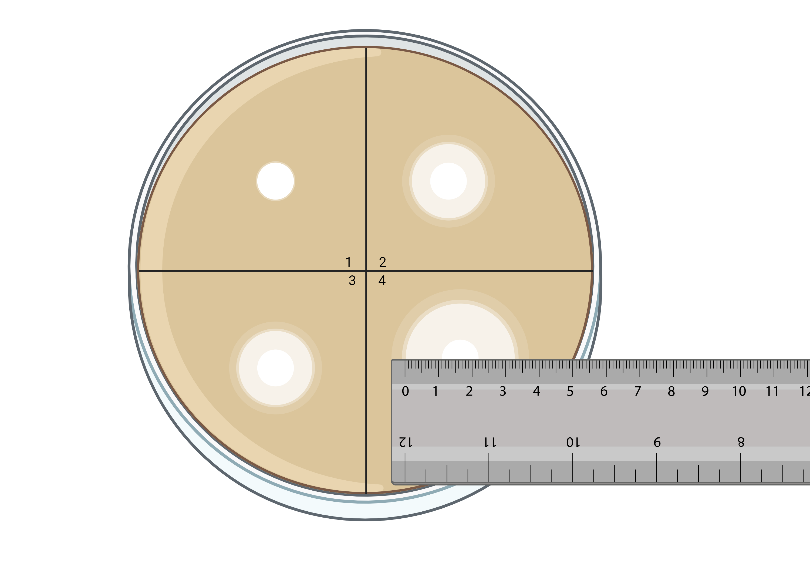
* Distribute one plate per laboratory bench and have students move from one bench to another to measure the zones of inhibition.
* Take photographs of the plates. The size of the printed images should be as close as possible to the actual size of the plates. (Steps to do this are outlined below).

Students will measure the zone of inhibition for each treatment and trial in this task. To do this, they will use a ruler to measure the diameter of the cleared zone. The ruler must go through the centre of the disk. If there is no zone of inhibition the result should be recorded as 0 mm (not the diameter of the disk).

Sometimes, the zone is not very clear, and this is a point that students can explain in their discussion. Students must decide how the zone of inhibition is determined in these cases. In the example in Figure 4, a decision has been made not to measure from the outer faint zone. The ruler below shows that the zone of inhibition for the measured treatment is 33.0 mm. The ruler has millimetre markings, so the precision of the ruler is +/- 0.5 mm or half the reading limit.

If the zone of inhibition is not a circle, multiple measurements may be taken and then a mean zone of inhibition recorded. If the zone of inhibition has been disrupted, by the side of the plate for example, a dot can be placed in the middle of the antiseptic disc and the radius measured. This value would then be multiplied by 2 to represent the diameter.

Figure 4 – measuring the zone of inhibition



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**Photographing the results**

1. Place the agar plates on a clean, flat surface.
2. Position the camera above the plate, parallel to the surface. Take a photo of each agar plate.
3. Crop the digital image to the edges of the plate and paste it into a Word document.
4. Adjust the size of the image by right-clicking on it and selecting **Size** and **Position**. Enter the diameter of the plates (for example, 9.0 cm) in the height and width and press **OK**.
5. Repeat steps 3 and 4 for each photograph.

## Links to the National Literacy Learning Progressions

The teaching and learning program provides opportunities to develop students literacy skills aligned with the [National Literacy Learning Progression V3 [PDF 1.36 MB]](https://v9.australiancurriculum.edu.au/f-10-curriculum/general-capabilities/literacy?element=2&sub-element=LWCrT). This task links to the National Literacy Learning Progressions – Informative text indicators CrT9 through CrT11.

Table 4 – informative text indicators relevant to this assessment task.

|  |  |  |
| --- | --- | --- |
| Feature | Level and indicators | Link to the assessment task |
| Crafting ideas | * **CrT9** selects structural elements to comprehensively and accurately represent the information (e.g. a fact sheet includes an opening statement, labelled diagrams and text boxes) * **CrT9** uses written and visual supporting evidence * **CrT11** uses structural features flexibly to organise ideas strategically (e.g. includes a defined, cogent conclusion/summation) * **CrT11** uses evidence and references | * Students use collected evidence to construct components of a scientific report * Students draw a concise and evidence-based conclusion to summarise their findings |
| Text forms and features | * **CrT9** includes salient visual and audio features to expand on written information (e.g. creates graphs and other technical diagrams from authentic data) * **CrT9** uses formatting appropriately to reference and label graphics * **CrT11** maintains tone appropriate to the audience | * Students construct a table and graph to represent the results * Students use labelling conventions to structure tables and graphs * Students communicate formally in a scientific report appropriate to the identified audience |
| Vocabulary | * **CrT9** uses a range of learnt, technical and discipline-specific terms (e.g. adapt, survive) * **CrT10** uses discipline-specific terminology to provide accurate and explicit information (e.g. discipline metalanguage) * **CrT10** uses vocabulary to indicate and describe relationships (e.g. additionally, similarly) | * Students use appropriate scientific terminology throughout their report * Students use a range of tier 2 and tier 3 vocabulary correctly |

# Appendix B – lab technician preparation

## Preparing nutrient agar plates

**Equipment**

* Autoclave or pressure cooker (used for sterilisation purposes only)
* Balance
* Measuring cylinder
* Schott bottle/s to hold the amount of agar produced
* Hotplate with magnetic stirrer
* Sterile plastic Petri dishes
* 70% ethanol
* Nutrient agar powder

**Method** (adapted from Science ASSIST 2016; Southern Biological 2024)

Use [aseptic technique](#_Aseptic_technique)s to prepare the agar plates to make sure that all plates are initially free of microorganisms and other contaminants.

1. Mix the nutrient agar powder and water according to the manufacturer’s instructions. Bring the mixture to a boil on the hot plate with a magnetic stirrer to prevent clumping. Boil for 5 minutes. Check carefully that all solids have dissolved. Using an incorrect amount of agar or not adequately dissolving it before sterilising may result in the agar not setting. Pour the agar mixture into Schott bottles (only half-fill the Schott bottles). Close the lid of the Schott bottle.

**Note:** overfilling the Schott bottles can lead to the agar boiling over in the autoclave/pressure cooker.

1. Loosen the lid of the Schott bottle one-quarter turn and place a strip of autoclave indicator tape over the lid before placing it into the autoclave or pressure cooker. Sterilise the agar for 20 minutes at 121°C.
2. Ensure the pressure in the vessel is at zero before opening the equipment. Allow the sterile agar to cool to the supplier’s recommended temperature for pouring (approximately 50°C–55°C is recommended).

**Note:** agar can be prepared, sterilised and stored in Schott bottles ahead of time. The set agar can be melted by placing the bottle in a water bath set to 55 °C.

1. Sterilise the workspace with ethanol and set up a Bunsen burner to maintain a sterile work environment. Organise the sterile agar plates with the base down on the bench. You may need to put the Schott bottle into a water bath (set at 50–55 °C) prior to and between pouring to maintain the optimal pouring temperature. Use heat proof gloves to handle the Schott bottle.
2. Pour about 15–20 mL of agar into the base of the sterile Petri dish until it is about half full. Hold the Petri dish lid so that it partially covers the bottom of the dish as you pour to prevent microbes and airborne dust particles from dropping into the sterile plate and contaminating it (shown in Figure 5).

**Note:** condensation inside the agar plates occurs when the lid has been fully replaced on the dish when the agar is too hot, allowing steam to be trapped inside the plate.

Figure 5 – pouring an agar plate with half of the lid covering the base to prevent contamination



‘[Pouring an agar plate](https://assist.asta.edu.au/sites/assist.asta.edu.au/files/SOP%20Preparing%20agar%20plates_v2.pdf)’ by [Science ASSIST](https://assist.asta.edu.au/) is licensed under [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/).

1. Immediately place the lid on the base at an angle so that steam can escape. After a few minutes, place the lid on the plate completely and allow the gel to set (agar solidifies at 42°C). The plates can now be carefully inverted and stacked back in the plastic sleeve they came out of and stored in the fridge until they are required.

**Note:** inverting the plates ensures that any condensation will form on the lid of the plate and not on the agar. If condensation has formed, water can be flicked off or wiped away with a tissue moistened in 70% ethanol immediately prior to use.

**Waste disposal**

All equipment used to prepare agar must be washed with warm, soapy water, rinsed and dried.

All agar plates, including those not cultured, must be sterilised/autoclaved before being put in double plastic garbage bags and sealed for immediate disposal in waste bins. The dishes should be placed in an autoclavable biological waste disposal bag or a microwavable oven cooking bag and sterilised in an autoclave or pressure cooker at a pressure of 110 kPa/15 psi and 121°C for 25 minutes.

Chemical safety in schools [3.2.6: Safe use of biological materials/organism/tissues](https://education.nsw.gov.au/inside-the-department/facilities-assets-and-equipment/school-infrastructure-nsw/knowledge/directorates/operations/technical-services/compliance-and-environment/chemical-safety-in-schools/section-3--curriculum-support-documents/3-2-6--safe-use-of-biological-materials-organism-tissues): this page outlines procedures related to microbiology in schools.

# Appendix C Investigation data

Figure 6 – sample agar plates showing zones of inhibition for eucalyptus oil (quadrant 1), tea tree oil (quadrant 2), Dettol (quadrant 3), and Betadine (quadrant 4). A control plate with a blank disc is also included

|  |  |
| --- | --- |
| Plate 1  Photo of agar plate 1. | Plate 2  Photo of agar plate 2. |
| Plate 3  Photo of agar plate 3. | Plate 4  Photo of agar plate 4. |
| Plate 5  Photo of agar plate 5. | Control plate  Photo of control agar plate with a blank disk in the middle. |

# Appendix D – depth study alternative

There is an opportunity to turn this task into a depth study by involving local Aboriginal communities and/or appropriate knowledge holders in determining suitable local plant resources that could be used in the investigation.

**Aboriginal and Torres Strait Islander histories and cultures**

**Planning and programming**

When planning and programming content relating to Aboriginal and/or Torres Strait Islander histories and cultures, teachers are encouraged to:

* involve local Aboriginal communities and/or appropriate knowledge holders in determining suitable resources or use Aboriginal and/or Torres Strait Islander-authored or endorsed publications
* read the [principles and protocols](https://www.educationstandards.nsw.edu.au/wps/portal/nesa/k-10/diversity-in-learning/aboriginal-education/aboriginal-and-torres-strait-islander-principles-and-protocols) relating to teaching and learning about Aboriginal and/or Torres Strait Islander histories and cultures and the involvement of local Aboriginal communities.

The [Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) Guide to evaluating and selecting education resources](https://aiatsis.gov.au/education/guide-evaluating-and-selecting-education-resources) has been developed to assist teachers in selecting appropriate resources for respectfully and effectively teaching Aboriginal and Torres Strait Islander histories, cultures, and languages.

Table 5 – some plants used by Aboriginal and Torres Strait Islander Peoples for skin and wound-related medicinal purposes

|  |  |
| --- | --- |
| Plant | Use |
| Common name – Narrow-leafed paperbark  Scientific name – Melaleuca linarifolia | The thin layers of bark can be applied to open wounds like a bandage. Elder Fran Bodkin describes the powder inside the layers of bark as an antibiotic ([My Garden Path – Fran Bodkin, 2020](https://www.abc.net.au/gardening/how-to/my-garden-path-fran-bodkin/12852286)). |
| Common name – Sydney peppermint  Scientific name – Eucalyptus piperita | ‘The fresh gum was collected, mixed with warm water and applied to sores, burns, cuts and scabies’ (Waraburra Nura, [Fran Bodkin](https://waraburranura.com/plants/eucalyptus-piperita/)). |

It should be noted that if a plant substance does not stop the growth of the specific bacteria used in the investigation, it does not mean that it is not a suitable antiseptic. Possible explanations may be:

* The plant material may have been prepared incorrectly
* The plant material may work on other pathogens
* The methodology used may not reflect the traditional use of the plant substance
* The medicinal properties of plants can vary depending on the environmental conditions and season in which they are harvested.

# Appendix E – alternative introduction

**Differentiation:** this introduction could be used to extend students with an advanced vocabulary and an excellent understanding of disease concepts.

## Introduction

Antiseptics are substances that inhibit the growth of microorganisms on living tissues and are essential in preventing infections in wounds and cuts. Their use is widespread in both healthcare and household settings to ensure hygiene and prevent the spread of infections. This study compares the antiseptic qualities of 4 existing antiseptics, eucalyptus oil, tea tree oil, Betadine and Dettol, that could be included as an ingredient in skin creams to treat skin grazes and small cuts.

Aboriginal and Torres Strait Islander Peoples have used natural plant matter for thousands of years to treat disease. Eucalyptus oil is derived from the leaves of the eucalyptus tree and contains several compounds believed to have bactericidal properties (Bachir and Benali 2012). Aboriginal peoples have used eucalyptus plants for various purposes, including traditional medicinal uses (Vecchio et al. 2016).

Tea tree oil is extracted from the leaves of Melaleuca alternifolia and is another essential oil used for its antimicrobial effects (Carson et al. 2006). The Bundjalung people from the coast of New South Wales crushed tea tree leaves into a paste and applied it to wounds as an antiseptic (Kamenev 2011).

Betadine is a well-established antiseptic containing iodine that is commonly used for skin disinfection and wound care. Its rapid action kills bacteria that may cause skin and wound infections (Health Direct 2024a). Dettol antiseptic liquid is commonly used to clean and disinfect minor skin wounds such as cuts and scratches. Its antimicrobial properties can protect a wound from becoming infected by bacteria (Health Direct 2024b).

The effectiveness of these substances against Staphylococcus epidermidis is assessed using the disc diffusion method. Discs of paper impregnated with solutions of the test substances are placed on agar plates inoculated with the bacteria. The inhibition of bacterial growth around the discs can be measured to determine the antibacterial activity of each substance.

# Evidence base

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