Department of Education
GOVERNMENT OF WESTERN AUSTRALIA

CURRICULUM RESOURCE MODULE

Contagion

YEAR 12

THE STEM LEARNING PROJECT
scitech
STAWA SCIENCE TEACHERS' ASSOCIATION OF WESTERN AUSTRALIA

Acknowledgements

The STEM Learning Project respectfully acknowledges the Traditional Custodians of the lands upon which our students and teachers live, learn and educate.

The STEM Learning Project is funded by the Western Australian Department of Education (the Department) and implemented by a consortium in STEM education comprising the Educational Computing Association of WA, the Mathematical Association of WA, the Science Teachers Association of WA and Scitech. We acknowledge and thank the teachers and schools who are the co-creators of these resources.

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The STEM Learning Project

The aim of the STEM Learning Project is to generate students' interest, enjoyment and engagement with STEM (Science, Technology, Engineering and Mathematics) and to encourage their ongoing participation in STEM both at school and in subsequent careers. The curriculum resources will support teachers to implement and extend the Western Australian Curriculum across Kindergarten to Year 12 and develop the general capabilities.

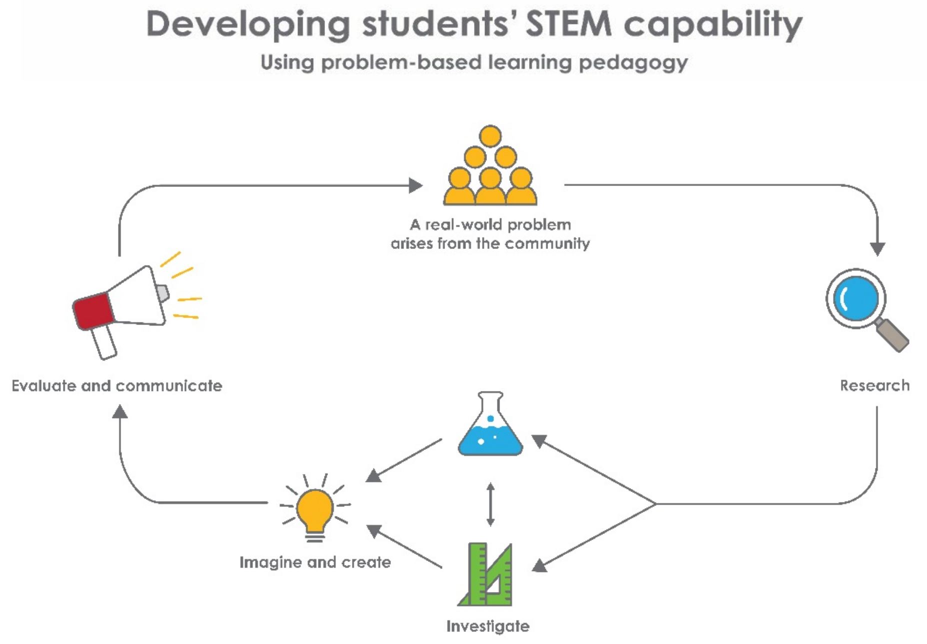
Why STEM?

A quality STEM education will develop the knowledge and intellectual skills to drive the innovation required to address global economic, social and environmental challenges.

STEM capability is the key to navigating the employment landscape changed by globalisation and digital disruption. Routine manual and cognitive jobs are in decline whilst non-routine cognitive jobs are growing strongly in Australia. Seventy-five per cent of the jobs in the emerging economy will require critical and creative thinking and problem solving, supported by skills of collaboration, teamwork and literacy in mathematics, science and technology. This is what we call STEM capability. The vision is to respond to the challenges of today and tomorrow by preparing students for a world that requires multidisciplinary STEM thinking and capability.

The approach

STEM capabilities are developed when students are challenged to solve open-ended, real-world problems that engage students in the processes of the STEM disciplines.



STEM Consortium

Year 12 – Contagion

Overview

In the *Contagion* module, students learn about the causes and transmission of infectious diseases. They investigate the microorganisms found on the surfaces we are in contact with every day and the effectiveness of antibacterial agents. Using the design process and digital technologies, students develop and communicate strategies to raise awareness of the ways to prevent the spread of disease-causing microorganisms.

What is the context?

Microorganisms are too small to see with the naked eye and include bacteria, viruses and small fungi such as yeasts. Microorganisms are the most abundant life forms on Earth and are found in every environment. Recent research has raised awareness about the importance of the microorganisms that inhabit our lower intestines. This 'gut microbiome' plays a key role in digesting food, absorbing and synthesising nutrients, metabolism, body weight, the immune system, appetite and mood.

Most microorganisms are beneficial or harmless, however, some infections can make us unwell, such as *E. coli, Listeria, Salmonella* bacteria and the influenza virus, or result in life-threatening diseases such as typhoid fever or cholera.

Scientific and technological research and development have made significant advancements in the control of infectious diseases.

Understanding the growth and spread of microorganisms can help students learn to stay healthy and design ways to reduce the spread of microorganisms in the community.

What is the problem?

How can we make our community more aware of the ways to prevent the spread of disease-causing microorganisms?

How does this module support integration of the STEM disciplines?

Contagion presents students with the problem of how to raise awareness of methods to reduce the transmission of infectious diseases within their school community.

Students develop understandings about the causes and transmission of infectious diseases and the effectiveness of various antimicrobial agents, and apply science inquiry skills to investigate the prevalence of microbes. They use mathematical techniques to represent the structure and size of cells using scale drawings, and use simulation data to predict the number of people likely to be infected with a pathogen. Students then apply design skills and processes to the development of a strategy to raise awareness of the problem in their school community.

Year 12 *Human Biology General* students will engage with the following understandings and inquiry skills:

- The development of the microscope was important in linking specific pathogens to specific diseases, which then allowed for the appropriate treatment or preventative measures to be used, including antiseptics, antibiotics, quarantine measures and improved hygiene for water and food, which have reduced the impacts of myths and misconceptions around disease and its transmission.
- Infectious disease is caused by the invasion of a pathogen and can be transmitted from one host to another.
- Pathogens include bacteria, viruses, fungi, parasites, and are the causes of common diseases, including Ross River disease, influenza, food poisoning, tinea and malaria.
- The transmission and spread of infectious disease is facilitated by local, regional and global movement of individuals.
- Pathogens have adaptations that facilitate their entry into the body and transmission between hosts; transmission occurs by various mechanisms, including through:
  - Direct and indirect contact
  - Contaminated food and water
  - Disease-specific vectors, including airborne transmission.
- Preventing the transmission of disease includes strategies of quarantine, immunisation and disruption of pathogen life cycle.
- Hygiene practices by individuals in workplaces, especially in places of food preparation and in hospitals, affect the transmission of disease.
- Population density and movement patterns influence the transmission of disease.
- Identify, research and construct questions for investigation; propose hypotheses, and predict possible outcomes.
- Design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics.
- Conduct investigations safely, competently and methodically for the collection of valid and reliable data.
- Represent data in meaningful and useful ways, including the use of mean and median; organise and analyse data to identify trends, patterns and relationships; discuss how measurement error, instrumental accuracy, the nature of the procedure and the sample size may influence uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions.
- Select, use and/or construct appropriate representations, to communicate conceptual understanding, solve problems and make predictions.

- Communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports.

Year 12 *Mathematics Essentials General* students will have the opportunity to:

- Calculate areas of parallelograms, trapeziums, circles and semi-circles.
- Determine the area of composite figures by decomposition into familiar shapes.
- Understand and apply drawing conventions of scale drawings, such as scales in ratio, dimensions and labelling.
- Construct scale drawings by hand and by using appropriate software/ technology.
- Interpret and use graphs in practical situations, including travel graphs, time series and conversion graphs.
- Draw graphs from given data to represent practical situations.
- Describe the patterns and features of bivariate data.
- Perform simulations of experiments using technology.
- Recognise that the repetition of chance events is likely to produce different results.
- Identify factors that may cause the simulation to no longer model the real-world event.
- Construct a sample space for an experiment which represents a practical situation.
- Use arrays or tree diagrams to determine the outcomes and the probabilities for experiments.
- Identify situations in real-life contexts where probability is used for decision making.

Year 12 *Applied Information Technology General* students will have the opportunity to:

- Identify and explain the elements of design and the principles of design in an existing digital product and/or solution.
- Apply the elements of design and principles of design when developing a digital product and/or solution:
  - Create accurate visuals/layouts
  - Apply principles of layout and composition.
- Apply the elements of design and principles of design when developing a digital product and/or solution.
- Develop and apply detailed annotations for digital designs, relevant to a particular design brief.
- Apply the elements of design and the principles of design relevant to a particular design brief.
- Apply a design process to create a digital product, design and/or digital solution.
- Apply techniques for representing the design of a digital product and/or digital solution.

Year 12 *Design General* students will have the opportunity to engage with the:

- Development and documentation of a design process, including research and/or investigation, analysis, idea development and critical reflection.
- Creation and/or interpretation of diagrams, layouts, plans and drawings.
- Application of design process, such as visual research, idea generation techniques, synectics, mind maps, brainstorming.
- Reflection and evaluation of solutions to design problems.
- Identification of specific audiences in terms of lifestyle behaviour, values and beliefs.
- Development of suitable formats of presentation for design solutions.

General capabilities

There are opportunities for the development of general capabilities and cross-curriculum priorities as students engage with *Contagion*. In this module, students:

- Develop problem solving skills as they research the problem and its context in *Activity 1*; investigate parameters impacting on the problem in *Activity 2*; imagine and develop solutions in *Activity 3*; and evaluate and communicate their solutions to an audience in *Activity 4*.
- Utilise creative thinking as they generate possible design solutions; and critical thinking, numeracy skills and ethical understanding as they choose between alternative approaches to solving the problem.
- Utilise personal and social capability as they develop socially cohesive and effective working teams; collaborate in generating solutions; adopt group roles; and reflect on their group work capabilities through self and peer evaluation.
- Utilise a range of literacies and information and communication technologies (ICT) capabilities as they collate records of work completed throughout the module in a journal; represent and communicate their solutions to an audience using digital technologies in *Activity 4*.
- Communicate and, using evidence, justify their group's design to an authentic audience in *Activity 4*.

What are the pedagogical principles of the STEM learning modules?

The STEM Learning Project modules develop STEM capabilities by challenging students to solve real-world problems set in authentic contexts. The problems engage students in the STEM disciplines and provide opportunities for developing higher order thinking and reasoning, and the general capabilities of critical and creative thinking, communication and collaboration.

The design of the modules is based on four pedagogical principles:

- Problem-based learning
  This is an underlying part of all modules with every module based around solving an initial problem. It is supported through a four-phase instructional model: research the problem and its context; investigate the parameters

impacting on the problem; design and develop solutions to the problem; and evaluate and communicate solutions to an authentic audience.

- Developing higher order thinking
  Opportunities are created for higher order thinking and reasoning through questioning and discourse that elicits students' thinking, prompts and scaffolds explanations, and requires students to justify their claims. Opportunities for making reasoning visible through discourse are highlighted in the modules with the icon shown here.

- Collaborative learning
  This provides opportunities for students to develop teamwork and leadership skills, challenge each other's ideas, and co-construct explanations and solutions. Information that can support teachers with aspects of collaborative learning is included in the resource sheets.
- Reflective practice
  Recording observations, ideas and one's reflections on the learning experiences in some form of journal fosters deeper engagement and metacognitive awareness of what is being learned. Information that can support teachers with journaling is included in the resource sheets.

These pedagogical principles can be explored further in the STEM Learning Project online professional learning modules located in Connect Discover.

Activity sequence and purpose

Activity 1

RESEARCH

Causes and transmission of infectious diseases

Students research how scientific discoveries have enabled us to link specific pathogens to specific diseases and better understand their causes, transmission and control.

Students research and compare the structure of bacterial, plant and animal cells. They study how cells multiply by cell division to help understand the spread of infectious disease.

Activity 2

INVESTIGATE

Investigating microorganisms and their growth

Students observe the effectiveness of various antibacterial solutions on bacteria growth. They investigate the prevalence of microorganisms by growing and calculating the area of the colonies. Students analyse data and draw conclusions about disease transmission and prevention.

Activity 3

IMAGINE & CREATE

Designing a solution

Students design a practical and engaging solution to the problem of making the community more aware of the spread of infectious diseases and actions for prevention.

Students document their design processes for the proposed solution in a digital design portfolio.

Activity 4

EVALUATE & COMMUNICATE

Sharing our findings

Students present their proposed solutions to a panel of school or community members. Presentations provide evidence-based arguments from students' research, investigation and design process to support their chosen solution.

Background

Expected learning	Students will be able to: 1. Explain how scientific discoveries, made possible by developments in mathematics and technology, have derived new understandings and technologies for the prevention and treatment of infectious diseases. 2. Develop science understanding about the different types of pathogens and their specialised cell structures and functions. 3. Explain how infectious diseases are transmitted within a community and measures that can be taken to minimise disease transmission. 4. Use a microscope to examine a variety of cells and identify cell structures. 5. Create a scientific drawing of cells by hand or using technology, applying drawing conventions of scale drawings where appropriate. 6. Use field of view calculations, including unit conversions for measurements, to estimate cell sizes. 7. Formulate a testable hypothesis or question, plan and conduct a scientific investigation, analyse and interpret data and communicate findings using appropriate conventions. 8. Identify the needs of a client, develop a design brief, develop a design and from this a solution that meets the expectations of the client. 9. Use appropriate digital technologies to document and communicate the design process and solution to an authentic audience.
Vocabulary	This module uses subject-specific terminology which is shown in *Teacher resource sheet 1.5: Vocabulary list*.
Timing	There is no prescribed duration for this module. The module is designed to be flexible enough for teachers to adapt. Activities do not equate to lessons; one activity may require more than one lesson to implement.
Consumable materials	A *Materials list* is provided for this module. The list outlines materials outside of normal classroom equipment that will be needed to complete the activities.

Safety notes	There are potential hazards inherent in these activities and with the equipment being used. A plan to mitigate any risks will be required. Potential hazards specific to this module include but are not limited to: • Possible exposure to cyber bullying, privacy violations and uninvited solicitations when using the internet. • Risks associated with growing and observing bacteria. Appropriate aseptic techniques and safety precautions are outlined in the Education Department's Laboratory Manual. See *Teacher resource sheet 1.7: Safety procedures for microbiology activities*.
Assessment	The STEM modules have been developed to provide students with learning experiences to solve authentic real-world problems using capabilities from science, technologies and mathematics. *Links to the Western Australian Curriculum* indicates the expected learning for the Year 12 *Human Biology General* course students will engage in as they work through the module. It also indicates the links to the Year 12 *Mathematics Essentials General, Applied Information Technology General* and *Design General* courses, as opportunities may arise for students to engage in learning from these Western Australian Certificate of Education courses. While working through the module, the following assessment opportunities will arise: Human Biology • Science inquiry investigation report – students provide a journal and report following the completion of the *Activity 2* inquiry work. The journal documents observations, choices made about methods and reflections on data. The report provides a systematic presentation of the plan for the investigation, how it was conducted, the data collected, analysis, interpretation of the data and conclusions. • This module provides contexts for extended response tasks and test items on scientific understanding of infectious diseases and science inquiry skills.

Mathematics Essentials

- Response and Practical application tasks related to calculation of areas, scale drawings and graphing data.
- Application of the statistical investigation process in the context of spread of infections.

Applied Information Technology

- Project involving researching technology-based ideas and processes to create a digital solution to raise awareness about the spread of infections.
- Contexts for short and extended answer tasks

Design

- A Production task in which students investigate, explore ideas and follow a design process, collating evidence of choices and solutions.

Activity 1: Causes and transmission of infectious diseases

Activity focus

Students research how scientific discoveries, made possible by developments in mathematics and technology, have enabled us to better understand the causes of infectious diseases as well as their transmission and control. They research and compare the structure of bacteria, plant and animal cells, and study how cells multiply by cell division.

Background information

How have scientific discoveries contributed to our understanding of the causes of infectious diseases, their spread and control?

Thousands of people succumbed to epidemics of smallpox and bubonic plague in the 1500s and 1600s. Many people believed that these diseases were caused by evil spirits, the bad air or miasma found in the overcrowded living conditions in cities.

Laboratory research conducted by Pasteur, Koch and their pupils significantly advanced our understanding of the causes of disease. The resulting germ theory gradually replaced the prevailing miasma theory.

Industrialised and overcrowded 19th century cities were havens for diseases such as typhoid, tuberculosis and cholera. While researching a cholera outbreak in 1854, London doctor John Snow demonstrated that cholera was spread in water collected from wells that were contaminated with cholera bacteria.

The control of infectious diseases was advanced by discoveries made by Joseph Lister who used carbolic soap as an antiseptic to reduce infection rates in surgery; Jenner who demonstrated the effectiveness of vaccination; and Fleming's research that advanced the development and use of the antibiotic penicillin. Scientific and technological research and development have enabled huge contributions to advancements in the control of infectious diseases.

Science Museum Group UK
broughttolife.sciencemuseum.org.uk/broughttolife

What are microorganisms?

A microorganism, or microbe, is a microscopic organism that is too small to be seen with the naked eye and a microscope must be used to see them. There are seven types of microorganisms: bacteria, archaea, protozoa, algae, fungi, viruses and multicellular animal parasites.

What are bacteria?

Bacteria are single-celled organisms that live on, in and around most living and non-living things.

Bacteria play a vital role in recycling nutrients in the environment. In humans, it has been found that there are large numbers of bacteria lining the gastrointestinal tract and living on the skin. Recent medical research has shown that gut bacteria play an important role in health.

There are also pathogenic species of bacteria that can lead to infectious diseases if they enter the bloodstream and tissues.

Where can bacteria grow and what conditions promote bacteria growth?

Bacteria grow in very diverse conditions which explains why they are found nearly everywhere on Earth. Although bacteria are good at adapting to their environments, certain conditions promote bacterial growth more than others. These conditions include warm temperatures, moisture, a neutral pH and a source of oxygen.

What are pathogenic bacteria?

Pathogenic bacteria are microorganisms that cause disease. In response to an infection, various types of white blood cells can ingest pathogenic bacteria while other types of white cells produce antibodies to destroy them.

How are pathogens spread?

Pathogens can be spread in several ways:

- Contact – pathogens can spread through direct or indirect contact between people. This is the most common way.
- Inhalation – pathogens can be quickly passed through the air (eg someone coughing or sneezing).
- Ingestion – pathogens that have been eaten or taken into the body from contaminated food or water.

- Inoculation – when pathogens get into a wound in body tissue.
- Vectors – transfer of pathogens by other animals (eg insects, ticks, mites).

How did disease-causing bacteria and viruses brought by the first settlers affect Aboriginal populations?

Pathogenic forms of bacteria introduced by European settlers spread rapidly among Aboriginal peoples as they had little resistance to these new diseases. The major epidemic diseases caused by bacteria and viruses during early contact and colonisation were smallpox, syphilis, tuberculosis, influenza and measles. Soldiers returning from the First World War brought Spanish Flu to Australia, which accounted for many deaths among Aboriginal people.

How can the transmission of infectious diseases be limited?

By taking the following simple precautions, people can generally avoid pathogens that cause infections:

- Washing hands
- Safely storing, preparing and cooking food
- Containing coughs and sneezes using a handkerchief
- Isolating sick people from healthy people
- Keeping surfaces clean.

Antiseptics and disinfectants can be used to kill microorganisms. Antiseptics are used on the body, while disinfectants are used on non-living surfaces.

If bacteria have entered the body and caused an infection, most can be treated with antibiotics. However, some bacteria have developed resistance to antibiotics that are commonly used to treat them. Antibiotics work by disrupting the bacterium's metabolic processes or their cell structure.

Immunisation is available to prevent many common infectious diseases such as influenza, tetanus, whooping cough and measles. Not all Australian children receive the scheduled vaccinations and this exposes them to preventable infections. In the case of measles, while immunisation has prevented millions of people from contracting the disease, the World Health Organization states there has been a 30% increase in the number of reported cases since 2016 (see *Digital resources*).

	There are several natural remedies used by different cultures to treat bacterial infections. Some include coconut oil, lemon, garlic, Manuka honey, as well as tea tree and eucalyptus oils.
Instructional procedures	The delivery of this activity can be modified to account for differences in the time and materials available. The research activities provide opportunities for collaborative group work that could be set as homework tasks with the findings discussed in small groups in class. The observation and drawing of cells and tissues using microscopes provides an opportunity for the application and development of mathematical skills. This occurs as students use units of measurement, prefixes and indexes for sizes of cells in the nanometer and micrometer size range, as well as microscope calculations. Teachers may find this context appropriate for the development of skills associated with understanding and applying drawing conventions of scale drawings, such as scales in ratio, dimensions and labelling, and constructing scale drawings by hand or using appropriate software/technology. This context also provides opportunities to use simulations and data to predict the number of people likely to be infected with a strain of flu, which will increase understanding of the transmission and spread of infectious diseases. Students engage in reflection and journaling after all activities. This provides opportunities to develop metacognitive awareness, critical and creative thinking and competence in compiling a digital journal or portfolio.
Expected learning	Year 12 *Human Biology General* students will develop understandings of: 1. The development of the microscope was important in linking specific pathogens to specific diseases, which then allowed for the appropriate treatment or preventative measures to be used, including antiseptics, antibiotics, quarantine measures and improved hygiene for water and food, which have reduced the impacts of myths and misconceptions around disease and its transmission. 2. Infectious disease is caused by invasion of a pathogen, and can be transmitted from one host to another.

3. Pathogens include bacteria, viruses, fungi, parasites, and are the causes of common diseases, including Ross River disease, influenza, food poisoning, tinea and malaria.
4. The transmission and spread of infectious disease are facilitated by local, regional and global movement of individuals.
5. Pathogens have adaptations that facilitate their entry into the body and transmission between hosts; transmission occurs by various mechanisms, including through:
   - Direct and indirect contact
   - Contaminated food and water
   - Disease-specific vectors, including airborne transmission.
6. Preventing the transmission of disease includes strategies of quarantine, immunisation, and disruption of the pathogen life cycle.
7. Hygiene practices by individuals in work places, especially in places of food preparation and in hospitals, affect the transmission of disease.
8. Population density and movement patterns influence the transmission of disease.

Year 12 *Mathematics Essentials General* students will be able to:

1. Understand and apply drawing conventions of scale drawings, such as scales in ratio, dimensions and labelling.
2. Construct scale drawings by hand and by using appropriate software/technology.
3. Perform simulations of experiments using technology.
4. Recognise that the repetition of chance events is likely to produce different results.
5. Identify factors that may cause the simulation to no longer model the real-world event.
6. Construct a sample space for an experiment which represents a practical situation.
7. Use arrays or tree diagrams to determine the outcomes and the probabilities for experiments.
8. Identify situations in real-life contexts where probability is used for decision making.

Equipment required	**For the class:** Computer Speakers Digital projector with the ability to connect to a microscope and a computer Whiteboard or interactive whiteboard For *Part 5* simulation: Test tube and droppers for each class participant Test tube lids Distilled water 0.1 molar NaOH pH 7.0 buffer solution Phenolphthalein solution, dissolved in alcohol and diluted in water (as a pH indicator)
	For the students: Camera Microscopes A3 paper, pens, pencils, markers Small newspaper clippings of text Prepared slides of cells or tissues Three microscope slides and coverslips per student Tweezers, paper towel, Methylene blue solution in a dropper bottle Onion segment Craft materials for creating a model cell
Preparation	Ensure access to digital devices for online research. Check the websites listed in the *Digital resources* section are accessible to students for their research and for accessing the simulation. Review and have resources set up for *Simulating the spread of an infectious disease* listed in the *Digital resources* section.

Review *Teacher resource sheet 1.6: Microscope calculations* and *Teacher resource sheet 1.7: Safety procedures for microbiology activities*.

Activity parts

Part 1: Introduction

Explain that infectious diseases caused by bacteria and viruses have accounted for a large proportion of deaths globally. In developed countries, diarrhoeal diseases and influenza are the most common infectious diseases. This is also found to be the case in school communities and aged care homes.

View with students the *World Health Organization Infographics* (see *Digital resources*) on infectious diseases and explore their thinking and questions.

Conduct a class discussion where students share their experiences with infectious diseases to determine their prior knowledge. Record student responses as a brainstorm on a digital platform such as *Padlet* or the whiteboard using the following prompt questions as headings:

- What infectious diseases have you or your family members had?
- How are infectious diseases like these contracted?
- How did you know that you/they had these infectious diseases?
- What treatment did you/they receive?
- How was the infectious disease cured? With or without treatment? Why is it important that it was cured?
- What actions were taken to prevent the spread of these infectious diseases? Why is it important that these actions were taken?

Introduce students to the challenge of minimising the spread of infections in our community and so, find a solution to the problem:
How can we make our community more aware of the ways to prevent the spread of disease-causing microorganisms?

Part 2: Causes and control of infectious diseases

Throughout history, advances in medical science, mathematics and technologies have developed our understanding of the causes of infectious diseases. This has led to the development of technologies such as vaccinations and antibiotics, which have reduced the incidence of these diseases.

Working in small groups, students research the contributions made by historical figures to our understanding of:

- Causes of contagious diseases (ie miasma to germ theory – Pasteur, Koch and van Leeuwenhoek)
- Disease transmission (Snow)
- Antiseptic surgical techniques (Lister)
- Vaccination (Jenner)
- Antibiotics (Fleming).

Allocate one of the above scientists to each group member. Research should include images, dates, an explanation of the person's contribution to scientific understanding, and developments in mathematics or technology that made the discovery possible. Several online resources are listed in the *Digital resources* section.

Students use the resources along with the following questions to assist with research:

- What keywords will improve your online search results?
- How can you determine which information is credible? Why? …*because*…
- How can you organise information efficiently and effectively?
- Why is it important to reference resources correctly?

Each group constructs a digital timeline infographic to represent the development of our understandings of the causes, transmission, prevention and treatment of infectious disease. Prompt students to consider their audience and the key messages to be communicated by their infographic.

Once the contribution of historical figures has been researched, students extend their research to current challenges and developments in the control of infectious diseases, including antibiotic resistance, the anti-vaxxer movement, the rapid mutation of pathogens making some vaccines less effective, DNA vaccines, vaccine patches and adjuvants, and bacteriophages. Direct students to *New vaccines on the horizon* in *Digital resources*.

Groups report back to a class discussion in which timelines are shared and compared. Focus questions can include:

- How has our understanding of the causes, transmission, prevention and treatment of infectious diseases developed through the contributions of scientific discoveries?

- How have scientific discoveries benefited from developments in technology and mathematics?
- What can we learn about the nature of science from the study of historical developments in disease control?

Part 3: Observing cells

Present an introduction to the science of microorganisms using *Comparing the Sizes of Microorganisms Up to 1mm* and *Types of microorganisms* (see *Digital resources*), which provide useful graphics of the relative sizes of viruses, bacteria, plant and animal cells.

Students' research of cell structures is extended by conducting a microscopic examination of prepared slides of cells.

Review the microscope with students, making sure they are familiar with the following:

- Naming parts of the microscope
- Comparing binocular and monocular microscopes
- Focusing a microscope
- Calculating magnification by multiplying ocular lens magnification by objective lens magnification.

Students can practise microscope techniques by focusing on a newspaper clipping. Observe students and give feedback on their technique.

Students examine prepared slides of animal cells and draw diagrams in their notebooks of what they see under low and high magnification. Students should identify the components of a cell (nucleus, cytoplasm, cell membrane) visible through a typical school light microscope and in their diagrams. Provide feedback on students' diagrams and ensure they have an informative title, labels and a scale.

Ask students to consider the following questions while completing observations:

- What additional observations were made possible by using a microscope?
- Which magnification was the most useful? What could you see best under low magnification? What could you see best under high magnification?
- Why would it be beneficial to have access to microscopes with greater resolving power?

There is an opportunity for students to develop mathematical understandings by practising unit conversions from millimeters to micrometers, using the field of view diameter to estimate the average length of the cells they observe, and devising an appropriate scale to include in their drawings (see *Teacher resource sheet 1.6: Microscope calculations*). This may be a suitable context for Year 12 *Mathematics Essentials General* students to apply drawing conventions of scale drawings, such as scales in ratio, dimensions and labelling, and construct scale drawings by hand and by using appropriate software/technology.

Students research of cell structures is supported by preparing slides of onion epithelium using methylene blue stain. Onion cells provide a useful material on which to practise microscopy, as the cells are large and it is relatively easy to identify major cell structures.

Demonstrate slide preparation and methylene blue staining to students.

Students prepare their slides and observe the onion epithelium under low magnification and then under high magnification. Students draw what they see; label the cell wall, nucleus and cytoplasm; provide an informative title for their drawing; and add a scale to indicate the size of the cells.

To check students' understanding, facilitate a discussion using the following question prompts:

- How do onion cells differ from the animal cells you have observed? Why is that? …*because*…
- Why is it important to add a title, labels and a scale to your cell drawings?
- How has the technological development of microscopy helped advance scientific understandings of cells and disease?

Part 4: Cell structure and function

Engage students in researching the structure and function of the parts of cells, including the cell membrane, and the similarities and differences in the structure of bacteria and viruses. Challenge students to plan how they will summarise, organise and present their findings. The teacher may choose to extend the research of structures and how they facilitate disease transmission.

In groups, students produce a physical or digital model cell that showcases their knowledge of either bacterial or virus-cell structures. The *Bacteria, Plant and Animal Cell Structure* resource (see *Digital resources)* can be used to initiate student research.

Groups report back to a class discussion in which models are shared and cell structures are compared. Explore student thinking by asking the following focus questions:

- What are the key features of your model that allow it to be identified as your chosen cell type?
- What features of these cells facilitate the success of these disease-causing microorganisms?

Part 5: Multiplication, spread and control of pathogens

Students view the *Cell division* and *How are pathogens spread and controlled?* video clips in *Digital resources* to develop an understanding of the multiplication, spread and control of pathogens.

These video clips are information-dense. Show a clip once to the whole class and challenge students to devise the best way of summarising the key points. Then allow students to view the clip repeatedly to extract information, preferably on their own devices.

Focus questions might include:

- How do cells multiply? How do new cells gain a share of the cytoplasm, organelles and genetic information?
- Why is the proliferation of bacterial cells an important aspect of disease transmission?
- What are the main mechanisms of disease transmission? How can each transmission method be controlled?
- Why have measles outbreaks occurred recently in Perth and throughout the world?

Invite students to share what they have learnt from the video clips and how that might help them plan approaches to minimising the spread of infectious diseases in their community.

Part 6: Simulating the spread of pathogens

<u>Task 1:</u>

Present a scenario where the class simulates the spread of a simple imaginary disease, so that factors that affect the rate of infection can be explored.

Conduct a class activity by following the procedure in *Simulating the spread of an infectious disease* listed in *Digital resources.* Once 'infected' participants are identified, hold a class discussion and model on the board how to trace the source of infection.

This may be a suitable context for students to apply arrays or tree diagrams to determine patient zero.

Explore student thinking by asking the following focus questions:

- Is the order in which you exchanged fluids important?
- What challenges could face real-world tracing of an infection?
- What measures could be used to prevent the spread of disease?

Demonstrate how the spread of disease in this activity could be decreased by using processes to minimise exposure through public health measures, immunity and therapeutic drugs.

Task 2:

This is an opportunity for students to develop mathematical understandings by using simulation and data to predict the number of people to be infected with a pathogen.

Students view *Interactive Labs Disease Lab Overview* and then work through these tasks using the *Human disease transmission, interactive lab for The Habitable Planet online course* simulation listed in *Digital resources.* Explore student understanding and thinking while they interact with the simulation by asking the following focus questions:

- Do you get the same results each time the simulation is run? How do your results compare to others and your predictions?
- What could be done to prevent the spread of disease in a low population density? What kinds of challenges would high population density present?
- How does using vaccination compare to changing the population mixing or population density?
- For a disease that has a death rate, how many people die, on average, when the simulator runs on a scenario in which humans have no immunity to the disease? What effect does population mixing and population density have on the death toll?

	Students report back to a class discussion and share what they have learnt from the simulations and how this might help them plan approaches to minimising the spread of infectious diseases in their community.
	Part 7: Reflection and journaling Provide time for students to review and reflect on this activity and discuss the questions below. Students record their reflections in a digital journal. • How has the technological development of microscopy enhanced scientific understanding of disease? • What can we learn about the nature of science from the historical development of our understanding of disease and disease transmission?
Resources	*Teacher resource sheet 1.6: Microscope calculations* *Teacher resource sheet 1.7: Safety procedures for microbiology activities*
Digital resources	*Miasma to germ theory and penicillin* (Science Museum Brought to Life: Exploring the history of medicine, n.d.) *broughttolife.sciencemuseum.org.uk/broughttolife/themes/diseases*
	Lister's development of antiseptic surgical techniques *Antiseptic* (Wikipedia, 2019) *en.wikipedia.org/wiki/Antiseptic*
	World Health Organization Infographics (WHO, 2019) *who.int/mediacentre/infographic/en/*
	The development of vaccination *Smallpox: inoculation and vaccination* (Science Museum Brought to Life: Exploring the history of medicine, n.d.) *broughttolife.sciencemuseum.org.uk/broughttolife/themes/diseases/smallpox*
	John Snow and discovery of the spread of cholera from contaminated water (Science Museum Brought to Life: Exploring the history of medicine, n.d.) *broughttolife.sciencemuseum.org.uk/broughttolife/people/johnsnow*

	New vaccines on the horizon (Immunize for good, n.d) immunizeforgood.com/vaccines/new-vaccines-on-the-horizon
	Comparing the Sizes of Microorganisms Up to 1mm (YouTube, 2018) youtube.com/watch?v=h0xTKxbIEIU
	Types of microorganisms (OpenStax College Microbiology, 2016) courses.lumenlearning.com/microbiology/chapter/types-of-microorganisms/
	Bacteria cell structure (Molecular Expressions, 2015) micro.magnet.fsu.edu/cells/bacteriacell.html
	Plant cell structure (Molecular Expressions, 2015) micro.magnet.fsu.edu/cells/plantcell.html
	Animal cell structure (Molecular Expressions, 2015) micro.magnet.fsu.edu/cells/animalcell.html
	Bacteria (Encyclopedia Britannica, 2019) britannica.com/science/bacteria/Growth-of-bacterial-populations/media/48203/106340
	Cell division (Frank Gregorio, 2010) youtu.be/Q6ucKWIIFmg
	How are pathogens spread and controlled? (FuseSchool – Global Education, 2016) youtu.be/vO51sFre6fg
	Measles cases spike globally due to gaps in vaccination coverage (World Health Organization, 2018) who.int/news-room/detail/29-11-2018-measles-cases-spike-globally-due-to-gaps-in-vaccination-coverage
	Simulating the spread of an infectious disease (Koshland Science Museum – National Academy of Sciences, 2012) koshland-science-museum.org/sites/default/files/uploaded-files/ID_Disease_Spread_Activity_FINAL.pdf
	Interactive Labs Disease Lab Overview (The Habitable Planet online course– Annenberg Foundation, n.d.) learner.org/wp-content/interactive/envsci/disease/index.html

	Human disease transmission, an interactive lab for The Habitable Planet online course (The Habitable Planet online course – Annenberg Foundation, n.d.) *learner.org/wp-content/interactive/envsci/disease/disease.html*

Activity 2: Investigating microorganisms and their growth

Activity focus

Students observe the effects of antibacterial treatments on the growth of bacteria and investigate the prevalence of microorganisms on surfaces they touch every day. Students use a microscope and mathematical techniques to assess the growth of colonies, draw conclusions and consider implications about disease transmission and prevention.

Background information

Three types of chemical substances kill bacteria or inhibit bacterial growth: disinfectants, antiseptics and antibiotics. Antiseptics are used to kill bacteria on living tissue. Disinfectants are used to kill bacteria on non-living surfaces. Disinfectants do not kill all microorganisms; especially resistant bacterial spores. Disinfectants work by destroying the cell wall of microbes or interfering with their metabolism. Disinfectants are frequently used in hospitals, dental surgeries, kitchens and bathrooms to kill infectious organisms.

Antibiotics are chemical substances produced by living organisms that kill or inhibit the growth of bacteria and work by affecting cell structures or the metabolic processes of bacteria that are different from those of human cells.

"For example, human cells do not have cell walls, while many types of bacteria do. The antibiotic penicillin works by keeping a bacterium from building a cell wall. Bacteria and human cells also differ in the structure of their cell membranes and the machinery they use to build proteins or copy DNA. Some antibiotics dissolve the membrane of just bacterial cells. Others affect protein-building or DNA-copying machinery that is specific to bacteria."

Genetic Science Learning Centre
learn.genetics.utah.edu/content/microbiome/antibiotics

Unfortunately, antibiotics also affect the gut bacteria that help keep us healthy, so taking antibiotics frequently or long term needs to be avoided if possible. The over-use of antibiotics has led to some bacteria becoming antibiotic-resistant (ie the bacteria develop the ability to survive exposure to antibiotics designed to kill them or stop their growth).

	The effectiveness of bactericidal agents is influenced by many factors, such as the environmental conditions in which the agent is applied, the chemical properties of the agent, its concentration, how long the agent has been stored, and the development of resistance by bacteria themselves. Bacteria and fungi live on, in, and around most living and non-living things. Fungi and most bacteria are heterotrophic, meaning they cannot make their food. They must obtain their food by being parasitic (an organism that depends on other organisms for its nourishment and growth) or saprophytic (an organism that grows on dead and decaying material).
Instructional procedures	Students conduct two experiments in this activity. The first experiment tests the effectiveness of different antimicrobial agents, and the second is an investigation of the prevalence of microbes on surfaces students contact at school. Here, various treatments are investigated to minimise microbial contamination and the spread of microbes. The investigation provides an opportunity for students to design and carry out complex inquiries. These might involve replication, the collection of time-series data, the use of spreadsheets and digital platforms for collating and sharing data, and the use of aseptic microbiology techniques. The investigation lends itself to students writing formal investigation reports that will provide evidence of attaining science inquiry skills. The experiments provide contexts for calculating the area of basic shapes. If needed, *Circle* and *Area formulas* in the *Digital resources* section can be used as a refresher on these mathematical concepts. Petri dishes or photographs of Petri dishes showing the growth of bacterial colonies can offer a context for developing content relating to calculating areas of parallelograms, trapeziums, circles and semi-circles and the area of composite figures by decomposition into familiar shapes.

Expected learning	Year 12 *Human Biology General* students will be able to: 1. Identify, research and construct questions for investigation, propose hypotheses and predict possible outcomes. 2. Design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics. 3. Conduct investigations safely, competently and methodically for the collection of valid and reliable data. 4. Represent data in meaningful and useful ways, including the use of mean and median; organise and analyse data to identify trends, patterns and relationships; discuss how measurement error, instrumental accuracy, the nature of the procedure and the sample size may influence uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions. 5. Select, use and/or construct appropriate representations to communicate conceptual understanding, solve problems and make predictions. 6. Communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports. 7. Identify that: Hygiene practices by individuals in workplaces, especially in places of food preparation and in hospitals, affect the transmission of disease. Year 12 *Mathematics Essentials General* students will be able to: 1. Calculate areas of parallelograms, trapeziums, circles, and semi-circles. 2. Determine the area of composite figures by decomposition into familiar shapes. 3. Interpret and use graphs in practical situations, including travel graphs, time series and conversion graphs. 4. Draw graphs from given data to represent practical situations. 5. Describe the patterns and features of bivariate data.

Equipment required	**For the class:** Prepared nutrient agar plates inoculated with Risk Group 1 bacteria For each group, eight paper disks each soaked in one of the following: sterile distilled water (x2), disinfectant, antiseptic, eucalyptus or tea tree oil, antibacterial hand soap, non-antibacterial hand soap, and 70% alcohol hand sanitiser Incubator Digital projector with the ability to connect to microscope and computer Autoclave	
	For the students: *Student resource sheet 2.1: Investigation report task brief* Binocular microscopes Nutrient agar plates Permanent markers, sticky tape Cotton swabs Safety glasses, disposable gloves Camera Access to *Excel* and *Google docs*	
Preparation	Print or provide digital access to the resource sheet. There are potential hazards inherent in this activity and with the equipment being used. Review your plan to mitigate any risks and ensure that it aligns with the Department's advice regarding the safe use of bacteria in schools. Details can be accessed in the Department of Education Laboratory Manual. **Part 1:** Prepare nutrient agar plates cultured with Risk Group 1 bacteria. To prepare disks: Use a hole punch to create paper disks from a piece of filter paper or paper towel. Soak disks in agents being tested. Place disks on the surface of the agar so there are equal distances between them.	

Two inoculated plates will be used. Both Plate A and Plate B will each contain four paper disks.

On each inoculated Plate A, place four paper disks, one each soaked in sterile distilled water, disinfectant, antiseptic, and eucalyptus or tea tree oil. Label the base with an identifier for each disk.

On each inoculated Plate B, place four paper disks, one each soaked in sterile distilled water, antibacterial hand soap, non-antibacterial hand soap, and 70% alcohol hand sanitiser. Label the base with an identifier for each disk.

Part 2:

Nutrient agar plates for each group to culture.

Activity parts

Part 1: Introduction

Remind students of the problem being addressed: *How can we make our community more aware of the ways to prevent the spread of disease-causing microorganisms?*

Discuss with students the likely causes of infectious diseases within their school community and how they are spread:

- Which infectious diseases are commonly spread through school communities?
- How are these diseases transmitted?
- What measures might be taken to reduce the spread of these diseases?

Explain to students they will be investigating the effectiveness of antibacterial agents and the prevalence of microbial contamination of the surfaces they touch every day at school.

Part 2: Observing bacteria growth

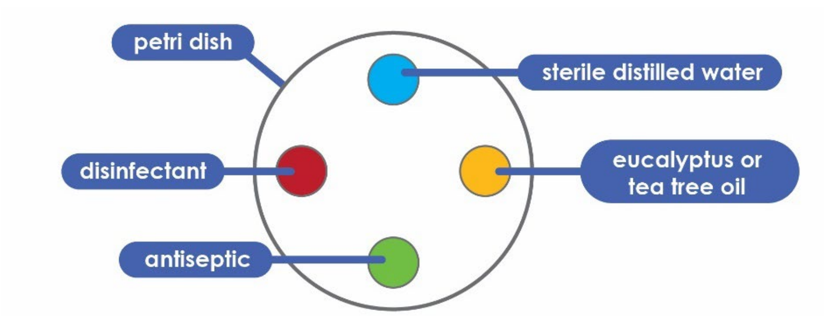


Plate A: inoculated with bacteria with disks of paper soaked in sterile distilled water, disinfectant, antiseptic, and eucalyptus oil or tea tree oil.

STEM Consortium

Explain to students that they will use binocular microscopes to examine two nutrient agar plates that have been cultured with bacteria.

Plate A has four paper disks soaked in either sterile distilled water, disinfectant, antiseptic, and eucalyptus or tea tree oil, and placed on the surface of the agar at equal distances between them. Plate B has four paper disks soaked in either sterile distilled water, antibacterial hand soap, non-antibacterial hand soap, and 70% alcohol hand sanitiser, and placed on the surface of the agar at equal distances between them.

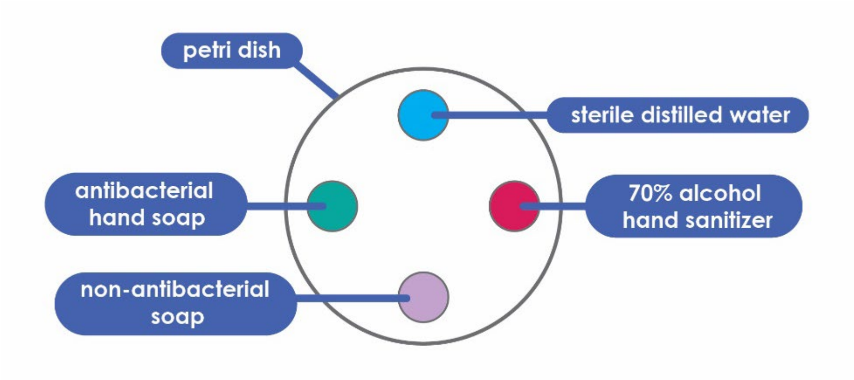


Plate B: inoculated with bacteria with disks of paper soaked in sterile distilled water, antibacterial hand soap, non-antibacterial hand soap, and 70% alcohol hand sanitiser.

STEM Consortium

Before examining the plates, ask students to discuss and record the following:

- Which solutions on the paper disks do you expect will have the most and least effects on bacteria growth? Why?
- How will you know whether the solutions have affected the growth of the bacteria? How could you measure the effect?
- What variables would have been controlled in the preparation of the plates? Which variables may not have been controlled? How would this affect the results?
- Why was the disk soaked in sterile distilled water included in the plates?

Explain that the plates should not be opened and must always remain sealed.

Colonies differ in their shape, size, colour and texture. Students can use photographic evidence and *Observing* *bacteria in a Petri dish* (see *Digital resources*) to help describe the appearance of bacterial colonies.

Students may observe a clear area around the disks. This halo indicates a zone of no growth. The area of the zone is an indicator of the effectiveness of the substance in inhibiting the growth of bacteria.

Refer students to the *Circle* resource (see *Digital resources*) to help with making and recording comparisons between the diameter and the area of any halos around the four disks. Challenge students to devise the most appropriate way of documenting their observations in their journal.

Students record their observations and answer the following questions:

- Is the diameter or the area of the halo the best measure of the effectiveness of the antibacterial agent? Why?
- From your observations, what conclusions can you draw about the effectiveness of each of the agents applied to the disks? Use your results to support these claims.
- What have you learnt from the results for the sterile distilled water disk?
- Were your group's results similar to other group's results? What does this comparison of replicates indicate about the reliability of your data?
- What factors may have affected the reliability of your data?

Part 3: Investigating factors that may affect the spread of diseases at school

Students plan and investigate factors that might affect the spread of infections at their school. This might include:

- Determining the numbers and types of microorganisms found on various surfaces encountered at school
- The effect of disinfectants on the number and types of microorganisms found on surfaces, and how quickly they repopulate after disinfection
- The effectiveness of various handwashing procedures and how quickly they are contaminated after washing.

Students conduct their investigations in groups and then write individual reports. Distribute *Student resource sheet 2.1: Investigation report task brief* for students to use as they prepare their reports during the investigation.

Planning the investigation

Students separate into small groups, identify a question for investigation and begin to document a plan for their investigation. Students should use a shared document technology such as *Office365* or *Google Docs* so that all members of a group can access the documents.

Ask students to consider the following guiding questions when designing their investigation:

- Does your hypothesis make a prediction that can be tested?
- What surfaces, treatments or timeframes will be investigated?
- How will samples be collected? How will the procedure be standardised for each surface?
- How many samples will be taken to enhance reliability?
- Which variables will need to be controlled to make it a fair test? How will they be controlled?
- What potential hazards are involved in sample collection? How can risks be minimised to people, places and property?
- What procedures will need to be followed to inoculate and culture the microorganisms?
- What observations and measurements of the growing microorganisms will be necessary to test your hypothesis?
- How often will observations need to be made? Will time-series data be collected for analysis and graphing?
- How will you record your quantitative and qualitative data?
- How can digital tools such as *Excel* and *Google docs* facilitate the documentation and sharing of data?

When groups have progressed as far as they can, it may be helpful to facilitate a class discussion that supports their current thinking around these questions and leads them further. Ask groups to share their thinking and encourage other groups to provide verbal feedback. Allow time for groups to further develop their plan.

Conducting the investigation

Review the safety precautions and working procedures for microbiology activities as specified in the Department of Education Laboratory Manual.

Demonstrate sample collection including culturing techniques, sealing and labelling dishes.

Students are expected to collect both quantitative and qualitative data and may use photographic evidence to collect observations. *Observing bacteria in a Petri dish* and *Observing fungi in a Petri dish* (see *Digital resources*) may assist with observations.

Analysing the observations

Colonies can grow in several shapes and forms. Students can divide these growth areas into familiar shapes, measure key dimensions and calculate the area of colony growth and the percentage of the plate area. Demonstrate to students how to mark up the plates for familiar shapes and make measurements without opening the plates. A digital projection of an image of a plate on the interactive whiteboard can be used to facilitate whole class viewing.

Discuss the following questions to determine how results will be recorded:

- What shapes can you identify?
- Which composite figures can be decomposed into familiar shapes?
- What mathematical formulas are needed to calculate the areas of the familiar shapes making up the colonies?
- What steps are involved in calculating the percentage of the plate covered?
- How will you record your observations and measurements?
- How might a spreadsheet be used to record measurements and calculate areas and percentage of the plate covered?

Facilitate groups reporting back to the class so that findings from each of the investigations are shared. Digital tools such as *Excel* and *Google sheets* can be used for tabulating and graphing class results.

Question students on presenting results for analysis:

- What is the most appropriate format for presenting the data?
- How will this format help you identify patterns, trends and relationships within the data?
- What does the data tell you about the hypothesis being investigated?
- How do the other groups' findings add to your findings?

Evaluating the investigation

This is a complex investigation that provides many opportunities for developing science inquiry skills and mathematical processes to represent and analyse numerical data.

A thorough debriefing of the investigation can help to clarify and extend students' thinking when making conclusions using the following questions:

- Did the results support your hypothesis? How? …*because*…
- Make a comparison between bacterial and fungal growth in the different locations or treatments, including the largest and smallest numbers and types of colonies.
- How quickly does reinfection of surfaces and hands occur after cleaning?
- What do your results suggest about current procedures to ensure no harmful microorganisms are found on surfaces in the school?
- How reliable are your results? What might have affected their reliability?
- How could the design of your investigation be improved?

What further investigations could be carried out to confirm or extend your conclusions?

Part 4: Reflection, journaling, and forward-thinking

In their groups, students use the following questions to reflect on what they have learnt from this activity that could be applied to developing strategies to reduce the spread of infections within the community:

- To what extent were surfaces we touch each day contaminated with microbes?
- What antimicrobial agents or procedures were most effective in limiting the growth and spread of bacteria?
- Based on your results, what recommendations would you make for hygiene procedures in the school?

In their journal, students record key information and ideas they consider important for informing the community. This will be their starting point in *Activity* 3.

Resource sheets	*Student resource sheet 2.1: Investigation report task brief*
Digital resources	*Circle* (Math is Fun, 2016) *mathsisfun.com/geometry/circle.html*
	Area formulas (Shmoop, 2008) *shmoop.com/basic-geometry/area-formulas.html*
	Observing bacteria in a Petri dish (Microbiology Online, n.d) *microbiologyonline.org/teachers/observing-microbes/observing-bacteria-in-a-petri-dish*
	Observing fungi in a Petri dish (Microbiology Online, n.d) *microbiologyonline.org/teachers/observing-microbes/observing-fungi-in-a-petri-dish*
	What is an antibiotic? (Genetic Science Learning Centre, n.d) *learn.genetics.utah.edu/content/microbiome/antibiotics*

Activity 3: Designing a solution

Activity focus

Students use their scientific understanding and findings from *Activities 1* and 2 to develop a solution that can be used to motivate their school community into limiting the spread of infectious diseases. Students create a digital design portfolio to document their solutions.

Instructional procedures

In this activity, students apply understandings about the cause and transmission of infectious diseases to designing a solution to minimise disease transmission in their school community.

Students engage in the design process through designing, developing, reviewing and communicating design ideas, plans and processes for their given context and clients. The *Design process guide* shows the cyclic nature of the design process that often involves evaluating and redesigning. Redesigning can be a formal process, or it can be performed 'on the run' during any stage of the process.

Encourage the sharing of knowledge and ideas between groups, however, each group should develop their own solution.

Students create a digital design portfolio as they work through the design process. See *Teacher resource sheet 3.1: Design portfolio notes* for more information. This will be used as they pitch their solution to an authentic audience in *Activity 4*. Possible options for creating a collaborative online design portfolio include *Microsoft OneNote*, *Sway*, *PowerPoint*, *Prezi*, *Weebly* and *Cool tools for schools*.

Students may choose to make the school community more aware of the ways of preventing the spread of infectious disease using a variety of methods. Some possibilities include:

- Create a game, workshop activity or video to educate students
- Create a workshop activity, video or online training to educate staff
- Design a campaign to raise awareness about infectious diseases common to the school community and ways of minimising transmission

- Create an app for individual daily monitoring of personal hygiene practices.

Each of these potential approaches to reducing the spread of infections requires a range of skills to develop the solutions. This may require point-of-need teaching of design elements and principles, typography and styles, aesthetics and functionality, and consideration of user experience.

Reflection is key to the design process. Ensure students are using their journals to reflect on the process. Students may find *Student activity sheet 3.2: Prototype troubleshooting* a useful resource to direct their reflection. Encourage students to reflect on at least one part of their journey towards the final solution. For example, students could choose to reflect on a different part of the journey each day, such as:

- Individual effort – How do you think you contributed to the group today?
- Feelings towards the project – Do you feel you have the basis of a solution?
- Group participation and collaboration – Identify one good thing about the group's participation and collaboration, and one thing that could be improved.
- Challenges met – What issues caused problems or roadblocks for you?
- Project solution – How well is your solution developing?

Expected learning

Students will be able to apply understandings from the Year 12 *Human Biology General* course curriculum to the design of their solution:

1. Infectious disease is caused by the invasion of a pathogen and can be transmitted from one host to another.
2. Pathogens include bacteria, viruses, fungi, parasites, and are the causes of common diseases, including Ross River disease, influenza, food poisoning, tinea and malaria.
3. The transmission and spread of infectious disease is facilitated by the local, regional and global movement of individuals.
4. Pathogens have adaptations that facilitate their entry into the body and transmission between hosts;

transmission occurs by various mechanisms, including through:

- Direct and indirect contact
- Contaminated food and water
- Disease-specific vectors, including airborne transmission.

5. Preventing the transmission of the disease includes strategies of quarantine, immunisation, and disruption of pathogen life cycle.
6. Hygiene practices by individuals in workplaces, especially in places of food preparation and in hospitals, affect the transmission of disease.

Students will be able to develop the following design skills from the Year 12 *Design General* course curriculum:

1. Development and documentation of a design process, including research and/or investigation, analysis, idea development and critical reflection.
2. Creation and/or interpretation of diagrams, layouts, plans and drawings.
3. Application of design process, such as visual research, idea generation techniques, synectics, mind maps, brainstorming.
4. Reflection and evaluation of solutions to design problems.
5. Identification of specific audiences in terms of lifestyle behaviour, values and beliefs.
6. Development of suitable formats of presentation for design solutions.

Students will be able to develop the following skills from the Year 12 *Applied Information Technology General* course curriculum:

1. Identify and explain the elements of design and the principles of design in an existing digital product and/or solution.
2. Apply the elements of design and principles of design when developing a digital product and/or solution:
    - Create accurate visuals/layouts
    - Apply principles of layout and composition.
3. Develop and apply detailed annotations for digital designs, relevant to a particular design brief.
4. Apply the elements of design and the principles of design relevant to a particular design brief.
5. Apply a design process to create a digital product, design and/or digital solution.

	6. Apply techniques for representing the design of a digital product and/or digital solution.
Equipment required	**For the class:** Computer and internet access Appropriate workspace for digital design portfolios
	For the students: Materials depending on requirements (eg computers and software for design, paper, pencils, rulers) *Student activity sheet 3.2: Prototype troubleshooting*
Preparation	Organise technical support, if required, to assist students with any of the digital technologies they have chosen. Teachers should familiarise themselves with the *Design process guide*. Review the skills and resources required to create the digital design portfolio (see *Teacher resource sheet 3.1: Design portfolio notes* which outlines the components of a design portfolio). Identify any point-of-need teaching that is required for students to complete the task.
Activity parts	**Part 1: Introduction** Use the students' journal reflections from *Activity 2* to review the problem: *How can we make our community more aware of the ways to prevent the spread of disease-causing microorganisms?* This information will help inform the design of a solution. Prompt questions can include: • What problem are we trying to solve? • Why is that important? • What have we learnt about microorganisms and their transmission that we want to communicate in our solution? • Who are the clients for any proposed solution? Explain to students that in this activity they will: • Consult with a member of the school executive, P&C or school board to develop a design brief

- Design a strategy, process or product that can contribute to making the community more aware of disease transmission and prevention
- Document their design process and solution as a digital design portfolio. The portfolio will include their design brief, information about the generation of initial ideas, justify the selected approach, describe the steps of developing the solution, show how the design has been evaluated and revised, and provide an appropriate digital representation of the proposed solution.

Part 2: Developing the design brief

Students meet with a representative of the school executive, P&C or school board to better understand the needs of the school community, as the client, for a strategy to minimise disease transmission.

The design brief is documented in the students' portfolios and should include:

- A statement of the problem
- The needs of the school community as the client
- A list of success criteria.

A file sharing platform should be used to make design brief documents available to all students.

Part 3: Ideation

Working in pairs or small groups, conduct a brainstorm session using a think-pair-share or placemat strategy (see *Teacher resource sheet 1.4: Cooperative learning – Think, Pair, Share* and *Teacher resource sheet 1.3: Cooperative learning – Placemat*) to identify potential approaches to raising awareness about minimising disease transmission.

Groups report proposed strategies to the class and ideas are collated for review. Engage students in an evaluation of the proposed strategies:

- Does the strategy fit the needs of the client? Would it be acceptable to students, staff and parents?
- How well would the strategy meet the success criteria?
- Is the proposed strategy easy to develop and implement with the available resources?

- Which of the proposed strategies has the potential to be developed into a viable solution?

Part 4: Designing the solution

Groups select one of the viable strategies for development into a design for a solution.

Students reflect on what they have learnt about the causes and transmission of diseases (*Activity 1*), the effectiveness of various antimicrobial agents, and the surfaces from which students might contact microorganisms (*Activity 2*) to identify the scientific principles that should guide the design of their solution.

The following prompts may be used to scaffold students' development of their design:

- What have you learnt about how disease-causing microorganisms are transmitted through a community?
- What methods can be used to minimise the transmission of microorganisms through a community?
- What strategy or combination of strategies could be implemented at your school?
- How well would these strategies meet the needs of your client and meet the criteria for success?
- How would you raise awareness of your school community about infectious diseases and your strategy to minimise the transmission of diseases?
- What resources and media would be required to communicate your strategy to the community?
- What would be the key messages in your campaign?

Students document their design in their digital design portfolio and use software such as *Adobe Illustrator*, *Canva*, *Corel Draw*, *Inkscape* and *Vectr* to draw any design elements. Ensure students reflect on the success criteria in their design brief and continually evaluate and refine their design as it is developed.

Groups report back to the class and share their designs. This encourages the justification of design choices. It also provides an opportunity for peers to provide feedback and for changes to be made before moving to the next phase of developing the solution.

Once students have completed documenting their finalised design in their portfolio, they begin creating the solution.

Part 5: Create

Throughout the construction of their solution to raising awareness in the school community, remind students to save their work to a file sharing platform and take photographs to document the process.

Prompt students to:

- Plan how members of the group can collaborate and work on different parts of the task
- Decide on the most appropriate media and software tools for developing the solution
- Prepare a storyboard or plan for the structure and content of the solution
- Review key messages
- Develop a timeline and milestones for managing the project.

Students complete *Student activity sheet 3.2: Prototype troubleshooting* and insert in their design portfolio.

Allocate time for groups to consider how their solutions would be implemented. Implementation could be with the class, the year group, the school community or the local community. Ensure students think through the implications of implementing their solution and how it would affect school or community members.

Part 6: Reflection and journaling

Evaluation, reflection and refinement are important parts of the design process. The following questions are a guide for students to consider at this stage of reflection:

- Why have you chosen your approach and strategies for solving the problem?
- How does your solution meet the needs of your client and to what extent have you met the success criteria?
- How could the product be redesigned/improved to have a further impact? (ie be more engaging, be more aesthetically pleasing)

At this point, it may be worthwhile to pause the module while students make refinements to the solution before communicating it to the client in *Activity 4*.

Resource sheets	*Design process guide* *Teacher resource sheet 1.3: Cooperative learning – Placemat* *Teacher resource sheet 1.4: Cooperative learning - Think, Pair, Share* *Teacher resource sheet 3.1: Design portfolio notes* *Student activity sheet 3.2: Prototype troubleshooting*

Activity 4: Sharing our findings

Activity focus

Students present their proposed solutions to a panel of school or community members. Presentations provide evidence-based arguments from students' research, investigation and the design process to support their chosen solution.

Instructional procedures

In this activity, students present their solution to representatives of their client, the school community. This could be a member of the school executive, the P&C, school board or the school nurse.

The presentation is the culmination of the work that has gone into the project. The more stakeholders invited to the final presentations, the more buy-in there will be from the students throughout the process. Students will be well rewarded by successfully presenting their work.

Students continue to work in their groups for the presentations. To scaffold cooperative group work, each member of the group could have a role and responsibility. For example, one could be the content director, one the media director and a third the presentation director. See *Teacher resource sheet 1.1: Cooperative learning – Roles*.

The time allocated for group presentations should be carefully planned. Students can choose the information to be included in their slides/digital portfolio, however, they should try and incorporate their various redesigns as well as presenting the final product. They should talk about the process they used to get to the final solution, the knowledge they gained in creating their solution, and how they have developed STEM capabilities for the jobs of the future.

Reflection is an important part of the design process. By looking back at the project, students have another opportunity to learn by evaluating what worked well and what could be improved. Students can consider how they might choose to approach this type of task in the future and improve on their solution.

Expected learning	Students will be able to apply understandings from the Year 12 *Human Biology General* course curriculum to the design, justification and communication of their solution: 1. Communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports. 2. The transmission and spread of infectious disease is facilitated by the local, regional and global movement of individuals. 3. Pathogens have adaptations that facilitate their entry into the body and transmission between hosts; transmission occurs by various mechanisms, including through: • Direct and indirect contact • Contaminated food and water • Disease-specific vectors, including airborne transmission. 4. Preventing the transmission of the disease includes strategies of quarantine, immunisation, and disruption of the pathogen life cycle. 5. Hygiene practices by individuals in workplaces, especially in places of food preparation and in hospitals, affect the transmission of disease. Students will be able to develop the following design skills from the Year 12 *Design General* course curriculum: 1. Development and documentation of a design process, including research and/or investigation, analysis, idea development and critical reflection. 2. Reflection and evaluation of solutions to design problems. 3. Identification of specific audiences in terms of lifestyle behaviour, values and beliefs. 4. Development of suitable formats of presentation for design solutions. Students will be able to develop the following skills from the Year 12 *Applied Information Technology General* course curriculum: 1. Identify and explain the elements of design and the principles of design in an existing digital product and/or solution. 2. Develop and apply detailed annotations for digital designs, relevant to a particular design brief. 3. Apply a design process to create a digital product, design and/or digital solution. 4. Apply techniques for representing the design of a digital product and/or digital solution.

Equipment required	**For the class:** A means to display and make their presentation (eg computer, digital projector, screens, overhead projector) An appropriate space to conduct student presentations
	For the students: Student journals or digital portfolios Laptops Paper or card for posters or presentations (if this is the chosen presentation method) *Student activity sheet 4.1: Peer evaluation* *Student activity sheet 4.2 Self-evaluation* *Student activity sheet 1.0: Journal checklist*
Preparation	Provide access to presentation apps such as *Google Slides* or *Microsoft PowerPoint*. Arrange a room for presentations. Provide students with access to activity sheets.
Activity parts	**Part 1: Outlining the presentation** Groups design a poster or digital presentation to showcase their final solution to the class and other invitees. Hold a class discussion to decide on the format of the presentation. Ask students to consider the following: • What key people from the school and the wider community should be invited to presentations? (eg school executive, P&C, school board, school nurse, cleaners) • What key messages are to be communicated? • How will our audience members be contacted and invited to the presentation? • How can we effectively use our class members in the roles of a presentation (eg meet and greet MC, chairperson) to engage our chosen audience?
	Part 2: Presentation planning Students draw on the resources in their digital design portfolios to create a presentation. Both visual and aural

aspects of the presentation must advocate for and inspire the clients to adopt and implement the proposed solution.

Assist students to plan and develop their presentations by asking the following questions:

- What are the key messages?
- What headings most effectively represent our information?
- How can our explanations be summarised?
- How will relevant diagrams and photos be included to support our information?
- What features will make our visual presentation engaging to our audience?
- What parts of the presentation will need a detailed explanation?
- What presentation skills will help our oral presentation impact our audience?
- How can the workload be divided to enable each group member to contribute to the presentation preparation and delivery?

Provide a combination of class and homework time for the development and review of presentations, drawing on a range of resources including any shared documents such as *Google docs*.

Each group will initially present to the class. Other students should write down at least one question they can ask each group. Students complete a peer assessment to evaluate each solution and presentation.

Students should add a link or embed their final presentation and peer assessments in their digital journal.

Part 3: Presentation of solutions

Groups present their work to an authentic audience. Students greet any visitors and chair the session so that time is managed effectively. Members of the groups respond to questions from guests and provide further justification for their plans as required.

At the end of the presentation, students thank the guests and, after the guests have departed, update their journal entries with reflections on their group's presentation.

If one of the proposed strategies is to be implemented at the school, groups negotiate and agree on which strategy or combination of strategies is to be implemented.

Part 4: Project evaluation

Following the implementation of the solution, groups need to determine if their solution meets the success criteria developed in *Activity* 3. Collect and collate evidence to determine the success of the project.

Students should evaluate if they have developed a successful solution to the problem posed: *How can we make our community more aware of the ways to prevent the spread of disease-causing microorganisms?*

Students record the following in their journals:

- Did our solution meet the success criteria? If so, was the solution a success according to the criteria that were established earlier in the design brief?
- To what extent was it successful?
- Why was the solution successful, or not?
- Given more time and resources what would you do differently? Why?

Part 4: Reflection and journaling

Debrief with the class and provide time for students to complete reflections and document their thoughts on the following questions in their journal:

- What are the most important things you learnt about disease transmission and how it can be controlled in a community?
- How did your solution meet the expectations and needs of your client?
- Did you enjoy solving the problem? Why?
- How do the STEM skills developed in this module prepare you for a successful future?

Alternatively, students could be debriefed with a digital survey using an online tool such as *Survey Monkey*.

Students complete *Student activity sheet 1.0: Journal checklist*.

Students complete *Student activity sheet 4.1: Peer evaluation* and *Student activity sheet 4.2: Self-evaluation*.

Resource sheets

Student activity sheet 1.0: Journal checklist

Student activity sheet 4.1: Peer evaluation

Student activity sheet 4.2: Self-evaluation

Appendix 1: Links to the Western Australian Curriculum

The *Contagion* module focuses on the following Science Inquiry Skills, Science Understanding and Science as a Human Endeavour content from the Year 12 *Human Biology General* course curriculum.

	ACTIVITY			
	1	2	3	4
SCIENCE **Year 12 Human Biology General course**				
SCIENCE INQUIRY SKILLS				
Identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes		●		
Design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics		●		
Conduct investigations safely, competently and methodically for the collection of valid and reliable data		●		
Represent data in meaningful and useful ways, including the use of mean and median; organise and analyse data to identify trends, patterns and relationships; discuss how measurement error, instrumental accuracy, the nature of the procedure and the sample size may influence uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions		●		
Select, use and/or construct appropriate representations, to communicate conceptual understanding, solve problems and make predictions		●		
Communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports		●		●

	ACTIVITY			
	1	2	3	4
SCIENCE **Year 12 Human Biology General course**				
SCIENCE AS A HUMAN ENDEAVOUR				
The development of the microscope was important in linking specific pathogens to specific diseases, which then allowed for the appropriate treatment or preventative measures to be used, including antiseptics, antibiotics, quarantine measures and improved hygiene for water and food, which have reduced the impacts of myths and misconceptions around disease and its transmission	•			
SCIENCE UNDERSTANDING				
Infectious disease is caused by invasion of a pathogen, and can be transmitted from one host to another	•		•	
Pathogens include bacteria, viruses, fungi, parasites, and are the causes of common diseases, including Ross River disease, influenza, food poisoning, tinea and malaria	•		•	
Pathogens have adaptations that facilitate their entry into the body and transmission between hosts; transmission occurs by various mechanisms, including through: • Direct and indirect contact • Contaminated food and water • Disease-specific vectors, including airborne transmission	•		•	•
Preventing the transmission of disease includes strategies of quarantine, immunisation and disruption of pathogen life cycle	•		•	•
Hygiene practices by individuals in workplaces, especially in places of food preparation and in hospitals, affect the transmission of disease	•	•	•	•
Population density and movement patterns influence the transmission of disease	•			

This module also provides opportunities to develop outcomes from Year 12 *Design General* course, Year 12 *Applied Information Technology General* course and Year 12 *Mathematics Essentials General* course curriculum in the areas described below.

	ACTIVITY			
	1	2	3	4
TECHNOLOGIES Year 12 Design General course				
Design process and methods				
Development and documentation of a design process, including research and/or investigation, analysis, idea development and critical reflection			●	●
Application of design process, such as visual research, idea generation techniques, synectics, mind maps, brainstorming			●	
Reflection and evaluation of solutions to design problems			●	●
Stakeholders				
Identification of specific audiences in terms of lifestyle behaviour, values and beliefs			●	●
Production processes and methods				
Development of suitable formats of presentation for design solutions			●	●

	ACTIVITY			
	1	2	3	4
TECHNOLOGIES **Year 12 Applied Information Technology General course**				
Design concepts: Skills				
Identify and explain the elements of design and the principles of design in an existing digital product and/or solution			●	●
Apply the elements of design and principles of design when developing a digital product and/or solution • Create accurate visuals/layouts • Apply principles of layout and composition			●	
Develop and apply detailed annotations for digital designs, relevant to a particular design brief			●	
Apply the elements of design and the principles of design relevant to a particular design brief			●	
Project management: Skills				
Apply the elements of design and the principles of design relevant to a particular design brief			●	
Apply a design process to create a digital product, design and/or digital solution			●	●
Apply techniques for representing the design of a digital product and/or digital solution			●	●

	ACTIVITY			
	1	2	3	4
MATHEMATICS **Year 12 Mathematics Essentials General course**				
Topic 3.1: Measurement				
Area measure: 3.1.2 calculate areas of parallelograms, trapeziums, circles and semi-circles		●		
Area measure: 3.1.3 determine the area of composite figures by decomposition into familiar shapes		●		
Topic 3.2: Scales, plans and models				
Create scale drawings: 3.2.7 understand and apply drawing conventions of scale drawings, such as scales in ratio, dimensions and labelling	●			
Create scale drawings: 3.2.8 construct scale drawings by hand and by using appropriate software/technology	●			
Topic 3.3: Graphs in practical situations				
Using graphs: 3.3.4 interpret and use graphs in practical situations, including travel graphs, time series and conversion graphs		●		
Using graphs: 3.3.5 draw graphs from given data to represent practical situations		●		
Topic 3.4: Data collection				
Bivariate scatterplots: 3.4.12 describe the patterns and features of bivariate data		●		
Topic 4.1: Probability and relative frequencies				
Simulations: 4.1.3 perform simulations of experiments using technology	●			

	ACTIVITY			
	1	2	3	4
MATHEMATICS **Year 12 Mathematics Essentials General course**				
Topic 4.1: Probability and relative frequencies				
Simulations: 4.1.4 recognise that the repetition of chance events is likely to produce different results	●			
Simulations: 4.1.6 identify factors that may cause the simulation to no longer model the real-world event	●			
Simple probabilities in practical situations: 4.1.7 construct a sample space for an experiment which represents a practical situation	●			
Simple probabilities in practical situations: 4.1.9 use arrays or tree diagrams to determine the outcomes and the probabilities for experiments	●			
Probability applications: 4.1.10 identify situations in real-life contexts where probability is used for decision making	●			

Note: These syllabus outcomes are not assessment criteria. They are indicators which, when used collectively, represent the pitch for each grade standard for reporting purposes. They describe some of the things students may do at each standard but will vary depending on the specific tasks selected by the teacher. They should not be used as an assessment checklist. Grade judgements should occur after some time (usually a semester or year) using several pieces of work.

Further information about these courses is available at:

senior-secondary.scsa.wa.edu.au/__data/assets/pdf_file/0011/581258/Human-Biology-Y12-Syllabus-General-2020-GD-EST.pdf

senior-secondary.scsa.wa.edu.au/__data/assets/pdf_file/0009/14022/Design-Y12-Syllabus-General-GD-EST.pdf

senior-secondary.scsa.wa.edu.au/__data/assets/pdf_file/0007/10996/Applied-Information-Technology-Y12-Syllabus-General-EST-GD.pdf

senior-secondary.scsa.wa.edu.au/__data/assets/pdf_file/0007/581272/Mathematics-Essential-Y12-Syllabus-General_GD-EST.pdf

Appendix 2: Materials list

The following materials are required to complete this module:

- Access to a computer or device
- A3 paper, notebook
- Permanent markers, pens, pencils, eraser
- Ruler
- Calculator
- Microscopes

Activity 1

- Microscopes
- A3 paper, pens, pencils, markers
- Small newspaper clippings of text
- Prepared slides of cells or tissues
- Three microscope slides and coverslips per student
- Tweezers
- Onion segment
- Paper towel
- Methylene blue solution in a dropper bottle
- Craft materials for creating a model cell
- Test tubes and droppers (for class activity)
- Test tube lids
- Distilled water
- 0.1 molar NaOH
- pH 7.0 buffer solution
- Phenolphthalein solution, dissolved in alcohol and diluted in water (as a pH indicator)

Activity 2

- Disinfectant, antiseptic, sterile distilled water, eucalyptus or tea tree oil, antibacterial hand soap, non-antibacterial hand soap, and 70% alcohol hand sanitiser.
- Risk group 1 bacteria
- Filter paper
- Nutrient agar plates
- Sticky tape, cotton swabs
- Safety glasses, disposable gloves, laboratory coats
- Camera
- Incubator
- Autoclave

Appendix 3: Design process guide

Research

Finding useful and helpful information about the design problem.

Gathering information, conducting surveys, finding examples of existing solutions, testing properties of materials, practical testing.

Analysis

Understanding the meaning of the research findings.

Analysing what the information means, summarising the surveys, judging the value of existing solutions, understanding test results.

Ideation

Idea generation – turning ideas into tangible forms so they can be organised, ordered and communicated to others.

Activities such as brainstorming, mind mapping, sketching, drawing diagrams and plans, collecting colour samples and/or material samples and talking through these ideas can help to generate further creative ideas.

Using the **SCAMPER** model can assist with this:
www.mindtools.com/pages/article/newCT_02.htm

www.designorate.com/a-guide-to-the-scamper-technique-for-creative-thinking

Development

Development of the design ideas. Improvements, refinements, adding detail, making it better.

Activities such as detailed drawings, modelling, prototyping, market research, gaining feedback from intended user, further research – if needed – to solve an issue with the design, testing different tools or equipment, trialling production processes, measuring or working out dimensions, testing of prototypes and further refinement.

Production

Safe production of the final design or multiple copies of the final design.

Fine tuning the production process, such as division of labour for batch or mass production.

Use of intended materials and appropriate tools to safely make the solution to the design problem.

Evaluation

Reflection on the process taken and the success of the design.

Evaluation can lead to further development or improvement of the design and can be a final stage of the design process before a conclusion is reached.

Could be formal or informal and verbal or written.

Appendix 4: Student journal

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When students reflect on learning and analyse their ideas and feelings, they self-evaluate, thereby improving their metacognitive skills.

These modules encourage students to self-reflect and record the stages of their learning in a journal. This journal may take the form of a written journal, a portfolio or a digital portfolio.

Using digital portfolios can help develop students' Information and Communication Technology (ICT) capability.

Reflective practice and recording can be supported in classrooms by creating opportunities for students to think about and record their learning through notes, drawings or pictures. Teachers should encourage students to revisit earlier journal entries to help them observe the progress of their thoughts and understanding.

Journals are a useful tool that gives teachers additional insight into how students value their own learning and progress, as well as demonstrating their individual achievements.

The following links provide background information and useful apps for journaling.

Reflective journal (University of Technology Sydney) uts.edu.au/sites/default/files/reflective_journal.pdf
Reflective writing (University of New South Wales Sydney)) student.unsw.edu.au/reflective-writing
Balancing the two faces of ePortfolios (Helen Barrett, 2009) electronicportfolios.org/balance/Balancing.jpg
Digital portfolios for students (Cool tools for school) cooltoolsforschool.wordpress.com/digital-student-portfolios
Kidblog – digital portfolios and blogging kidblog.org/home
Evernote (a digital portfolio app) evernote.com
Weebly for education (a drag and drop website builder) education.weebly.com
Connect – the Department of Education's integrated, online environment connect.det.wa.edu.au

Appendix 5: Student activity sheet 1.0: Journal checklist

As an ongoing part of this module, you have been keeping a journal of your work.

Before submitting your journal to your teacher please ensure you have included the following information:

- Tick each box once complete and included
- Write N/A for items that were not required in this module.

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Your name and group members' names or photographs	
An explanation of the problem you are solving	
Your notes from *Activity 1*	
Your notes from *Activity 2*	
Your notes from *Activity 3*	
Your notes from *Activity 4*	
Student activity sheet 4.1: Peer evaluation	
Student activity sheet 4.2: Self-evaluation	

Student activity sheet 1.0: Journal checklist	

Appendix 6: Teacher resource sheet 1.1: Cooperative learning – Roles

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Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

When students are working in groups, positive interdependence can be fostered by assigning roles to group members.

These roles could include:

- Working roles such as Reader, Writer, Summariser, Time-keeper
- Social roles such as Encourager, Observer, Noise monitor, Energiser.

Further to this, specific roles can be delineated for specific activities that the group is completing. It can help students if some background to the purpose of group roles is made clear to them before they start, but at no time should the roles get in the way of the learning. Teachers should decide when or where roles are appropriate to given tasks.

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Appendix 7: Teacher resource sheet 1.2: Cooperative learning – Jigsaw

Cooperative learning frameworks create opportunities for groups of students to work together, generally for a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

The jigsaw strategy typically has each member of the group becoming an 'expert' on one or two aspects of a topic or question being investigated. Students start in their cooperative groups, then break away to form 'expert' groups to investigate and learn about a specific aspect of a topic. After developing a sound level of understanding, students return to their cooperative groups and teach each other what they have learnt.

Within each expert group, issues such as how to teach the information to their group members are considered.

Step 1	**Cooperative groups** (of four students)	**1 2 3 4**		**1 2 3 4**	
Step 2	**Expert groups** (size equal to the number of groups)	**1 1**	**2 2**	**3 3**	**4 4**
Step 3	**Cooperative groups** (of four students)	**1 2 3 4**		**1 2 3 4**	

Appendix 8: Teacher resource sheet 1.3: Cooperative learning – Placemat

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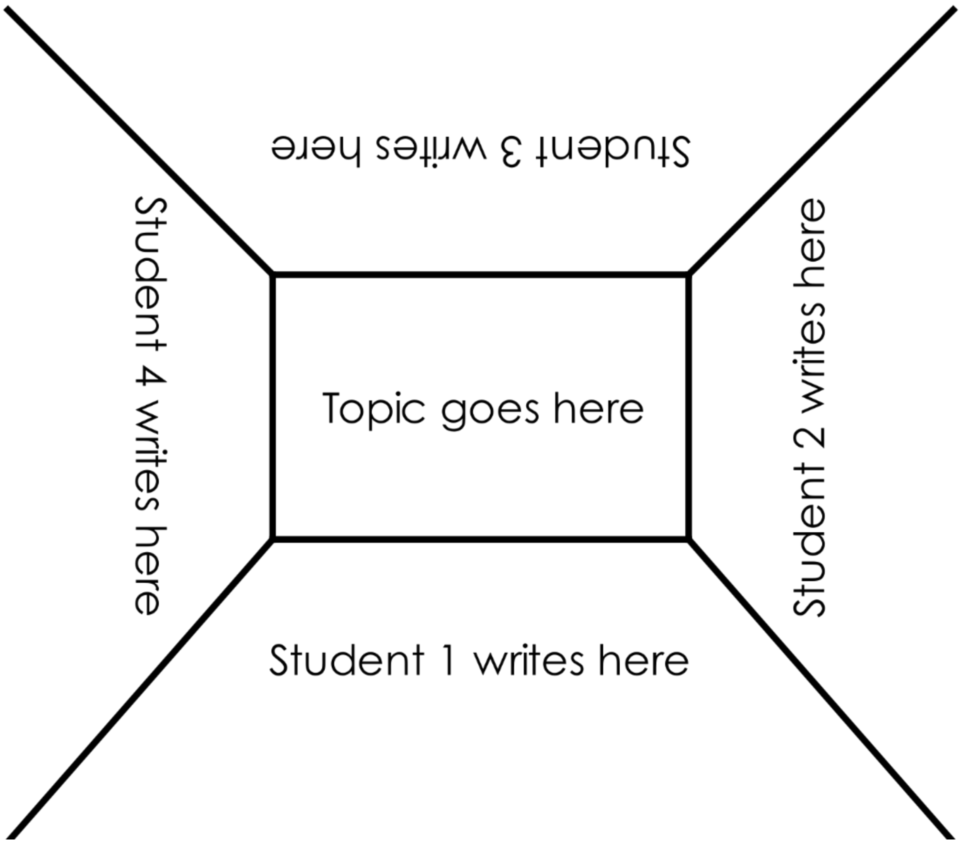
Cooperative learning frameworks create opportunities for groups of students to work together, generally for a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

The placemat strategy involves students working collaboratively to record prior knowledge about a common topic and brainstorm ideas. It also allows teachers to readily see the contribution of each student. The diagram below shows a typical placemat template.



STEM Consortium

Appendix 9: Teacher resource sheet 1.4: Cooperative learning – Think, Pair, Share

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Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

The think-pair-share strategy increases student participation and provides an environment for higher levels of thinking and questioning.

In the 'think' stage, each student thinks silently about a question asked by the teacher.

In the 'pair' stage, students discuss their thoughts and answers to the question in pairs.

In the 'share' stage, students share their answer, their partner's answer or what they decided together. This sharing may be with other pairs or with the whole class. It is important also to let students 'pass'. This is a key element of making the strategy safe for students.

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Appendix 10: Teacher resource sheet 1.5: Vocabulary list

Agar
Aim
Antibiotic
Antiseptic
Area
Average
Bacteria
Cell
Circumference
Contagious
Control variable
Dependent variable
Diameter
Disease
Disinfectant
Fungi
Hypothesis
Independent variable
Infection
Infectious disease
Ingestion
Inhalation
Inoculation
Microorganism
Microscope
Multicellular
Organism
Parasite
Pathogen
Percentage
Petri dish
Radius
Unicellular
Vaccine
Virus

Appendix 11: Teacher resource sheet 1.6: Microscope calculations

Introduction

This resource sheet provides an outline of how to introduce estimating the size of objects seen with a microscope to students in *Activity 1*. Developing an understanding of these skills would support the microscopic examination of cells.

Materials

Mini-grid or clear plastic ruler

Step 1: Calculate the magnification

Total magnification = Ocular lens magnification x Objective lens magnification

Step 2: Measure the field of view diameter

When looking into a microscope, the field of view is the visible circular area. If you know the diameter of the field of view, you can estimate the size of objects viewed with a microscope.

To measure the field of view diameter, place a mini-grid or clear plastic ruler on the microscope stage, view it using the low power objective lens and count the number of divisions across the field of view at its widest point. If using a mini-grid, each square is 1 mm by 1 mm in size.

Convert this measurement from millimeters(mm) to micrometers (μm) where, 1 mm = 1000 μm.

As the magnification is increased, the field of view diameter decreases by the same factor. For example, if the field of view diameter at a magnification of x40 is 2000 μm, doubling the magnification to x80 halves the field of view diameter to1000 μm. Therefore, the field of view diameter for a higher magnification can be calculated from the diameter measured for the lower magnification.

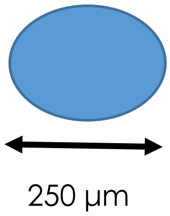
Step 3: Estimate the size of an object

The size of cells viewed under a microscope can be estimated by comparing them with the known diameter of the field of view.

For example, if the field of view diameter is 100 μm and about four cells could fit side-by-side across the centre of the field, then the cell has a diameter that is about one-quarter of the field of view diameter or 25 μm.

Step 4: Using a scale to represent the size of drawn objects

Once the size of a cell has been estimated (eg 250 μm) this measurement can be used to provide a scale on the drawing of the cell so that the person viewing the drawing will know how large the object is. A double-headed arrow with the size can be drawn below the object to indicate its size.



Alternatively, a scale can be calculated as the number of times the drawing is larger than the object, for example, if a cell of actual diameter 250 μm is drawn 2.5 cm in diameter, then the drawing is 100 times larger than the real object so that the scale is x100; which is not to be confused with the total magnification of the microscope used the view the cell.

Appendix 12: Teacher resource sheet 1.7: Safety procedures for microbiology activities

There are potential hazards inherent in this activity and with the equipment being used. A plan to mitigate any risks will be required and should align with the Department's advice regarding the safe use of bacteria in schools.

Potential hazards specific to this activity for working safely with microorganisms include but are not limited to:

- Only Risk group 1 bacteria, those bacteria that are unlikely to cause human, plant or animal disease, should be used. These bacteria should only be purchased from a reputable scientific supplier to ensure that acceptable pure strains are provided.
- When exposing agar plates, students should not be allowed to inoculate them with human materials (eg coughing, skin scrapes, scrapes from toilets).
- Students will need to use lab safety equipment including goggles, disposable gloves and lab coats when handling plates.
- Microbiological activities must be done on a designated work area, not on student desks. Before and after practical activities using bacteria, disinfection of work area surfaces with 70% alcohol is required.
- Staff or students who are immunocompromised or immunosuppressed should not participate in microbiological activities using bacteria. Although the risk is very low, some Risk group 1 bacteria can be pathogenic to at-risk people.
- When students examine plates, they should be sealed, but not anaerobically, and never re-opened. Either parafilm or three to four pieces of sticky tape should be used to allow for aerobic conditions. Under no circumstances is there to be any subculturing.
- Agar plates should be incubated at room temperature or up to a maximum of 30 degrees Celsius. Do not incubate at 37 degrees Celsius as this provides ideal conditions for the growth of human pathogens.
- Correct handwashing techniques must be followed by staff and students before leaving the laboratory.
- The plates are not to be kept for more than a week before proper disposal.

At the end of the activity, agar plates must be correctly sterilised in an autoclave or pressure cooker at 121 degrees Celsius or 100kPa/15psi for 20 minutes. A sterile confirmation strip (Class 5) should be used with every batch of plates being sterilised to verify the process was sufficient. These sterilised plates should remain sealed, but not anaerobically, and never re-opened.

Appendix 13: Student resource sheet 2.1: Investigation report task brief

You are required to prepare a formal scientific report of the investigation. The outline of the requirements for each part of this task is set out in the table below.

Report section	Outline	Assessment weighting (marks)
Introduction	• General information – state what you know about the topic • State what you are going to investigate, including the aim of the investigation and the independent and dependent variables	5
Hypothesis	• A short, testable statement • Identifies expected outcome • Includes independent and dependent variables	5
Materials	• Give a complete list of types and quantity of equipment used	5
Method	• Step-by-step instructions • Diagram if necessary • Replicates • Recording data • Variables – controlled, dependent, independent • Sufficient detail to allow repeatability	5
Results	• Summarise the data gathered and analysed, then represented as tables, graphs, drawings, photographs and/or text highlighting trends in the results • Table – title, units, variables • Graph – title, appropriate scale, labelled axes, plotted accurately, drawn in pencil with a ruler or using graphing software	30
Discussion	• Identify and describe trends in the data noting variation between replicates and how this is an indication of reliability • Relate results to hypothesis • Use science knowledge to explain results • Additional future research that may lead on from these results	25
Conclusion	• Draw connections between the hypothesis and the results of the investigation and evaluate the hypothesis • Reflect on the limitations to validity and reliability of your investigation methods and suggest improvements	15
References	• List of sources • Correct format as advised by teacher	5
Appendices	• Photographs • Spreadsheets of raw data	5

Appendix 14: Teacher resource sheet 3.1: Design portfolio notes

Design portfolio

The *Design portfolio* is a document that summarises the activities and outcomes of the design process in a professional manner. As a minimum, the design portfolio should demonstrate the elements of the design and design process relevant to the project, including:

- A definition of the problem
- The client and the needs of the client
- Success criteria
- Research about the problem and its context
- Analysis of the research findings
- Ideas for the solution and the chosen option
- How the idea developed into a design
- Details about the design
- Evaluation of the design through feedback and reflection
- Redesigns and improvements to the solution
- Results of the design process and solution.

Appendix 15: Student activity sheet 3.2: Prototype troubleshooting

Problem	Reason for the problem	Possible changes to your design to solve the problem

Appendix 16: Student activity sheet 4.1: Peer evaluation

	Always	**Usually**	**Sometimes**	**Rarely**
Remains focused on tasks presented				
Completes set tasks to best of their ability				
Works independently without disrupting others				
Uses time well				
Cooperates effectively within the group				
Contributes to group discussions				
Shows respect and consideration for others				
Uses appropriate conflict resolution skills				
Comes to class prepared for activities				
Actively seeks and uses feedback				

Comments:

____

____

____

Appendix 17: Student activity sheet 4.2: Self-evaluation

	Always	Usually	Sometimes	Rarely
Remains focused on tasks presented				
Completes set tasks to best of their ability				
Works independently without disrupting others				
Uses time well				
Cooperates effectively within the group				
Contributes to group discussions				
Shows respect and consideration for others				
Uses appropriate conflict resolution skills				
Comes to class prepared for activities				
Actively seeks and uses feedback				

Comments:

Notes