Year 12 Biology Module 7: Infectious disease

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## The Year 11 course

During the teaching of the Year 11 course, it is expected that students have been provided opportunities to develop all seven of the Working Scientifically skills. Ideally, these would be embedded into the teaching of the Knowledge and Understanding components of the course, which allows students to develop a sound knowledge of the structure and function of living things, from the sub-cellular level through to the ecosystem level. In preparation for the Year 12 course, students in Year 11 could benefit from work that engages them in the following areas:

* Propose hypotheses and design and conduct valid and reliable practical investigations that enable the collection and analysis of data. Teachers should look for opportunities to engage students in these beyond where the syllabus explicitly states the need to conduct a practical investigation.
* Collect and analyse data from primary and secondary sources, including tables and graphs. It is important that students are proficient in these areas, as there is a considerable focus on population studies of genetics and disease (epidemiology) in the Year 12 course.
* Assess the uses, benefits and limitations of various types of scientific models. Many of the biological processes that are investigated occur on a cellular or molecular level (e.g. DNA replication) or happen over a long time period (e.g. evolution). Models help us to better understand these types of processes.
* Determine the impacts of various technologies in improving the understanding of various concepts, including ideas around evolution, microscopic life and processes that occur on a molecular level.
* Collect relevant information from secondary sources and determine the accuracy, reliability and validity. Many of the investigations will require students to obtain information from the Internet or other sources. Students will benefit from learning how to access the correct sort of information. They will appreciate how new evidence can change prevailing views about biological concepts developed in Year 12, including genetics, biotechnologies and diseases.
* Biology can often be best understood through the lens of evolution. Students should develop a deep understanding of the concept that all species are related through sharing a common ancestor, and patterns can therefore be observed in the living world. This will be essential to appreciate heredity and genetic processes, manipulation of genetic material, the concept of biodiversity and the understanding of diseases which are all covered in the Year 12 course.
* Construct labelled diagrams, flowcharts and other methods of communicating information. This skill is important to develop when students in Year 12 use pedigrees and Punnett squares, negative feedback loops or outline aspects of the immune response.
* Understanding of biological processes has been significantly impacted upon by societal, cultural and economic factors. Students should be provided opportunities to engage in work that allows them to acknowledge these influences.
* Develop a deep understanding of the impacts of humans on ecosystems and an appreciation of the importance of sustainability in its various forms. This includes understanding the roles of Aboriginal and Torres Strait Islander Peoples in caring for Country and Place.

## Course overview

The Year 12 course follows some major themes that weave throughout all modules. These include:

* **Survival:** Individuals and populations have strategies that enable them to survive. Some of these include successful reproduction, metabolism, responses to infection and homeostatic mechanisms. The survival of species is reliant on genetic variation in changing environments.
* **Patterns exist in biology**: Various types of patterns can be observed in the natural world. For example, the inheritance of certain traits and the occurrence of infectious and non-infectious diseases can be predicted through the observation of patterns. Although the biosphere is diverse, similarities and patterns in the molecular makeup (e.g. DNA structure) of all species can be observed and these are explained through evolution and common ancestry.
* **Technologies**: Various types, including biotechnologies, can be used to better understand biological processes. They can help us to better understand life in the past, enhance survival and quality of life in human populations, productivity and sustainability in the environment.
* **Society**: Biology is influenced significantly by societal factors. The economy, cultural influences and ethics have all played important roles in shaping how we understand the living world.

## Module summary

This module explores the following inquiry questions:

* **IQ7-1:** How are diseases transmitted?
* **IQ7-2:** How does a plant or animal respond to infection?
* **IQ7-3:** How does the human immune system respond to exposure to a pathogen?
* **IQ7-4**: How can the spread of infectious diseases be controlled?

Infectious diseases can significantly impact human health and that of other animals and plants and can have devastating impacts on agricultural production. These impacts are not equal throughout the world. Prevention of infectious diseases relies on limiting transmission of pathogens and is dependent upon a range of biological, economic, social and governance factors. The content focus is on:

* Causes of infectious disease
* Responses to pathogens
* Immunity
* Prevention, treatment and control of infectious disease

## Big ideas

* **Survival:** Infectious diseases are caused by pathogens. Pathogens or their products must infect a host to cause disease. Preventing infectious disease depends on preventing this transmission. Many animals and plants display a range of responses to infection which are designed to isolate and destroy the pathogen and its products.
* **Patterns exist in Biology:** Immunisation and mobility of individuals will affect the spread of disease.
* **Technologies:** Humans can treat and/or prevent some diseases with a range of strategies, including medicines, which must be used appropriately to be effective. The importance of prevention strategies in more recent years has been emphasised.
* **Society:** infectious diseases have economic and social consequences and therefore governments have a role in preventing infectious diseases.

## Relationships to other modules

Teachers could teach this module after Module 8 if they wish, since Module 8 has close ties with Modules 5 and 6.

Some suggested areas of focus to activate prior knowledge could include:

* Investigating prokaryotic and eukaryotic cell structures (Module 1).
* Impacts of disease in ecosystem relationships (Module 4).
* Genetic engineering practices to prevent infectious disease (Module 6).

Some potential future links to other Modules in the Year 12 course could include:

* The concepts of epidemiology and the study of disease occurrence in populations and data analysis is a theme that continues into Module 8.

## Core concepts

* The discovery that infection by an organism (pathogen) is the cause of disease was essential to our understanding of disease treatment and prevention.
* Recognising the mode of transmission is also essential in preventing the spread of infectious disease.
* Some animals and plants have innate responses to infection that distinguish between self and not self. The innate responses are non-specific and are effective against the majority of types of pathogens.
* Animals also have an adaptive response to infection, called the immune response, which is specific to each pathogen. The immune response usually destroys the infection by the pathogen, but may take some time, during which the animal will exhibit symptoms of the disease. As a result of a specific infection, the immune response will also prevent the animal from getting a subsequent infection from the same pathogen. This is called immunological memory.
* Vaccination is a way of stimulating the immune system so that immunity to a specific pathogen is achieved without infection. This is called acquired immunity.
* Prevention is better than cure. Controlling the spread of disease is only achieved by understanding how the disease is transmitted then limiting that transmission. There are a wide range of methods available for preventing infectious disease and for controlling the spread of infectious diseases.
* Treatment may be provided to individuals if they become infected with a disease. Pathogens are continually evolving resistance to drugs. In order for drugs (antivirals and antibiotics) to remain effective they need to be prescribed and taken, according to instructions.
* Infectious diseases have an economic cost and social impacts for individuals and society as a whole, because of their impact on both human health and agriculture.

### Opportunities for extending concepts

These are some suggested pathways students could investigate to allow for a deeper appreciation of the inquiry questions within this module. Any extension activities should always be related to the inquiry question:

* Fredrich and Relman’s 21st century postulates are a new set of rules to determine if a specific pathogen is responsible for an infectious disease. It is based on nucleic acid base (DNA or RNA) identification to include viruses and viroids (prion diseases are not included).
* Clonal selection theory explains how lymphocytes are able to produce a large number of antibodies specific to an antigen and the importance of the work of Sir Frank Macfarlane Burnet.
* Immunotherapy as a treatment for cancer and the importance of a healthy gut microbiome in the immune response.
* The processes of bioaccumulation and biomagnification and the health impacts of pesticide use in humans or other animals.
* Rational drug design to produce new drugs that target the structure of a pathogen/disease causing molecule and manufacture a drug that has a complementary shape to obstruct the action of the pathogen/disease causing molecule.
* John Snow and the importance of his work with the London cholera epidemic and how water can harbour and transmit pathogens. Development of the science of epidemiological studies to identify hazards and risk factors in disease outbreaks.

### Misconceptions and alternative conceptions

* Students often confuse the terms infectious and contagious. Use examples to distinguish between the terms. Salmonella food poisoning and tetanus are examples of diseases that are infectious but not contagious.
* Incorrect ideas exist about modes of transmission. For example:
  + If you are healthy you cannot catch an infectious disease.
  + You can only catch an infectious disease from contact with another person.
  + You cannot catch a sexually transmitted infection (STI) through oral or anal sex.
  + Getting an infection once will always protect a person in the future.
  + Birth control pills can prevent an STI.
  + You can catch an STI from touching a door handle or using a toilet seat.
* Perceived risks associated with vaccination. Despite being widely discredited, one pervasive misconception is that vaccination will give a person the disease or another disorder such as autism. Some communities may have religious or ethical objections to some vaccinations.
* Immunity can be built from healthy diet and lifestyle. Large amounts of misinformation are present online and in social media. Even with all of the current evidence this is an area where some students still bring misconceptions into the course. This can often largely be attributed to the students’ previous experiences, and so these misconceptions can be difficult to address.
* Students often have misconceptions around the level of protection given by one round of immunisations and do not understand the need for booster vaccinations for some diseases. An understanding of herd immunity is required to appreciate the need for high vaccination rates. Prevention has scientific evidence. It is not better to get the disease than to be vaccinated.
* Use of drugs, especially antibiotics, to treat infections. There is a belief that antibiotics will cure viral infections such as influenza, and that it is appropriate to take someone else’s antibiotics if you can’t get to the doctor. Students need to be aware of the issues associated with the overuse and incorrect use of antibiotics and the ongoing research into treatments for antibiotic resistant bacteria.
* Cleanliness and its relationship to hygiene (preventing the spread of infectious disease) is frequently misunderstood. Students are often unaware of the risks associated with the overuse of disinfectants and the rise of biocidal resistant bacteria. Hygienic practices to avoid disease transmission, such as hand hygiene, respiratory hygiene as well as food, laundry and toilet hygiene are important protocols.

### Conceptual difficulties

* Understanding the different types of pathogens may require explicit teaching and repetition to avoid confusion, to be followed with formative assessment, such as exit tickets and quizzes.
* Understanding that the digestive tract, respiratory tract and urogenital tract are not sterile and are separate from the sterile cranial, thoracic and abdominal cavities in this sense.
* Fever is one of the body’s responses to infection, designed to inhibit the growth of pathogens and inactivate their products, rather than a product of the infection itself.
* Use of the following terms correctly can sometimes be confusing and difficult – self and not self, antibody and antigen.
* The adaptive immune response, specifically, the cascades of responses and the interaction between B & T cells can be quite challenging. Teachers may need to encourage the use of flow charts and diagrams to outline some of the main steps involved in adaptive immunity.
* Distinguishing between the terms prevention, treatment and control can sometimes be difficult possibly due to their misuse in the media.
* Horizontal gene transfer in bacteria and viruses, and important in antibiotic and other drug resistance, is a new concept that is contrary to all that students have learned about the inheritance of genes.

## Suggested teaching strategies

This section provides an overview of some suggested practical and secondary source investigations and resources that could be explored for each of the inquiry questions in these modules. There are no expectations that teachers need to teach these in any particular order; teachers are encouraged to link ideas across inquiry questions where they see fit.

### IQ7-1: How are diseases transmitted?

* Recalling students’ prior knowledge of cell structure is important in differentiating between types of pathogens. Students may need to review cell structure/function and compare prokaryotic and eukaryotic cells from Year 11 Module 1.
* This inquiry question could be effectively presented by developing the concepts though a number of practical activities that have been used for many years and can be adjusted to be inquiry based learning. There is opportunity to address working scientifically outcomes BIO12-1, BIO12-2 and BIO12-3 in these investigations:
  + Practical investigation: Pasteur’s swan neck flask experiment.
  + Practical investigation: Microbes in Food and Water.
  + Practical investigation: Tracing the source of infections. Using simple reagents, students conduct an investigation into [Simulating the spread of an infectious disease](https://www.koshland-science-museum.org/sites/default/files/uploaded-files/ID_Disease_Spread_Activity_FINAL.pdf) (a PDF from [koshland-science-museum.org](https://www.koshland-science-museum.org/)).
* These are [interactive activities](http://members.ziggo.nl/norbertvanveen/Gezondheid/koch_postulaten.swf) that model Koch’s postulates (requires Internet Explorer for Flash).
* Knowledge of the types of pathogens and modes of transmission, as well as agricultural diseases, can be developed though students investigating specific examples of infectious diseases.
* Engagement will be enhanced with learning that is relevant and contextual, such as issues currently in the news locally, nationally or internationally.

### IQ7-2: How does a plant or animal respond to a pathogen?

* The use of live plant specimens will allow students to observe local plants responses to a range of pathogens. Infected native plants, however, can be difficult to source so online images will be needed.
* Research: Use [ausveg.com.au](https://ausveg.com.au/biosecurity-agrichemical/crop-protection/overview-pests-diseases-disorders) to complete a table of common plant pathogens. In the table:
  + briefly describe each pathogen
  + identify the part of the plant affected by the pathogen
  + list any indications of disease caused by the pathogen
  + describe the effects at the cellular level
* Undertake a practical investigation of plants showing symptoms of pests and diseases. (see Appendix one).
* Students view the first segment of the video [plant and animal defence mechanisms](http://www.bozemanscience.com/023-plant-and-animal-defense) (duration 5:35). Students define, describe and write an explanation of how the hypersensitive response defends plants against pathogens, then discuss the limitations of this response against pathogens.
* Investigate snot as a response of animals to pathogens by watching a video and making snot. See Appendix 2.
* Fever Investigation: view the PBS Learning Media clip: [Fever](https://www.pbslearningmedia.org/resource/tdc02.sci.life.reg.fevervid/fever/#.WXmgr4pLe34) (duration 7:34). Discuss why having a set point of 37.5˚C is helpful to the cell functions in the body. Discuss the chemical changes (release of pyrogens) that occur in the body in response to pathogens.
* Students construct a flowchart summary of the physiological responses of the body to damage using the [interactive](https://www.nottingham.ac.uk/nmp/sonet/rlos/bioproc/inflam/index.html): The Inflammatory Response. Include labelled diagrams in the flowchart to assist in demonstrating the major steps involved.

### IQ7-3: How does the human immune system respond to a pathogen?

* Human immune response to pathogens will require direct instruction as the concepts are complex and completely new to the students. Modelling the response of the specific immune system to antigen detection and creating flow charts can help students conceptualise the process. There are also several good animated videos on YouTube that can reinforce student understanding. This is a good [visual aid](https://highered.mheducation.com/sites/0072507470/student_view0/chapter22/animation__the_immune_response.html) to explain a complex process (requires Internet Explorer and Flash player).
* The core concept in this inquiry question is the understanding of how the body detects foreign cells and the cascaded response to this detection. [Infectious diseases interactive](https://www.abpischools.org.uk/topic/infectiousdiseases-immunity/2/1) provides a broad overview of the immune response for student formative assessment/revision.

### IQ7-4: How can the spread of infectious diseases be controlled?

* This inquiry question can be approached holistically, with disease case studies looking at the impact of disease on a population and the resources available to prevent or minimise damage from that disease. (See activity on Measles in Appendix 3). Performing guided research around this topic is a good opportunity for students to develop their research skills, particularly in designing and conducting secondary investigations and collecting reliable and valid sources of information. (BIO12-2 and BIO12-3) and presenting information using a range of graphical representations (BIO12-4).
* A good starting point to this IQ is to look at the scale of effect a disease can have, from the individual to the global. The [Australian Institute of Health and Welfare](https://www.aihw.gov.au/) provides a wide range of statistics around the incidence of disease nationally and students can analyse this data to perform statistical analysis of the diseases impacting Australians (BIO12-4). The [World Health Organisation](https://www.who.int/) has a large amount of data around global incidence of disease.
* These levels can be linked to different levels of prevention from personal hygiene at the individual level to quarantine and public health campaigns nationally and globally.
* Practical investigation: Hygiene and Microbial growth. Students can investigate different hand hygiene protocols and treatments. The Cosmos article [How to wash your hands](https://cosmosmagazine.com/biology/how-to-wash-your-hands) about hand washing protocol in hospitals could provide the stimulus for a depth study.
* Practical investigation: Effectiveness of various water treatment methods. Students can investigate different water treatment methods, for example: boiling, various water purification tablets, home water purifiers.
* Data analysis: Students could perform a case study on the global response to an epidemic/pandemic outbreak. [Age structure of Ebola outbreaks](https://www.biointeractive.org/classroom-resources/age-structure-ebola-outbreaks), from Biointeractive, presents data from 1975-2014 in a graph form that students may not be familiar with. The accompanying worksheet requires students to analyse the data. Students contrast the strategies used in these situations with the strategies used in ongoing diseases like malaria.
* Pose the question: Is it possible to eradicate a disease?
  1. View either of these videos: Discovery UK - [The eradication of smallpox: invisible killers](https://www.youtube.com/watch?v=dVmkYSkQEN8) (duration 7:29) or TED Ed [Learning from small pox: How to eradicate a disease](https://www.youtube.com/watch?v=oBSandHijDc) (duration 5:45).
  2. Students answer the following:
  + What were the challenges in attempting to eradicate smallpox?
  + Explain how smallpox was eradicated.
  + What are the benefits of other eradication programs?
* Students to use their blue books (or access Medicare app) showing their vaccination record and design a discussion around this.
  + What were they vaccinated for, how often, at what age?
  + Did their parents consider not vaccinating them?
  + How do they feel about being vaccinated now as teenagers?
  + Have they travelled overseas? Did they need vaccinations for this travel?
  + Have the diseases they have been vaccinated against been eradicated?
* Students undertake an investigation into measles or another of the diseases for which they have been vaccinated (see appendix three).
* Students can view [ABC Catalyst](https://iview.abc.net.au/show/catalyst/series/17/video/SC1502H012S00) and write an explanation of the problem of antibiotic resistance. A brief case study can be completed.
  + [Whooping cough evolving to beat antibiotics and possibly vaccine](https://newsroom.unsw.edu.au/news/health/whooping-cough-evolving-beat-antibiotics-and-possibly-vaccine) a UNSW Newsroom article. A new strain of Bordetella pertussis – the bacterium that causes whooping cough – has become resistant to antibiotic treatment and may also be resistant to the vaccine used in China. The need to maintain our high vaccination coverage is discussed **or**
  + [The looming threat of C-diff](https://cosmosmagazine.com/biology/the-looming-threat-of-c-diff): a Cosmos article on the rise of yet another antibiotic resistant bacteria and also links back to the microbiome being a natural barrier to infection.
* Antibiotic resistance can be investigated through playing [Bacterial Survivor](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6203629/#sup1), an interactive game that combats misconceptions about antibiotic resistance.

## Resources

* [World Health Organisation](https://www.who.int/westernpacific/our-work/resources/data) and [Australian Institute of Health and Welfare](https://www.aihw.gov.au/) both have websites providing large amounts of high quality, reliable information that may be used for planning lessons or secondary source research projects.
* Local healthcare providers – May be able to provide information on current issues facing the local community or talks on health safety and education. This can be a powerful educational tool as it shows real world links and relevance of course content.
* Local Indigenous people (AECG) re application of Aboriginal protocols.
* The Museum of Human Disease at UNSW offers educational tours for schools.
* [Garvan Institute](https://www.garvan.org.au/) has a range of videos and interactives.
* [Cosmos](https://cosmosmagazine.com/) – an Australian based online magazine that summarises reports in scientific journals and convert them to plain English so that they are accessible to high school students.
* [Doherty Institute](https://www.doherty.edu.au/): based in Melbourne the Doherty Institute work on infection and immunity through a broad spectrum of activities. This includes discovery research; diagnosis, surveillance and investigation of infectious disease outbreaks; and the development of ways to prevent, treat and eliminate infectious diseases
* [Science journal for kids](https://www.sciencejournalforkids.org/): Cutting edge peer-reviewed science research adapted for students.

### IQ 7-1

* + [Simulating the spread of an infectious disease](https://www.koshland-science-museum.org/sites/default/files/uploaded-files/ID_Disease_Spread_Activity_FINAL.pdf) (a PDF from [koshland-science-museum.org](https://www.koshland-science-museum.org/)): Using simple reagents, students simulate the spread of a simple imaginary disease in order to explore some factors that affect the rate of infection, the challenges of epidemiology, and measures which can help prevent the spread of disease.
* [Koch’s Postulates animation](http://members.ziggo.nl/norbertvanveen/Gezondheid/koch_postulaten.swf) (use Internet Explorer for Flash) clearly steps out the postulates by infecting mice with anthrax.

### IQ 7-2

* Overview: [Pests, diseases and disorders](https://ausveg.com.au/biosecurity-agrichemical/crop-protection/overview-pests-diseases-disorders/) from Ausveg. This page provides a diagnostic guide and key reference for pests, diseases and disorders affecting vegetable crops in Australia. They hyperlinked topics provide further detailed information about the pests, diseases, disorders – their identification, types, management, and source of information and related tools.
* [Signalling between plants and pathogens:](https://www.whfreeman.com/BrainHoney/Resource/6716/SitebuilderUploads/Hillis2e/Student%20Resources/Animated%20Tutorials/pol2e_at_2801_Signaling_between_Plants_and_Pathogens/pol2e_at_2801_Signaling_between_Plants_and_Pathogens.html) About plant diseases and disorders a video about plant detection of pathogens, is a resource for extension of concepts.
* [Plant and Animal Defense](http://www.bozemanscience.com/023-plant-and-animal-defense) (duration 13:04) in this video Paul Andersen describes how plants and animals defend themselves against pathogens. He begins by discussing the hypersensitive response in plants as a nonspecific form of immune response. The later part of the video he discusses both the humoral and cell-mediated immune response in mammals. This could be useful in IQ 7-3.
* [What is Snot?](https://www.sciencelearn.org.nz/videos/57-what-is-snot) Video (duration 0:51) from the Science Learning Hub at the University of Waikato. Dr Joanna Kirman talks about snot. Although it seems disgusting, we learn snot is actually a good thing and is one of our weapons to fight disease. It is produced to clear the airways of infectious diseases and anything else that should not be there.
* [Making snot](https://www.sciencelearn.org.nz/resources/196-making-snot) for the activity see Appendix one. From the web page you can download the Word file for:
  + introduction/background notes
  + what you need
  + what to do
  + fake snot recipes.
* [Fever](https://www.pbslearningmedia.org/resource/tdc02.sci.life.reg.fevervid/fever/#.WXmgr4pLe34) (duration 7:32) video from PBS Learning Media describes in detail the response of overheating on a hot day and getting a fever and takes some of the mystery out of fever. Some background reading and discussion questions are included.
* [The Inflammatory Response](https://www.nottingham.ac.uk/nmp/sonet/rlos/bioproc/inflam/index.html) - a series of short videos from the University of Nottingham about each step in the inflammatory response. Included is a short self-assessment crossword puzzle.

### IQ 7-3

* [The Immune Response](https://highered.mheducation.com/sites/0072507470/student_view0/chapter22/animation__the_immune_response.html) from McGraw Hill is a video animation that explains a complex process (requires Internet Explorer and Flash player). Text and a short quiz are included.
* [Infectious diseases](https://www.abpischools.org.uk/topic/infectiousdiseases-immunity/2/1) - an interactive from ABPI, provides a broad overview of the immune response for student formative assessment/revision.

### IQ 7-4

* [How to wash your hands](https://cosmosmagazine.com/biology/how-to-wash-your-hands) article from COSMOS. Researchers suggest that shorter washing times for health workers can prevent bacterial spread in hospitals.
* [Age structure of Ebola outbreaks](https://www.biointeractive.org/classroom-resources/age-structure-ebola-outbreaks) from BioInteractive. This activity guides the analysis of published scientific figures from a study that investigated demographic patterns in Ebola outbreaks from the Democratic Republic of the Congo. An educator materials document includes a captioned figure, background information, graph interpretation and discussion questions. The graph presented is a box and whisker plot which the students may not have seen before, so this provides an excellent opportunity to increase their knowledge of different data representations. There are also links to other data studies including the Nipah virus outbreak in Malaysia.
* Discovery UK - [The eradication of smallpox: invisible killers](https://www.youtube.com/watch?v=dVmkYSkQEN8) (duration 7:29) or TED Ed [Learning from smallpox: How to eradicate a disease](https://www.youtube.com/watch?v=oBSandHijDc) (duration 5:45) are videos that look at the strategies employed to eradicate smallpox.
* Some possible resources for Measles:
  + Video at SBS: [Measles surge in Europe: What does it mean for Australia?](https://www.sbs.com.au/news/measles-surge-in-europe-what-does-it-mean-for-australia) (duration 2:45) - looks at herd immunity and why it is so important.
  + [Measles in Australia](https://www.aihw.gov.au/getmedia/c828baef-75d9-4295-9cc9-b3d50d7153a2/aihw-phe-236_Measles.pdf.aspx)  (Australian Institute of Health and Welfare) – good graphs and a concise report on the effectiveness of MMR vaccination.
  + SBS world news video: [No link between measles vaccine and autism, major study confirms](https://www.sbs.com.au/news/no-link-between-measles-vaccine-and-autism-major-study-confirms) (duration 2:03). Looks at the underlying premise for anti-vaxxers opposing the MMR vaccine, its validity and what the latest study shows about the connection between MMR and autism.
* [Antibiotic resistance.](https://iview.abc.net.au/show/catalyst/series/17/video/SC1502H012S00) Catalyst (ABC) looks at the problem of antibiotic resistance and how researchers are approaching the problem.
* [Whooping cough](https://newsroom.unsw.edu.au/news/health/whooping-cough-evolving-beat-antibiotics-and-possibly-vaccine)  A UNSW web page that discusses how a new strain of Bordetella pertussis – the bacterium that causes whooping cough – has become resistant to antibiotic treatment and may also be resistant to the vaccine used in China.
* [The looming threat of C-diff](https://cosmosmagazine.com/biology/the-looming-threat-of-c-diff) : A Cosmos article on the rise of yet another antibiotic resistant bacteria. Links back to the microbiome being a natural barrier to infection.
* [Bacterial Survivor:](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6203629/#sup1) an interactive game that combats misconceptions about antibiotic resistance

## Appendix one

### IQ 7-2 Investigating plant pathogens

* Gather four or five plants that show symptoms of disease.
* Use table previously constructed to identify the type of pathogen/pest present and describe its effects.
* Construct labelled diagrams of plant samples. Students should use the following prompts to help identify the pathogen/pest:
  + Look at the whole plant
  + Check for damage to roots
  + Observe the distribution of signs within the plant, for example, is only the new growth affected or only one stem?
  + Observe the pattern of affected plants within a population
* Infected native plants, however, can be difficult to source so online images will probably be needed.

## Appendix two

### IQ 7-2 Responses to pathogens

Watch video clip: [What is snot?](https://www.sciencelearn.org.nz/videos/57-what-is-snot) (duration 0:51) Discuss why snot is a good thing and why there are different types/colours of snot. Divide students into small groups and give a different type of snot ([Science learning hub recipe](https://www.sciencelearn.org.nz/resources/196-making-snot)) to each group. Discuss the texture of each group’s fake snot - is it stringy or stretchy. Ask students again what snot is and what it is for. Compare with students’ original answers.

## Appendix three

### IQ7-4 Prevention, treatment and control

An investigation of measles, or another disease that students could select from their vaccination record.

Students investigate:

* The disease the situation pre & post vaccination development, in Australia, another first world country and a third world country.
* What is limiting the uptake of vaccines in each?

Students will need to show data to support this. As a result of their research into measles or other disease students **complete both parts 1 and 2.**

1. **Students complete one of the following (a or b)** 
   1. Write an article for the newspaper in a low vaccination area in Australia to explain to the local population why they should be vaccinating their children for the chosen disease
   2. Prepare a presentation to a local ante natal class in Australia to explain to the parents why they should be vaccinating their children for the chosen disease
2. Write a report to an aid agency about the level of vaccination in a third world country, along with suggestions about how to improve the situation

This meets the following content descriptors:

* investigate and analyse the wide range of interrelated factors involved in limiting local, regional and global spread of a named infectious disease
* investigate procedures that can be employed to prevent the spread of disease, including but not limited to:

**Vaccination**

Interpret data relating to the incidence and prevalence of infectious disease in populations, for example:

* mobility of individuals and the portion that are immune or immunised
* and Working Scientifically outcomes Bio 11/12-3, 11/12-5, 11/12-6 and 12/12-7