Year 12 Biology Module 8: Non-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 (for example DNA replication) or happen over a long time period (for example 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 (for example 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:

* **IQ8-1:** How is an organism’s internal environment maintained in response to a changing external environment?
* **IQ8-2:** Do non-infectious diseases cause more deaths than infectious diseases?
* **IQ8-3**: Why are epidemiological studies used?
* **IQ8-4:** How can non-infectious diseases be prevented?
* **IQ8-5:** How can technologies be used to assist people who experience disorders?

For an organism to be functioning effectively its internal environment must be maintained within normal limits despite the changing external environment it is exposed to. Disorders and diseases can cause the internal environment to be not maintained. Non-infectious diseases can significantly impact human health and are the major cause of deaths world-wide. The study of diseases in populations (epidemiology) can be used to determine the cause of disease and provide data that will support preventative measures. Management of disorders can be enhanced with the use of technology.

## Big ideas

* **Survival:** When homeostasis fails survival is impaired. Animals and plants use a range of mechanisms to maintain homeostasis. Non-infectious diseases and disorders can affect survival. They are not caused by pathogens but by a range of factors, or combination of factors including genetics, nutrition, environmental exposure and cancer.
* **Patterns exist in Biology**: The patterns of incidence of non-infectious diseases can be studied to assist in determining the cause of the disease.
* **Technologies**: Emerging biotechnologies can help to prevent non-infectious diseases. Disorders caused by malfunctioning organs can be assisted by technologies designed to mimic the organ.
* **Society**: Many non-infectious diseases are preventable. Education and public health campaigns are examples of how governments can reduce the incidence of non-infectious diseases.

## Relationships to other modules

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

* The coordination of cellular activities within their internal and external environments (Module 1).
* Nutrient requirements of living things (Module 2).

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

* Concepts around genetic causes of disease and mutations (Modules 5 and 6).

This module could be taught directly after Modules 5 & 6 as there is a close link with genetics, environmental exposure and cancer as a cause of non-infectious disease. Alternatively, it can be taught after Module 7 as a contrast to Infectious Diseases. With the epidemiological study there is further development of data analysis that is developed in all modules.

## Core concepts

* Homeostasis involves detecting a change in a specific component of the internal environment and then undergoing a response that counteracts that change. This is response can be represented by a negative feedback loop and involves the coordination of hormonal and neural pathways.
* Endothermic animals display behavioural, structural and physiological adaptations that allow them to maintain their body temperature within a narrow range.
* As a country becomes more affluent the impact of infectious disease falls, allowing for non-infectious disease to become more significant. Whilst poverty and the associated lack of infrastructure contributes to non-infectious diseases in developing countries, lifestyle is a major contributor to their occurrence in developed nations.
* Many non-infectious diseases have risk factors associated with them. Governments can reduce the incidence of non-infectious diseases by legislating for safe environments and providing education and public health campaigns which allow people to make appropriate lifestyle decisions.
* The analysis of data relating to the incidence and prevalence of non-infectious diseases can be used to determine the susceptibility to the disease, if preventative measures and treatments are effective across a population and future areas for research.
* Like all scientific investigations it is important that epidemiological studies are valid. This is achieved by the study design conforming to epidemiological principles.
* Genetic technologies offer new methods of preventing the occurrence of genetic diseases.
* Body organs are complex structures. Failure of organs, whether it is congenital or due to disease or injury, has a profound effect on the individual. Advances in technology improve the quality of life for patients.

### Opportunities for extending concepts

* In detail study of specific hormones, their mode of action and feedback loops.
* A detailed study of biochemistry of action potentials.
* The effect of the P53 gene on the rate of mitosis. This is an important gene in the regulating the cell cycle and hence in the prevention of cancer.
* Epidemiology – a statistical analysis of an epidemiological study could be undertaken by students who are studying Extension Science or are competent mathematicians.
* A detailed study of photoreceptors.
* Other eye disorders – macular degeneration, retinitis pigmentosa and cataracts and the technologies available to assist people with them.

### Misconceptions and alternative conceptions

* Non-infectious diseases mainly affect the rich. Whilst non-infectious diseases cause more deaths than infectious diseases in developed countries, about 80% of world deaths from non-infectious diseases occur in the poorest countries.
* Non-infectious diseases are only a concern for older people. In reality, around 50% of people with a non-infectious disease are under the age of 70. The age of onset of ‘maturity onset’ diabetes, heart disease and cancer is decreasing.
* Non-infectious diseases are caused by poor choices by individuals, therefore it is not the responsibility of government to prevent them. Governments have a responsibility improve the health of the population through education, urban planning, and providing affordable and accessible foods.
* Because some people partake in risk-taking behaviours and don’t get sick, there is a belief that the risk-taking behaviour does not cause the disease. For example, “My 80 year old uncle has smoked all his life and does not have lung cancer, therefore smoking does not cause lung cancer”. Epidemiological studies have found a direct and undeniable link between smoking and lung cancer. These are based on collection of very large amounts of data.

### Conceptual difficulties

* Negative feedback loops can cause difficulty for students. The word ‘negative’ is often the source of the confusion. This is best approached by looking at temperature regulation first as these are responses students will have experienced and are familiar with. Exploring a model thermostat in a room can be useful. Then move to glucose regulation.
* Many of the non-infectious disease have multifactorial causes that are not straightforward. For example, there are number of factors that increase the risk of heart disease and cancers. Sometimes diseases develop without the patient having a known risk factor, e.g. non-smokers can develop lung cancer.
* The role of gene action in the regulation of the cell cycle can be confusing. The interactives on cell cycle and cancer (in Resources) will help students work through this. Developing a flow chart of gene action will also assist understanding.
* Methodology of epidemiological studies can be difficult for students, partly because of the new vocabulary and some students’ resistance to anything mathematical. When explaining methodology, a study of the epidemiology of lung cancer that was also in the previous syllabus, as well as current texts, will allow students to see the characteristics and role of the different studies. The textbooks have several activities that step students through the analysis of data.
* Kidney function has traditionally been an area that students have difficulty with. Be aware that significantly less detail is required in this syllabus. Students need to understand that potentially any small enough molecule or ion can be filtered out of the blood in the glomerulus. Most of these substances are then reabsorbed back from the tubules and/or loop of Henle by active transport, facilitated diffusion or osmosis. Only the substances that the body does not require remain in the filtrate to become urine. Additionally, there is active secretion of unwanted materials from the blood capillaries into the tubules.

## Suggested teaching strategies

### IQ 8-1: How is an organism’s internal environment maintained in response to changing external environments?

* The body’s response to temperature is an area that students are familiar with so is a good point of reference for introducing negative feedback loops.
* Undertake an analysis of data relating to thermoregulation. In the Nuffield Foundation’s exercise, [Interpreting information about sweating and temperature](https://pbiol.rsb.org.uk/control-and-communication/homeostasis/interpreting-information-about-sweating-and-temperature), data relating to sweating and body temperature is presented with questions guiding presentation and analysis.
* Students can then prepare a negative feedback loop for blood glucose after viewing the McGraw Hill video: Homeostasis in the Human Body, a 3D animation explaining the role of insulin and glucagon in maintaining blood glucose levels within normal limits.
* These two loops both use hormones and neural pathways. This can lead into a study of the structure of each and how they operate as mechanisms to maintain homeostasis.

### IQ 8-2: Do non-infectious disease cause more deaths than infectious disease?

* A Socrative or Kahoot activity could be a useful diagnostic assessment tool here. Students could be questioned about what constitutes a non-infectious disease, causes of deaths and the occurrence and importance of non-infectious diseases.
* The [World Health Organisation](https://www.who.int/gho/ncd/en/) is an excellent source of data for analysis of non-infectious (referred to as non-communicable) diseases. The site includes maps showing distribution of disease and data about the [Top 10 Causes of Death](https://www.who.int/en/news-room/fact-sheets/detail/the-top-10-causes-of-death).
* Many non-infectious diseases have a number of interacting causes. In order to keep the concepts straightforward for students it is advised to select examples, where possible, that have only one cause and clear, current information.
* Genetic diseases: PKU or cystic fibrosis are recommended as suitable examples. Resources are listed below
* Environmental diseases: Carry out a research-based investigation into mesothelioma or melanoma. There is a large amount of Australian data for the incidence, prevalence and mortality studies. These investigations can also address descriptors in the subsequent two IQ in the syllabus. Resources are listed below.
* Alternatively, a study can be carried out into silicosis. With stone bench tops being highly fashionable there is anecdotal evidence of an increase in the incidence of this ‘old’ disease. However, there is no official data. This ABC audio explains why [silicosis is NOT the new asbestosis](https://radio.abc.net.au/programitem/pgE6JRPW86)  (duration 11:20) on Ockham's Razor. This highlights the importance of data. The cause and effects of the disease can be seen on the 7.30 report: [Silicosis crisis: workers dying making kitchen benchtops](https://www.youtube.com/watch?v=c-zVty3zhLc) (duration 8:29).
* Nutritional diseases: Scurvy is a straightforward example. Another interesting example that flows well into the epidemiological study is neural tube defects. (See Appendix)
* [Pima Indians](https://www.biointeractive.org/classroom-resources/pima-indians) (duration 2:36) - a video that links lifestyle and non-infectious disease.
* Cancer: interactives, videos and activities for students to investigate the cell cycle and the role of the P53 gene is included in Resources below
* Students can collect data that shows incidence, prevalence and mortality rates of non-infectious disease from the [Australian Institute for Health and Welfare](https://www.aihw.gov.au/getmedia/e1be38c8-a3bb-4284-9b55-59ee47c7d31e/ntdia.pdf.aspx?inline=true) website

### IQ 8-3: Why are epidemiological studies used?

* The melanoma or mesothelioma investigation from the previous inquiry question can be continued into this inquiry question.
* This and the next inquiry question (How can non-infectious disease be prevented?) can be partially addressed with the investigation into neural tube defects that is detailed in the appendix.

### IQ 8-4: How can non-infectious diseases be prevented?

* Link the purpose of epidemiology (the study of the distribution and determinants of disease) to prevention. Prevention improves quality of life and has a monetary benefit of saving money on health budgets. Less sick people/early deaths means more years of productive life which has an economic benefit to the country.
* Promote class discussion with the question: “Why is it so difficult to change behaviour?” “We know smoking causes cancer, lung diseases and cardiovascular diseases. Why do people continue to smoke?” The same can be said of healthy lifestyles, healthy eating, exercise, obesity, drug alcohol use and links to disease and death. Ask students to give reasons. Possible discussion points:
	+ Is it the delay between cause and effect?
	+ Is it that these behaviour choices lead to increased risk not a definite poor outcome?
	+ Is it the entrenched belief that your death is predetermined and difficult to change?
	+ Do people not understand or trust the Science?
	+ Discuss with students other possible reasons for people continuing to engage in high risk behaviours/lifestyles despite the evidence.
* If Melanoma has been studied in the previous inquiry questions then the Sydney Morning Herald article [Here comes the sun: Defending our summer rays](https://www.smh.com.au/lifestyle/health-and-wellness/here-comes-the-sun-defending-our-summer-rays-20181120-p50h2j.html) about skin cancer and vitamin D exposure could be a useful investigation. Some possible points for discussion:
	+ Identify the environmental, genetic and cancer references in the article.
	+ How is the article reliable and valid?
	+ What message can you take from the article? How socially ethical is this article? Is it socially responsible? Justify your answer.
	+ What further questions do you have to investigate further? What hypothesis could you develop?
* Students investigate an educational campaign of their choice and then design and carry out a survey to analyse its impact on a local level. Compare this to available statistics on the incidence and prevalence of the disease before and after the campaign.
* Review genetic modification examples (for example genetically screening embryos and golden rice) that could be used for preventing disease from Module 6.

### IQ8-5: How can technologies be used to assist people who experience disorders?

* This inquiry question has caused some confusion as the first descriptor requires students to explain a range of causes of disorders and then lists some examples which could be studied to achieve this. The second descriptor lists specific technologies that must be investigated. In order for students to know need to know how each of the specified technologies assist with the disorder, they need to know how the organ’s functioning is impaired to cause the disorder. Details on all possible disorders of the organs are not required, just those that can be assisted by the listed technologies.
* Teachers are discouraged from trying to put all the previous Communication option into this IQ, however, there are several resources that relate to that option that could be used here. The focus is on the cause of the disorder and how the technology is used to overcome the disorder.
* The texts and a large number of videos (listed in Resources) explain the structure and function of the eyes, ears and kidneys.
* Ears:
	+ Flow charts and annotated diagrams are useful for the pathway of sound through the ear.
	+ Focus on the causes of hearing loss and why each technology is appropriate for each type of hearing loss.
	+ Watch Ear Science Institute Australia - [Hearing loss simulator - hear what hearing loss sounds like](https://www.earscience.org.au/news/making-waves-with-music) (duration 1:03) simulating the degrees of hearing loss(link provided at the end of the article).
	+ [Ear Science](https://www.earscience.org.au/) has a range of video and print personal stories of hearing implant recipients that students could use to evaluate effectiveness of the technologies.
* Eyes:
	+ Cow’s eye dissection: textbooks have instructions and questions or alternatively use the Exploratorium website which has eye dissection instructions and questions. It has clear pictures of what the students should see.
	+ Practical investigation using [a simple model of the accommodating lens of the human eye](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4056173/) ‘soft’ lens and suspensory ligaments to model accommodation. Alternatively, the textbooks provide investigations using hard lenses of different convexities.
	+ Students can determine the [range of accommodation in the eye](https://spark.iop.org/range-accommodation-eye#gref) by following this procedure.
	+ Link the failure of accommodation and problems with the curvature of the lens and cornea to long (hyperopia) and short (myopia) sightedness.
	+ Videos showing technologies designed to assist eye disorders are listed below.
* Kidneys:
	+ Explicit teaching with the use of flow charts and annotated diagrams will allow students to gain a clear understanding of the structure and function of the kidney.
	+ This BioInteractive [Kidney Function](https://www.biointeractive.org/classroom-resources/kidney-function) (duration 4:30) video clearly explains the filtration and absorption functions of the kidney.
	+ [KScience](http://www.kscience.co.uk/animations/anim_1.htm) produces an interactive kidney animation that will be changed from Flash Player to HTML5. It allows students to see how different parts of the kidney work. The level of detail is good, particularly with regard to the Bowman’s capsule, loop of Henle, collecting duct and proximal tubule. The section on the nephron allows students to select different molecules and watch their progress through the nephron. Students can use their understanding of the kidney to predict where the different molecules will go. This could be as an individual or whole class activity on the interactive whiteboard.
	+ Undertake a kidney dissection. Textbooks, both current and old syllabus, have instructions for this.
	+ Distinguish between chronic kidney disease (and the preventative measures that can be undertaken) and its progression to acute (or end stage kidney disease) and the need for dialysis. Be aware that students may know someone who is receiving dialysis, so it is important to be sensitive when introducing this topic. The patient may, on the other hand, be willing to talk to the students about their experiences of dialysis and its effectiveness. View videos of people undergoing dialysis and evaluate the effectiveness of the technology.
	+ [NITV Living Black S22 Ep11 - Inawintji's Story](https://www.sbs.com.au/nitv/video/455158339717/Living-Black-S22-Ep11-Inawintjis-Story) (duration 26:43) Inawintji Williamson is an Anangu woman from the APY lands who suffers from Renal Disease. She has been forced to move from her remote homelands, family and friends to receive dialysis in Adelaide.

## Resources

* [UNSW Museum of Human Disease](https://www.diseasemuseum.med.unsw.edu.au/visiting): has workshops with activities for students.
	+ Infectious and Non-Infectious Disease - This 45 minute presentation covers three key disease processes, cirrhosis (alcohol and viral hepatitis induced cirrhosis), atherosclerosis (smoking, poor diet and lack of exercise induced) and tuberculosis (bacterial infection). Inside the Museum, students work through 24 multiple choice, short response and extended case-based questions. These questions focus on pathogens, adaptations of pathogens, epidemiology and public health.
	+ Australia's Health Priorities - This 45 minute presentation covers the topics covered in the HSC Biology - Modules 7 & 8 presentation, however, the emphasis is on lifestyle choices and their effect on the body. In the Museum students work through a range of multiple choice, short response and extended response questions. These questions focus on lifestyle, non-infectious disease and drug use.
* [CDC](https://www.cdc.gov/): Centres for Disease Control and Prevention: A US site with large amount of information and data.
* [Science journal for kids and teens](https://sciencejournalforkids.org/articles/reading_level/high-school-upper/): Cutting edge peer-reviewed science research adapted for students. Easy to read articles on the latest research in all areas of science.

### IQ 8-1

* [Interpreting information about sweating and temperature](https://pbiol.rsb.org.uk/control-and-communication/homeostasis) from the Nuffield Foundation. Data relating to sweating and temperature are presented on a student worksheet with questions guiding presentation and analysis.
* [Homeostasis in the Human Body](https://www.youtube.com/watch?v=z1MLN5tAlNY) (duration 5:08) a 3D animation from McGraw Hill explaining the role of insulin and glucagon in maintaining blood glucose levels within normal limits.

### IQ 8-2

* [Newborn screening](https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/newborn-screening) (duration 3:01) - a video from the Victorian government explaining the new born bloodspot screening test for PKU, cystic fibrosis and hypoparathyroidism
* [Cystic Fibrosis Mechanism and Treatment](https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/newborn-screening) (duration 2:31) - a video explaining cause and effect of cystic fibrosis and how drugs operate at the molecular level.
* Mesothelioma: [ABC 4corners - Blue Death](https://www.abc.net.au/4corners/blue-death---1988/2841870) (duration 49:10). Broadcast in 2011 as a milestone story as part of Four Corners 50th Birthday celebrations. This original 1988 report exposed the scandalous impact of blue asbestos mining at Wittenoom in WA.
* Mesothelioma: [ABC News report](https://www.abc.net.au/news/2016-09-08/man-with-mesothelioma-from-asbestos-cant-sue-james-hardie/7823308) (duration 9:00) - James Hardie unlikely to pay compensation for Aboriginal kids exposed to asbestos in NSW town of Baryulgil.An Australian town next to an asbestos mine in northern NSW that has a serious mesothelioma problem
* Mesothelioma: [ABC News article](https://www.abc.net.au/news/2016-04-05/grant-i-was-blindsided-by-cancer/7299940)  - I was blindsided by cancer, and the asbestos that caused it. The widespread use of asbestos and the subsequent mesothelioma cases.
* To access the latest data on the incidence of mesothelioma in Australia access the [Australian Institute of Health and Welfare](https://www.aihw.gov.au/) website and then enter ‘Mesothelioma’ and the year preceding the current one (eg Mesothelioma 2019) into their search engine. Data and reports released from June to November of the previous year.
* [Mystery unravelled: How asbestos causes cancer](https://www.sciencedaily.com/releases/2010/06/100629094153.htm) – Science Daily article explaining the inflammatory response and mutations that follow the inhalation of asbestos fibres. For teacher reference.
* [Silicosis is NOT the new asbestosis](https://radio.abc.net.au/programitem/pgE6JRPW86)  (duration 11:20) on Ockham's Razor. When a young Gold Coast stonemason dies from silicosis in March, 2019, it was branded the new asbestosis. But the media couldn’t have been more wrong. This address highlights the importance of data when analysing incidence of disease.
* [Pima Indians](https://www.biointeractive.org/classroom-resources/pima-indians) (duration 2:36), a video from BioInteractive, about how environment has affected the Pima Indian tribe and the incidence of a range of non-infectious diseases in the population. The population is compared with a genetically similar tribe in Mexico.
* [The Eukaryotic Cell Cycle and Cancer](https://www.biointeractive.org/classroom-resources/eukaryotic-cell-cycle-and-cancer) from BioInteractive. This interactive module explores the phases, checkpoints, and protein regulators of the cell cycle. It shows how mutations in genes that encode cell cycle regulators can lead to the development of cancer. An overview and in-depth worksheet are available.
* [The p53 gene and cancer.](https://www.biointeractive.org/classroom-resources/p53-gene-and-cancer) A video, click and learn and worksheet from BioInteractive that describes the structure and function of the p53 protein, how its activity is regulated in cells, and how mutant versions of p53 can lead to cancer.
* [Role of p53 on the cell cycle:](https://www.biointeractive.org/classroom-resources/role-p53-cell-cycle) Follows on from above. An activity interpreting a graph showing the effect of the p53 gene on the rate of mitosis. For more advanced students.
* [Ultraviolet radiation and skin cancer](https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1365-4632.2010.04474.x). An extensive article from Wiley online library for teacher reference explaining how UV radiation causes melanoma, the mutation of the p53 gene and other factors
* [Australian Institute for Health and Welfare](https://www.aihw.gov.au/): Australia’s leading health and welfare statistics agency website has a range data relating to disease incidence, prevalence and mortality.

### IQ 8-3

* [Epidemiology for the uninitiated](https://www.bmj.com/about-bmj/resources-readers/publications/epidemiology-uninitiated) - a short book from the British Medical Journal, is an excellent resource for teachers. In their own words ‘It aims to provide an ABC of the epidemiological approach, its terminology, and its methods.’
* The textbooks written for this syllabus provide clear information regarding epidemiological study design and provide data for investigation for students.

### IQ 8-4

* [Here comes the sun: Defending our summer rays](https://www.smh.com.au/lifestyle/health-and-wellness/here-comes-the-sun-defending-our-summer-rays-20181120-p50h2j.html) - a magazine piece from the Sydney Morning Herald that looks at a range of views about the harm and benefits of being in the sun.

### IQ 8-5

* [Physiology videos](http://www.interactive-biology.com/physiologyvideos/) from Interactive Biology explain the structure and function of the eyes and ears.
* [Parts of the ear](https://academic.udayton.edu/gregelvers/psy323/labels/ear.asp) - interactive where students label parts of the ear
* [Making waves with music](https://www.earscience.org.au/news/making-waves-with-music) - Perth musician Olive, who is also a teacher of children with special needs, has joined with the Ear Science Institute of Australia to produce a hearing loss simulator which provides a simplified version of what hearing loss sounds like.
* [Hearing and How it Works](https://www.medel.com/en-us/about-hearing/how-hearing-works) - video from MED-EL with a clear explanation and graphics
* [Cochlea Implants](https://www.medel.com/hearing-solutions/cochlear-implants) - a video on this MED-EL page explains how the cochlear implant is fitted and works.
* [Ear Science](https://www.earscience.org.au/clinic/about-us/client-stories) has a range of video and print personal stories of hearing implant recipients that students could use to evaluate effectiveness of the technologies.
* [Cow’s Eye Dissection](https://www.exploratorium.edu/learning_studio/cow_eye/coweye.pdf): by Exploratorium has instructions for an eye dissection
* [A simple model of the accommodating lens of the human eye](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4056173/) from Advances in Physiology Education provides instructions for making the model and a discussion of the limitations of the model.
* The [range of accommodation in the eye](https://spark.iop.org/range-accommodation-eye#gref) from the Institute of Physics and the Nuffield Foundation provides a clear procedure for this to be determined in class. A graph of the range of accommodation plotted against age is provided. This can lead into a discussion about spectacles.
* [EyeSmart](https://www.aao.org/eye-health/resources/videos) - American Academy of Ophthalmology has a range of videos including Cataract Surgery and First Gene Therapy Cure for Blindness.
* [The LASIK procedure](https://www.allaboutvision.com/visionsurgery/lasik.htm) is a web page with video from All About Vision showing the steps in laser eye surgery.
* [Kidney Function](https://www.biointeractive.org/classroom-resources/kidney-function) - this video, from BioInteractive, explores how the kidneys filter blood to remove wastes and excess fluid from the body, maintaining a healthy balance of water and salts in the blood.
* [KScience](http://www.kscience.co.uk/animations/anim_1.htm) produces an interactive kidney animation that will be changed from Flash Player to HTML5. It allows students to see how different parts of the kidney work. The level of detail is good, particularly with regard to the Bowman’s capsule, loop of Henle, collecting duct and proximal tubule. The section on the nephron allows students to select different molecules and watch their progress through the nephron.
* [NITV Living Black S22 Ep11 - Inawintji's Story](https://www.sbs.com.au/nitv/video/455158339717/Living-Black-S22-Ep11-Inawintjis-Story) (duration 26:43) Inawintji Williamson is an Anangu woman from the APY lands who suffers from Renal Disease. She has been forced to move from her remote homelands, family and friends to receive dialysis in Adelaide.

## Appendix: Inquiry questions 8-2, 8-3, 8-4

The epidemiological study into neural tube defects is a good example of an epidemiological design and using data to drive a public health program.

Teachers should undertake a guided class discussion of what constitutes good epidemiological design. The textbooks cover this area well and a flipped classroom model would suit this type of discussion.

Neural tube defects (NTDs) are a group of major congenital anomalies (disorders present from birth), that result from very early disruption in the development of the brain and spinal cord. These conditions are often incompatible with life. Survivors frequently require intensive, costly, lifelong health and social care. A video or images of children with neural tube defects could be shown here.

Provide students with the following information:

In 1991 it was reported in The Lancet (a British Medical Journal):

A trial was conducted at 33 centres in seven countries to determine whether supplementation with folic acid (Vitamin B9) or a mixture of seven other vitamins (A, D, B1, B2, B6, C and nicotinamide) around the time of conception can prevent neural tube defects. A total of 1817 women at high risk of having a pregnancy with a neural tube defect, because of a previous affected pregnancy, were allocated at random to one of four groups--namely, folic acid, other vitamins, both, or neither. This was a double-blind study – neither the doctor nor the patient knew which group they were allocated to. Antenatal diagnosis of neural tube defects was available at all centres in the study. The outcome of every pregnancy was recorded.

Prevention of neural tube defects, Results of Medical Research Council Vitamin Study, The Lancet. Vol 338, July 20, 1990.

Students then evaluate the method used in the epidemiological study.

The method is valid because:

* it tests what is designed to be tested by comparing supplementation with folic acid with a vitamin mixture, both folic acid and the mixture and having a control group
* neither the doctor nor patient knew which group the patient was assigned so that they will not have consistent expectations and behaviours
* the study was conducted in 33 centres in 7 countries so that any effect of race or socio- economic standing was removed
* the women were allocated randomly to each group so there was no bias in the groups
* the women all had a history of NTDs so would be considered as being of high risk
* a large number of women were included in the trial so that the effect of individual difference due to genetics, lifestyle is significantly reduced.

As a result of the study it was found that the supplementation with folic acid had a significant effect on reducing the incidence of neural tube defects. Voluntary fortification of foods with folic acid has been permitted in Australia since 1995. These measures resulted in a very modest increase in folic acid consumption overall by women of childbearing age.

Students graph the following data: Data has been collected by the Australian Government Institute of Health and Welfare showing the prevalence of neural tube defects in New South Wales, Victoria, Western Australia and South Australia

Estimated total prevalence (per ten thousand births) of NTD, 1992-2009

|  |  |  |
| --- | --- | --- |
| Year | NSW, Vic, WA and SA | Vic, WA and SA |
| 1992 | 15.0 | 18.0 |
| 1993 | 14.4 | 17.1 |
| 1994 | 14.2 | 19.3 |
| 1995 | 15.5 | 21.3 |
| 1996 | 13.2 | 17.6 |
| 1997 | 13.3 | 19.3 |
| 1998 | 11.3 | 13.3 |
| 1999 | 11.8 | 14.3 |
| 2000 | 11.4 | 14.4 |
| 2001 | 10.7 | 13.4 |
| 2002 | 9.9 | 12.5 |
| 2003 | 9.7 | 11.9 |
| 2004 | 10.7 | 14.1 |
| 2005 | 10.1 | 13.3 |
| 2006 | 10.1 | 12.7 |
| 2007 | 10.1 | 12.1 |
| 2008 | 9.2 | 10.7 |

[Neural Tube Defects in Australia: An epidemiological report](https://www.aihw.gov.au/getmedia/e1be38c8-a3bb-4284-9b55-59ee47c7d31e/ntdia.pdf.aspx?inline=true)

Students to discuss the trends shown in the graph:

* There has been a downward trend in the incidence of NTDs from 1995 to 2009
* The incidence per thousand births is higher when the NSW data is excluded.

Students to justify why, in 2009, folic acid fortification of wheat flour for bread making became mandatory in Australia

* The decreasing incidence indicates that adding folic acid reduces the incidence of NTDs.
* From the difference in the two data sets it could be hypothesised that women in large metropolitan centres are better informed and/or have access to more fortified foods. Therefore, by making it mandatory to fortify food with folic acid, all women will have access to fortified foods.

Folic acid supplementation, while significantly reducing the risk of NTD’, does not completely prevent their occurrence. These videos discuss the treatment and further research into NTDs. [ABC Australian story - the hardest choice](https://www.abc.net.au/austory/the-hardest-choice/8263938) (duration 30:00) follows a couple over the course of their journey with neural tube defects. It is a moving story with a positive ending about treatment (in utero surgical intervention) for spina bifida. [ABC Australian story – Baby steps](https://www.abc.net.au/austory/baby-steps/9720326) (duration 29:17) reports on the progress of their baby.

It has now proposed that folic acid supplementation around the time of conception can prevent up to 70 percent of neural tube defects. [Spina Bifida and Neural Tube Defects](https://childrensnational.org/research-and-education/center-for-neuroscience-research/research-areas/spina-bifida-and-neural-tube-defects) (duration 2:57) from the Children’s Research Institute looks at research into additional strategies needed to further reduce their incidence.