Infectious disease and agriculture.

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### Overview

**Stage and Learning Area: Stage 6 Biology**

**Description: This resource has been designed to address the following syllabus reference in Module 7:** Assess the causes and effects of diseases on agricultural production, including but not limited to plant and animal diseases.

**This learning sequence builds understanding of the pathogens that cause plant and animal diseases, leading students to assess the impact of these diseases on agricultural practices.**

**Timing:** While timing will vary based on the mode of delivery, differentiation strategies employed and class or school context, this series of activities should take approximately 3 x 50-minute lessons.

# 

# Information for teachers

### Introduction

Australia is a unique landscape. Due to its isolation from other parts of the world Australia is relatively free of many plant and animal pathogens. However, Australia also relies heavily on agriculture for social and economic reasons. This can create conditions where various plant and animal diseases may persist and thrive.

Throughout this activity students will develop an understanding of the importance of agriculture in Australia to accurately assess the impact of plant and animal pathogens on Australia’s agricultural industry. Students will also understand management techniques that can reduce the impact of agricultural diseases.

This learning sequence is designed to build skills gradually throughout the task. Teachers may wish to modify the task or focus on specific sections based on their class context, student ability and current mastery of content.

This content also links with other sections of the Stage 6 course including:

* Module 5: mechanisms of reproduction in plants, bacteria, fungi and protozoans.
* Module 6: biodiversity
* Module 7: types of pathogens and modes of transmission.
* Module 7: strategies for managing, treating, and preventing infectious diseases.

### Outcomes

* **BIO12-3**: develops and evaluates questions and hypotheses for scientific investigation
* **BIO12-5**: analyses and evaluates primary and secondary data and information
* **BIO12-6**: solves scientific problems using primary and secondary data, critical thinking skills and scientific processes.
* **BIO12-7**: communicates scientific understanding using suitable language and terminology for a specific audience or purpose.
* **BIO12-14**: analyses infectious disease in terms of cause, transmission, management and the organism's response, including the human immune system

Outcomes referred to in this document are from Biology Stage 6 Syllabus © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2017.

### Learning Intentions and Success Criteria

**Learning Intention**: make informed judgements on the impacts of infectious disease.

**Success Criteria**:

* Define the term agriculture and describe the importance of agriculture in Australia.
* Identify reasons for Australia’s relatively disease-free status of agricultural pathogens.
* Identify and describe a disease caused by a plant pathogen and assess its impact on agriculture.
* Identify and describe a disease caused by an animal pathogen and assess its impact on agriculture.
* Extract information relating to the causes, effects and impacts of agricultural diseases from primary and secondary sources.
* Apply knowledge of agricultural infectious diseases and management strategies to assess the impact of various plant and animal diseases on agriculture.

**Differentiation consideration**: Learning Intentions should not be differentiated. All students need access to the same core content, big ideas and concepts. Differentiation should be evident in the success criteria, or the activities/support needed to achieve the success criteria. (Wiliam and Leahy, 2015). Teachers may co-construct the Success Criteria with students or adjust them to suit their class context, for example using the differentiation adjustment tools suggested in the differentiation section below.

### Teaching and Learning activities

##### Part 1: Introduction

Begin the lesson by outlining the Learning Intention and Success Criteria for the lesson sequence.

Students engage in a ‘[Think-pair-share’](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Browser?cache_id=1d29b) to discuss what is meant by the term ‘agriculture’ to elicit evidence of prior knowledge. Aboriginal agriculture and practices should also be discussed to highlight the importance of agriculture in Australia. [Food and fibre production - An Aboriginal Perspective](https://www.nswdpi-schools-program.com/_files/ugd/af7c66_de601df62abf457d819414c389e7b5d1.pdf?index=true) from the Department of Primary Industries provides relevant reference material to support class discussion.

Following the activity, students record a definition for the term ‘agriculture’ and engage in a class discussion on the different agricultural industries in their local area and Australia more broadly.

##### Part 2: Panama Disease

Watch the following videos on Panama disease. Students should be encouraged to make their own notes throughout the videos. Following each video, use questioning techniques to check for understanding. This may be delivered as a worksheet, online (Google Doc, Google Forms, Word or school-based LMS) or as a teacher-led discussion.

**Differentiation consideration**: Giving students a choice as to how to demonstrate their thinking and synthesis of the ideas in the videos supports the specific learning needs of high potential and gifted students. A variety of digital learning tools to support ‘choice’ can be found using the [HPGE Differentiation adjustment tool](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/implement/differentiation-adjustment-strategies#Adjustment:6).

**Video 1**: [‘Bananas as we know them are doomed’](https://www.youtube.com/watch?v=2Bm5NWCMlPo)

1. Why are the bananas considered to be clones?

Sample response: The Cavendish is sterile (does not produce seeds) so all bananas are grown from replanting identical offshoots.

1. What are the benefits and risks of a monoculture?

Sample response: Scale, speed and profits can be maximised as it is easier to manage the whole plantation, but the plants are all susceptible to the same diseases, for example TR4 – a strain of Panama disease.

1. Describe the impact of Panama disease in the Philippines.

Sample response: Kills bananas, makes it impossible to grow bananas in that place again, 90% of exported fruit in the Philippines is Bananas so it is having a large impact on the economy. Loss of money for the farmers and loss of work/jobs.

1. Describe strategies being used to ensure the future of the banana.

Sample response: Selective breeding to find a marketable breed of banana that is tolerant or resistant to Panama disease.

Students then use the information gained throughout the video to:

1. Predict: What impact do you think Panama disease would have in Australia?

**Video 2**: ‘Keeping bananas on the table: [The impact of Panama disease to QLD’](https://www.youtube.com/watch?v=kzoBO95gQYQ&t=1s)

1. Describe the biosecurity measures in place to prevent disease transmission.

Sample response: Foot washes, no entry in rainy weather, fencing all farms, quarantine

1. Identify the economic cost of the biosecurity measures to the farmer.

Sample response: $700000

1. Outline how Panama disease could affect the Australian economy.

Sample response: Affect the cost of production which may make the properties commercially unviable. Cost to the consumer will go up.

1. How are scientists trying to solve the problem?

Sample response: Selective breeding, planting tolerant varieties.

Students return to their predictions made following the first video to assess their accuracy.

Following questioning and before moving on to the next task, time should be allocated to clarify any misconceptions and ensure that students have a clear understanding of:

* The difference between the cause and effects of a disease.
* How diseases can impact on agricultural practices and economies.
* Prevention, treatment, and management strategies to reduce transmission of agricultural diseases.
* Reasons for Australia’s relatively disease-free status, especially its isolation and biosecurity measures. Use student understanding from the Covid-19 Pandemic to link the importance of these practices to agricultural pests and diseases.

##### Part 3: Assessment for learning.

This teacher-led demonstration should be completed on a whiteboard or digital platform. Explicit teaching of the process used to unpack an assessment question will allow students to develop their examination technique and become more independent learners.

Explicit teaching practices involve teachers clearly showing students what to do and how to do it, rather than having students discover that information themselves. Students who experience explicit teaching practices make greater learning gains than students who do not experience these practices.

[CESE What works best update 2020](https://education.nsw.gov.au/about-us/education-data-and-research/cese/publications/research-reports/what-works-best-2020-update)

**Practice question**: **Assess the impact of sexual and asexual reproduction on the biodiversity of the Cavendish banana population.**

**Step 1**: Unpack the question and verb with students. For example:

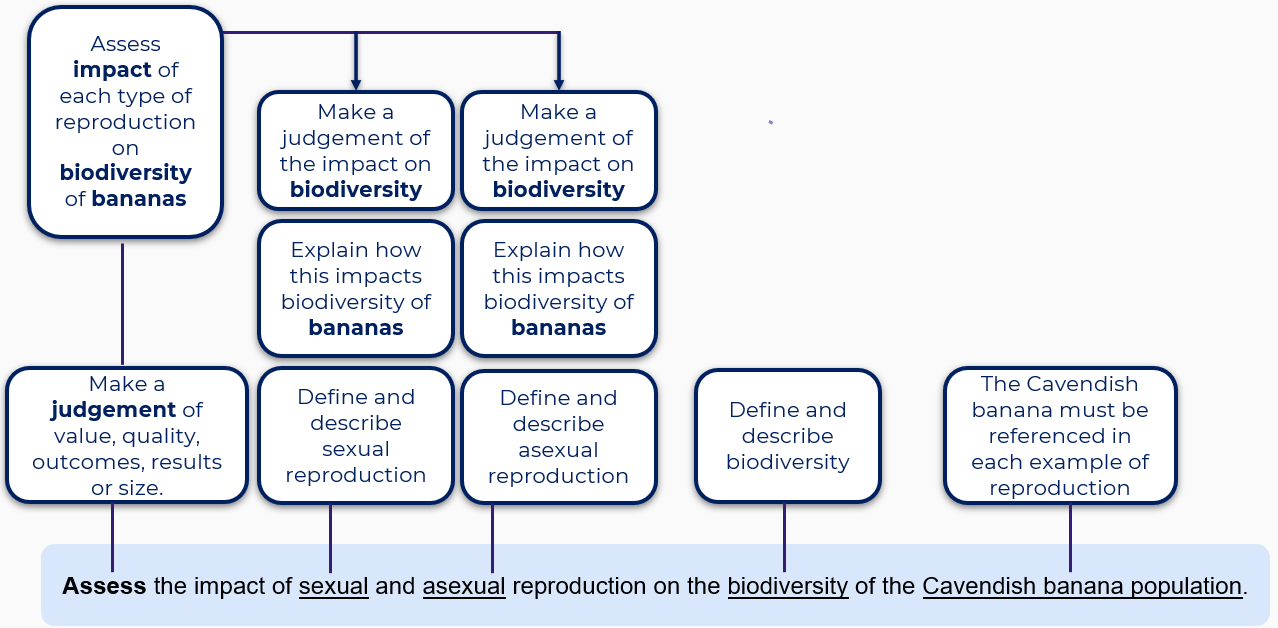


Figure 1: Unpacking an examination style question. (Image created by the author)

**Step 2**: Plan a response. Using the cues from Step 1, draft a plan for constructing an answer to the question. For example:

Figure 2: Structuring a long response. (Image created by the author)

**Step 3**: Co-construct a response to the question with students. Pre-prepared sentence stems could be provided to assist with this step if needed.

**Step 4**: Conduct a class discussion using the following marking criteria to highlight the critical components of the response.

|  |  |
| --- | --- |
| Mark | Description |
| 4 | * Demonstrates a thorough understanding of biodiversity, asexual and sexual reproduction * Clearly explains how each type of reproduction increases or decreases variation in Cavendish bananas. * Makes a judgement on the level of impact on the biodiversity of each type of reproduction |
| 3 | * Demonstrates a sound understanding of biodiversity, asexual and sexual reproduction * Explains how each type of reproduction increases or decreases variation in bananas. * Makes a judgement on the level of impact on biodiversity |
| 2 | * Demonstrates a sound understanding of biodiversity or asexual and sexual reproduction. * Identifies how each type of reproduction increases or decreases variation in Cavendish bananas. |
| 1 | * Includes some relevant information |

##### Part 4: Causes and effects of agricultural diseases

Students use their notes from the videos and other secondary sources to construct a table on agricultural diseases. Their table should include:

* Panama disease.
* A plant example of their choosing. Suggested examples include Citrus Canker, Black Spot or Bacterial Blight.
* Newcastle disease in chickens.
* An animal example of their choosing. Suggested examples include Foot and Mouth Disease, Rabies or Anthrax.

Students construct a table with the following headings:

* Disease name.
* Cause (name and type of pathogen).
* Effect of the disease on the plant/animal.
* Effect of the disease on agricultural practices.
* Management strategies.

[Peer feedback](https://www.aitsl.edu.au/docs/default-source/feedback/aitsl-peer-feedback-stratedy.pdf?sfvrsn=372dec3c_2) can be used following the completion of the table to ensure students have included all relevant information. Peer feedback can be supported by [online tools](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Browser?cache_id=1d29b) or paper-based strategies using “Post Its’ for strategies like ‘2 stars and a wish’ to provide feedback.

**Differentiation consideration**: EAL/D students or students with additional needs may require support to access secondary sources used for the research aspects of this task. The teacher may wish to provide a list of suitable websites to the students.

Some students may find it difficult to construct the table without teacher assistance. The sample table in the student materials section below can be used as a guide. Students may also benefit from completing the first row of the table with teacher guidance.

Opportunities to extend student thinking may include assessing the reliability, validity and accuracy of the secondary sources used in their research. Students could also be asked to compare and contrast the causes and effects of animal and plant diseases.

##### Part 5 – Assessment of learning question

Students are presented with a question to assess learning that can be printed or posted to a Learning Management System. This can be found in the student materials section below.

After completing the examination style questions, students are provided with the marking guidelines to reflect on, and if necessary, improve their work. Teacher feedback may also benefit students at this point in the learning sequence.

Exemplar responses have also been included in this resource to demonstrate ‘What a good one looks like’.

High expectations, explicit teaching strategies, formative assessment, and well-structured and sequenced learning experiences are just as important for gifted students as they are for all learners.

[Revisiting Gifted education](https://education.nsw.gov.au/about-us/education-data-and-research/cese/publications/literature-reviews/revisiting-gifted-education) CESE

##### Part 6 – Reflection

Refer students to the Success Criteria for this lesson sequence and have students reflect on their achievement. Further support, targeted teacher feedback or explicit instruction may be needed if students have not met any of the Success Criteria for the lesson sequence.

**Enrichment opportunity**: Utilise local opportunities to expand on the concepts covered, for example, working with the agriculture teacher if your school has an agricultural plot, visiting local farms to discuss disease management and the impact of disease on specific industries or contacting your local DPI office for information relevant to your area. The [DPI webinar](https://www.youtube.com/watch?v=325wliQ1aLI&list=PL4zlvcUKKUmViy1yl-4bdcerUW5Y-RTUo) on Fall armyworm also provides a current example of a pest in NSW and addresses the cause, effects and management strategies used to manage this pest.

### Student materials

#### Part 4 - Sample table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Disease | Pathogen | Effect of the disease on the plant/animal | Effect of the disease on agriculture | Management strategies |
| Panama disease |  |  |  |  |
| Plant example – student choice |  |  |  |  |
| Newcastle disease |  |  |  |  |
| Animal example – student choice |  |  |  |  |

#### Examination style question

Public health campaigns are a form of marketing designed to educate the public on important health campaigns. For example, the public health campaign for Covid-19 involved advertisements in the media and social media, posters, QR check ins and notifications.

Public health campaigns are also used to monitor and prevent diseases in agriculture. Use the social media post below to answer the following questions.

**Biosecurity Alert!**

There has been an outbreak of Anthrax at a farm in Orange. Anthrax is a highly infectious bacterial disease caused by the bacteria *Bacillus anthracis*. It can be fatal to livestock and spores can remain dormant in the soil for decades.

Stock infected usually die suddenly without notice. Just prior to death there may be signs of high fever, loss on interest in food or blood around the nose and mouth.

Anthrax is a notifiable disease and any suspected or confirmed cases must be reported immediately.

It is strongly encouraged that all farms in the area vaccinate their livestock immediately. Vaccines are highly effective in preventing transmission and loss of livestock.

* 1. Explain the benefits of Public Health campaigns, including social media, in agricultural disease management. (4 marks)
  2. Assess the social and economic impact of an outbreak of Anthrax on several farms in Orange. (6 marks)

### Marking guidelines and sample answers

##### Marking guidelines Part 5a

|  |  |
| --- | --- |
| Mark | Description |
| 4 | * Explains two benefits of public health campaigns. * Links the benefits of the health campaign provided to the stimulus material. |
| 3 | * Outlines 2 benefits of public health campaigns. * Weakly links the benefits of the health campaign provided to the stimulus material. |
| 2 | * Outlines a benefit of public health campaigns. |
| 1 | * Some relevant information provided. |

Sample response Part 5a

Public health campaigns control and prevent disease. In addition, public health campaigns are used to educate the public about strategies that can be used to assist surveillance, management and prevention of disease – in this case, Anthrax.

Informing farmers that Anthrax spores have been found in particular areas can alter behaviours, for example increasing vigilance which leads to farmers watching for possible infections and warning signs and reporting cases. This allows for early detection which can reduce the spread of the disease.

Increased biosecurity measures and management strategies, for example vaccination, can also play a significant role in reducing transmission and therefore reduce the likelihood of an Anthrax outbreak in Australia. Awareness of the importance of vaccination is likely to increase vaccination rates, which will reduce transmission and outbreaks of Anthrax.

The economic value of preventative measures is also a significant benefit of public health campaigns as it is much cheaper to prevent than treat and manage outbreaks. Social media is a particularly powerful tool as it can be used to target specific groups, for example farmers, and can reach many people to ensure that key public health measures are widely distributed, increasing the effectiveness of a public health campaign.

##### Marking guidelines Part 5b

|  |  |
| --- | --- |
| Mark | Description |
| 6 | * Economic and social factors are defined and described. * Influence of each factor assessed, with clear links to the stimulus material. |
| 5 | * Economic and social factors described. * Influence of each factor assessed with clear links to the stimulus material. |
| 4 | * Economic and social factors described. * Influence of each factor assessed. |
| 3 | * Economic or social factors described. * Influence of a factor outlined. |
| 2 | * Economic or social factors described. |
| 1 | * Some relevant information was provided. |

##### **Sample response Part 5b**

Anthrax is a serious bacterial disease that can be fatal to livestock. Therefore, an outbreak of Anthrax in Orange would be devastating, with significant social impacts such as loss of food supplies, increased hygiene and biosecurity measures and job availability and economic impacts at the farm, state, and potentially national level.

Social impacts affect the physical and social setting in which we live. An outbreak in Orange NSW would significantly impact a variety of social aspects. Food supplies may be affected, as any animals believed to be exposed would have to be destroyed. Farms will need to be quarantined limiting the movement of people and livestock throughout NSW. Employment opportunities may also decrease and the health and wellbeing of farmers and towns local to the outbreak would be affected.

Economic impacts are financial impacts. An outbreak of Anthrax in NSW will have financial impacts at the local, state and national level. Any livestock potentially exposed to Anthrax would be destroyed at a significant financial loss for farmers. A reduction in available livestock would affect the price for consumers with fewer products available for purchase. Increased quarantine and biosecurity measures come at a high cost to the farmer, and potentially the state, as measures are put in place to manage the spread of the disease. A large-scale outbreak could also affect our export market, which would significantly affect Australia’s economy.

Overall, any Anthrax outbreak in NSW would have significant and long-lasting social and economic impacts on agriculture in Australia.

# Additional Information

### Assessment for learning

Possible assessment for learning activities for this learning sequence include:

* Learning Intentions and Success Criteria assist educators to articulate the purpose of a learning task to make judgements about the quality of student learning. These help students focus on the task or activity taking place and what they are learning and also provide a framework for reflection and feedback. [Online tools](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/622#.YO5faIXvmek.link) can assist implementation and a reflection activity on the Learning Intentions and Success Criteria has been included in this task.
* Eliciting evidence strategies allow teachers to determine the next steps in learning and assist teachers in evaluating the impact of teaching and learning activities. All sections of this learning sequence allow teachers to collect evidence of student learning to inform the progression through the lesson sequence, with appropriate pause points to check for understanding. The lesson sequence can be adjusted based on formative data collected.
* Feedback is designed to close the gap between current and desired performance by informing teacher and student behaviour (AITSL). AITSL provides a [factsheet](https://www.aitsl.edu.au/docs/default-source/feedback/aitsl-feedback-factsheet.pdf?sfvrsn=2b2dec3c_4) to support evidence-based feedback and teachers can provide individual feedback verbally throughout the task and may choose to provide individual written feedback in Part 5.
* [Peer feedback](https://www.aitsl.edu.au/docs/default-source/feedback/aitsl-peer-feedback-stratedy.pdf?sfvrsn=372dec3c_2) is a structured process where students evaluate the work of their peers by providing valuable feedback in relation to learning intentions and success criteria. It can be supported by [online tools](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Browser?cache_id=1d29b). Peer feedback opportunities are embedded throughout this lesson sequence, particularly in Part 4.
* Self-regulated learning opportunities assist students in taking ownership of their own learning. Therefore, opportunities for self-regulation are embedded throughout this lesson sequence, particularly in Parts 1 and 5.

1. Feedback is one of the most powerful influences on student achievement. Feedback that focuses on improving tasks, processes and student self-regulation is the most effective. Giving feedback can take many forms including formal, informal, formative, summative, interactive, demonstrable, visual, written, verbal and non-verbal.
2. [CESE What works best 2020 Update](https://education.nsw.gov.au/about-us/education-data-and-research/cese/publications/research-reports/what-works-best-2020-update)

### Differentiation

Differentiated learning can be enabled by differentiating the teaching approach to content, process, product and the learning environment. For more information on differentiation go to [Differentiating learning (nsw.gov.au)](https://education.nsw.gov.au/teaching-and-learning/professional-learning/teacher-quality-and-accreditation/strong-start-great-teachers/refining-practice/differentiating-learning) and [Differentiation (nsw.gov.au)](https://education.nsw.gov.au/campaigns/inclusive-practice-hub/primary-school/teaching-strategies/differentiation).

When using these resources in the classroom, it is important for teachers to consider the needs of all students in their class, including:

* **Aboriginal and Torres Strait Islander students.** Targeted [strategies](https://education.nsw.gov.au/teaching-and-learning/aec/aboriginal-education-in-nsw-public-schools) can be used to achieve outcomes for Aboriginal students in K-12 and increase knowledge and understanding of Aboriginal histories and culture. Teachers should utilise students’ Personalised Learning Pathways to support individual student needs and goals.
* **EAL/D learners**. EAL/D learners will require explicit English language support and scaffolding, informed by the [EAL/D enhanced teaching and learning cycle](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/resources-for-schools/eald/enhanced-teaching-and-learning-cycle) and the student’s phase on the [EAL/D Learning Progression](https://education.nsw.gov.au/teaching-and-learning/curriculum/multicultural-education/english-as-an-additional-language-or-dialect/planning-eald-support/english-language-proficiency). In addition, teachers can access information about [supporting EAL/D learners](https://education.nsw.gov.au/teaching-and-learning/curriculum/multicultural-education/english-as-an-additional-language-or-dialect/planning-eald-support/english-language-proficiency) and [literacy and numeracy support specific to EAL/D learners](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/resources-for-schools/eald/enhanced-teaching-and-learning-cycle).
* **Students with additional learning needs**. Learning adjustments enable students with disability and additional learning and support needs to access syllabus outcomes and content on the same basis as their peers. Teachers can use a range of [adjustments](https://education.nsw.gov.au/teaching-and-learning/disability-learning-and-support/personalised-support-for-learning/adjustments-to-teaching-and-learning) to ensure a personalised approach to student learning. In addition, the [Universal Design for Learning Tool](https://education.nsw.gov.au/teaching-and-learning/learning-from-home/teaching-at-home/teaching-and-learning-resources/universal-design-for-learning) can be used to support the diverse learning needs of students using inclusive teaching and learning strategies and subject specific curriculum considerations can be found on the [Inclusive Practice Hub](https://education.nsw.gov.au/campaigns/inclusive-practice-hub).
* **High potential and gifted learners**. [Assessing and identifying high potential and gifted learners](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/assess-and-identify#Assessment1) will help teachers decide which students may benefit from extension and additional challenge. [Effective strategies and contributors to achievement](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/evaluate) for high potential and gifted learners helps teachers to identify and target areas for growth and improvement. In addition, the [Differentiation adjustment tool](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/implement/differentiation-adjustment-strategies) can be used to support the specific learning needs of high potential and gifted students. The [High Potential and Gifted Education Professional Learning and Resource Hub](https://schoolsnsw.sharepoint.com/sites/HPGEHub/SitePages/Home.aspx) supports school leaders and teachers to effectively implement the High Potential and Gifted Education Policy in their unique contexts.

1. All students need to be challenged and engaged to develop their potential fully.
2. [CESE What works best 2020 Update](https://education.nsw.gov.au/about-us/education-data-and-research/cese/publications/research-reports/what-works-best-2020-update)

### Support and Alignment

**Resource evaluation and support**: All curriculum resources are prepared through a rigorous process. Resources are periodically reviewed as part of our ongoing evaluation plan to ensure currency, relevance and effectiveness. For additional support or advice contact the Science Curriculum team by emailing [Science7-12@det.nsw.edu.au](mailto:Science7-12@det.nsw.edu.au)

**Alignment to system priorities and/or needs**: [School excellence policy](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468), [School Success Model](https://education.nsw.gov.au/content/dam/main-education/en/home/public-schools/school-success-model/The-School-Success-Model.pdf)

**Alignment to the School Excellence Framework**: This resource supports the [School Excellence Framework](https://education.nsw.gov.au/about-us/strategies-and-reports/school-excellence-and-accountability/school-excellence/about-sef) elements of curriculum (curriculum provision) and effective classroom practice (lesson planning, explicit teaching).

**Alignment to Australian Professional Teaching Standards**: This resource supports teachers to address [Australian Professional Teaching Standards](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher) 3.2.2, 3.3.2.

**Consulted with: Curriculum and Reform, Inclusive Education, Multicultural Education, Aboriginal Outcomes and Partnerships and Subject Matter Experts.**

**NSW Syllabus:** NESA Biology Stage 6 Syllabus (2017)

**Syllabus outcomes:** BIO12-3, BIO12-5, 12BIO-6, 12BIO-7 and 12BIO-14

**Author:** State of NSW, Department of Education

**Publisher**: State of NSW, Department of Education

**Resource:** Classroom resource

**Related resources:** further resources to support Stage 6 Biology can be found on the [HSC Hub](https://www.hschub.nsw.edu.au/science/science) and the [Science K-12 Curriculum Page.](https://education.nsw.gov.au/teaching-and-learning/curriculum/science)

**Professional Learning:** Professional Learning is available on the Science [statewide staffroom](https://education.nsw.gov.au/teaching-and-learning/curriculum/statewide-staffrooms) and through the [HSC Professional Learning](https://education.nsw.gov.au/teaching-and-learning/professional-learning/hsc-pl) strategy.

**Creation date:** 21/12/21

**Updated:** 10/01/24

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