# Biology Stage 6 – learning sequence –the Black Death: using claim-evidence-reasoning

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## Overview

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

**Description**: this resource has been designed to build skills in analysing new and unfamiliar information using concepts from Modules 5, 7 and 8.

**Duration**: 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 120 minutes of class time.

## Information for teachers

### Introduction

Frequently in examinations, students are required to either:

* assess a presented claim or statement, or
* make a claim and justify that claim.

The stimulus material provided often:

* covers new and unfamiliar situations
* draws from concepts developed in different modules.

Students need to use the evidence provided in the stimulus, together with their own understanding of concepts, to assess or justify the claim.

In this class activity, students review the investigation into the origins of the Black Death using the claim-evidence-reasoning (CER) scaffold. They then investigate a claim relating to a non-infectious disease and apply the CER scaffold to assess the claim. A list of claims students could choose from is provided or students could, with teacher approval, investigate a claim of their choosing.

Lengthy responses are not required. This task is designed to develop students’ skills in constructing succinct and well-structured answers that could be completed in the limited time available in an examination setting.

### Outcomes

A student:

* **conducts investigations to collect valid and reliable primary and secondary data and information BIO11/12-3**
* **solves scientific problems using primary and secondary data, critical thinking skills and scientific processes BIO11/12-6**
* **communicates scientific understanding using suitable language and terminology for a specific audience or purpose BIO11/12-7**
* analyses infectious disease in terms of cause, transmission, management and the organism’s response, including the human immune system **BIO12-14**

[Biology Stage 6 Syllabus](https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/stage-6-learning-areas/stage-6-science/biology-2017) © 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

Students:

* write a succinct, evidence-based assessment of a claim.

Students can:

* identify evidence that is significant in assessing a claim
* explain how and/or why the evidence supports or does not support the claim
* explain the role of DNA testing in identifying the origins of the Black Death.

**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 strategies and resources for curriculum planning on the [Planning, programming and assessing 7–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage.

## Teaching and learning activities

### Activity 1

Introduce this activity by asking students if they are aware of other pandemics prior to the Coronavirus pandemic. Explain that the video [What Was The Black Death? (4:56)](https://www.youtube.com/watch?v=y7OWLohZ_fs) provides some information about the Black Death (Bubonic Plague) that killed one-third of the European population between 1347 and 1350. Warn the students that there are some confronting images in the video.

### Activity 2

Provide students with the [COSMOS article](https://cosmosmagazine.com/history/origins-of-the-black-death-revealed) to answer the question, ‘Where did the Black Death originally come from?’

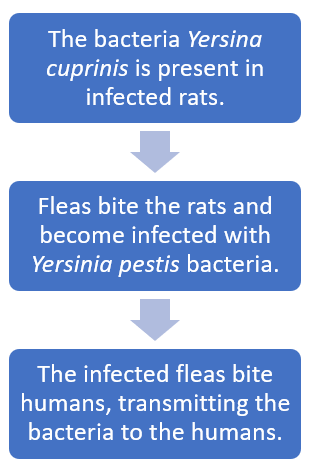
Discuss any terms your students are unfamiliar with.

Students answer the following introductory questions to understand the cause and transmission of the Black Death. Additionally, they process and analyse data to solve a problem.

1. Draw a flow chart to show why the Black Death is a zoonotic disease.

**Sample answer:**

Figure 1 – flow chart demonstrating why the Black Death is a zoonotic disease



Project the map [Spread of the Black Death](https://commons.wikimedia.org/wiki/File:1346-1353_spread_of_the_Black_Death_in_Europe_map.svg) from the above article (or provide this clearer copy to students).

Figure 2 – the spread of the Black Death in Europe from 1346 to 1353



‘[spread of the Black Death in Europe map](https://commons.wikimedia.org/wiki/File:1346-1353_spread_of_the_Black_Death_in_Europe_map.svg)’ by [Flappiefh](https://commons.wikimedia.org/wiki/User:Flappiefh) is licensed under [CC BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/deed.en).

1. How does the germ theory of disease and our current knowledge of the Black Death’s transmission explain the disease’s spread demonstrated in the map?

**Sample answer:** The map and timeline indicate that the Black Death originated in the olive green areas in 1346 and spread to the light green regions the following year. These are all countries that traded by land or sea routes with the areas of origin. The germ theory states that germs (microbes) cause infectious disease and all microbes come from pre-existing microbes. According to this, bacteria-infected rats and fleas would have been present in traded goods and thus, spread the disease to countries trading with the area where the disease first appeared. Over the following years, the disease spread as goods and infected rats travelled further across the sea and inland from the port cities, so by 1352, most of Europe was infected.

Where there is a border prohibiting the trading of goods (black dotted line on the map), there was no passage of the infection. This supports the hypothesis that the spread of the Black Death correlates with the movement of people and goods through trade. Furthermore, the trading activities also spread the disease by vectors, such as rats and fleas.

These facts provide an explanation for the spread of the pathogen, disease vectors and the disease in Europe, Asia and North Africa.

### Activity 3

Explain to the students that many examination questions require them to assess or justify a claim using:

* their understanding of biological concepts, and
* the evidence provided in the stimulus material (often about an example they will not have studied).

**Differentiation consideration**: depending on how confident your students are with the –claim-evidence-reasoning scaffold:

commence with Part A if your students need significant support and then move to Part B, or

proceed straight to Part B if your students are confident with CER scaffold.

#### Part A

Perfetto I (16 June 2022) ‘[Where did the Black Death originally come from?](https://cosmosmagazine.com/history/origins-of-the-black-death-revealed)’, *Cosmos*.

Discuss the purpose and structure of the article with students. The scientists:

* report on a research question they investigated
* provide evidence they gathered
* explain (using reasoning) how that evidence supports a conclusion (or claim) they are making.

Students highlight, in different colours, the parts of the article that are:

1. Claim: What claim or hypothesis are the researchers making?
2. Evidence: What evidence do the researchers use to support their claim?
3. Reasoning: How does the evidence support the claim?

Discuss with students that not all parts of the article will fit into CER scaffold. The context is set and additional information is provided. A suggested answer is provided on pages 11 to 13.

#### Part B

Provide students with following task:

‘Determining the origin of the Black Death has only been possible because of DNA testing.’

Critically evaluate **this** claim.

Students are to use the claim-evidence-reasoning scaffold provided to help structure their answer.

Table 1 – claim-evidence-reasoning scaffold

|  |  |  |
| --- | --- | --- |
| 1. Claim | 2. Evidence | 3. Reasoning |
| State an answer to the question/prompt. | Provide reliable information from experiments, facts or a reliable source that supports the claim. | Explain how the evidence supports the claim. |
| Helpful hints:  Use key words and ideas from your question as you write your claim. | **Suggested sentence starters**:  In the experiment…  The data shows…  According to the graph…  One example from the experiment is …  One piece of evidence is… | **Suggested sentence starters**:  Based on this evidence, it can be concluded that … because …  The evidence is significant because...  The evidence supports the claim because… |

**Sample answer:** Black Death is a zoonotic disease caused by the bacteria Yersinia pestis. The bacteria exists in wild rats. Rat fleas, which live on the rats, bite the rats, thereby taking in the bacteria. Subsequently, the fleas bite humans, transmitting the bacteria to them. The Black Death first appeared in sailors travelling across the Mediterranean Sea and in the surrounding sea ports in 1347. At that time, the cause and source of the disease was unknown.

With the development of the germ theory of disease, it was determined what the cause and mode of transmission of the Black Death was. However, not being able to accurately identify the strains of the bacteria meant that identifying the geographic location of the earliest infections was not possible.

Scientists investigating the tombstones of many individuals in a local trading community, close to Lake Issyk-Kul in the Chüy Valley of modern-day Kyrgyzstan, discovered they had died in an epidemic in 1338 and 1339. The villagers’ tombstones stated they died from ‘pestilence’. DNA analysis of 3 of these individuals identified Yersinia pestis DNA. This would indicate that the villagers died from the Black Death and they died 9 years earlier than the sailors’ deaths (in 1347).

This DNA evidence, together with the trade route information provided, would indicate that the Chüy Valley bacteria were the source of the pandemic. Additionally, DNA analysis of this and many other strains of Yersinia pestis shows that the Chüy Valley DNA contains the genome from which all other strains have diversified. This supports the statement that determining the origin of the Black Death has only been possible because of DNA testing.

### Activity 4

Students select a claim from the following list. They then undertake some research to find evidence that supports or refutes the claim. Next, they write a one-page report assessing their chosen claim using the collected evidence, making sure they explain how or why the evidence does or does not support the claim.

Examples of claims:

* Vaping is less dangerous than smoking.
* Non-infectious diseases are a bigger problem in developed countries than developing countries.
* Australian children should stay out of the sun.
* Pregnant women should take folate supplements.
* One glass of red wine per day is good for you.
* The measles vaccine causes autism.
* Coffee increases cancer risk.
* The cutting of stone kitchen bench tops is a health risk.

You could allow students to asses a claim of their own choosing.

#### Assessment for learning

##### Activity 4 marking guidelines

Table 2 – activity 4 assessment marking criteria

|  |  |
| --- | --- |
| Marks | Description |
| 5 | Provides a comprehensive analysis of significant scientific evidence that supports or refutes the claim  Clearly explains how each piece of evidence supports or refutes the claim |
| 4 | Provides a sound analysis of some scientific evidence that supports or refutes the claim  Describes how each piece of evidence supports or refutes the claim |
| 3 | Interprets some evidence that supports or refutes the claim  Demonstrates some understanding of the relationship between the evidence and the claim |
| 2 | Provides some evidence that supports or refutes the claim  Makes a link between the evidence and the claim |
| 1 | Lists limited evidence that relates to claim |

Students who experience explicit teaching practices make greater learning gains than students who do not experience these practices. Explicit teaching recognises that learning is a cumulative and systematic process. Explicit teaching helps students develop sophisticated and well organised ways of thinking, understanding and doing.

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

## Student resources

### Resource 1 ­– activity 2: the Black Death worksheet

1. Draw a flow chart to show why the Black Death is a zoonotic disease.
2. How does the germ theory of disease, and our current knowledge of the Black Death’s transmission, explain the disease’s spread demonstrated in the map?



‘[spread of the Black Death in Europe map](https://commons.wikimedia.org/wiki/File:1346-1353_spread_of_the_Black_Death_in_Europe_map.svg)’ by [Flappiefh](https://commons.wikimedia.org/wiki/User:Flappiefh) is licensed under [CC BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/deed.en).

### Resource 2 – activity 3 (Part A): worksheet

Determining the origin of the Black Death has only been possible because of DNA testing.

Critically evaluate **this** claim.

Use the claim-evidence-reasoning scaffold to help you structure your answer.

|  |  |  |
| --- | --- | --- |
| 1. Claim | 2. Evidence | 3. Reasoning |
| State an answer to the question/prompt. | Provide reliable information from experiments, facts or a reliable source that supports the claim. | Explain how the evidence supports the claim. |
| Helpful hints:  Use key words and ideas from your question as you write your claim. | **Suggested sentence starters**:  In the experiment…  The data shows…  According to the graph…  One example from the experiment is …  One piece of evidence is… | **Suggested sentence starters**:  Based on this evidence, it can be concluded that … because …  The evidence is significant because...  The evidence supports the claim because… |

### Resource 2 – activity 3 (Part B): suggested answers

Perfetto I (16 June 2022) ‘[Where did the Black Death originally come from?](https://cosmosmagazine.com/history/origins-of-the-black-death-revealed)’, *Cosmos*.

**Key:** claim-evidence-reasoning

The Black Death, often known simply as [the Plague](https://cosmosmagazine.com/history/plague-spread-quickly-in-medieval-europe/), was a pandemic that ravaged North Africa and Eurasia between 1347-1351 where it is estimated to have killed up to 60% of the population.

The first wave then extended into a 500-year-long pandemic (termed [the Second Plague Pandemic](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2630035/)) which lasted until the early 19th century and is considered one of the largest infectious disease catastrophes in human history.

It was caused by the [Bubonic plague](https://cosmosmagazine.com/health/medicine/together-in-death-early-victims-of-plague/), a disease caused by the bacterium [Yersinia Pestis](https://cosmosmagazine.com/science/plague-found-in-5000-year-old-hunter-gatherers-body/), which is usually transmitted to humans via the parasitic fleas that feed upon infected rats. They first entered the Mediterranean in 1347 via trade ships transporting goods from the territories of the [Golden Horde](https://www.britannica.com/place/Golden-Horde) in the Black Sea.



‘[spread of the Black Death in Europe map](https://commons.wikimedia.org/wiki/File:1346-1353_spread_of_the_Black_Death_in_Europe_map.svg)’ by [Flappiefh](https://commons.wikimedia.org/wiki/User:Flappiefh) is licensed under [CC BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/deed.en).

The exact geographical origins of the plague have been long debated, but new ancient DNA analysis of individuals who died in the 14th century suggests that the Black Death originated in communities in what is now modern-day Kyrgyzstan in the 1330s.

“Our study puts to rest one of the biggest and most fascinating questions in history and determines when and where the single most notorious and infamous killer of humans began,” says senior author Phil Slavin, associate professor of History at the University of Stirling, UK.

The [research](https://dx.doi.org/10.1038/s41586-022-04800-3) has been published in *Nature*.

**The Black Death was inscribed on ancient headstones**

Archaeological findings indicate that an epidemic devastated a local trading community close to Lake Issyk-Kul in the Chüy Valley of modern-day Kyrgyzstan, in the years 1338 and 1339.

Excavations almost 140 years ago revealed a disproportionally high number of burials and tombstones that indicated “pestilence” as the cause of death.

However, the relevance of these archaeological findings to the Black Death has remained controversial amongst experts until now.

An international team of researchers has now analysed ancient DNA (aDNA) from the teeth of the skeletal remains of seven individuals from this excavation and determined that DNA from *Yersinia pestis* was present in three that died there in 1338.

“Despite the risk of environmental contamination and no guarantee that the bacteria would have been able to be preserved, we were able to sequence aDNA taken from seven individuals unearthed from two of these cemeteries – Kara-Djigach and Burana in the Chu Valley. Most excitingly, we found aDNA of the plague bacterium in three individuals,” says lead author Dr Maria Spyrou, from the Institute for Archaeological Sciences at the University of Tübingen, Germany.

“We could finally show that the epidemic mentioned on the tombstones was indeed caused by plague,” adds Slavin.

Their archaeological and historical findings suggest that this area was the origin of the spread of the plague, as the ethnically diverse communities in the Chüy Valley relied on trade and maintained connections with several regions across Eurasia.

**Origin of the Black Death is in Central Asia**

The origins of the Black Death have been associated with a massive genomic diversification of *Y. pestis* strains, and though this was thought to have occurred sometime between the 10th and 14th centuries the exact date could not be estimated precisely.

However, using the ancient *Y. pestis* genome pieced together from the sites in Kyrgyzstan, the researchers have determined that this ancient strain must have been central to the diversification event.

“We found that the ancient strains from Kyrgyzstan are positioned exactly at the node of this massive diversification event. In other words, we found the Black Death’s source strain and we even know its exact date [the year 1338],” says Spyrou.



View of the Tian Shan mountains. Studying ancient plague genomes, researchers traced the origins of the Black Death to Central Asia, close to Lake Issyk Kul, in what is now Kyrgyzstan. Credit: © Lyazzat Musralina

Plague [still exists today](https://cosmosmagazine.com/nature/animals/tibetan-sheep-carry-the-plague/), surviving within wild rodent populations around the world in plague reservoirs. The authors suggest that the ancient Central Asian strain that caused the 1338-1339 epidemic around Lake Issyk Kul must have come from one such reservoir.

“We found that modern strains most closely related to the ancient strain are today found in plague reservoirs around the Tian Shan mountains, so very close to where the ancient strain was found. This points to an origin of Black Death’s ancestor in Central Asia,” concludes senior author Johannes Krause, director at the Max Planck Institute for Evolutionary Anthropology, Germany.

https://syndication.cosmosmagazine.com/?id=194911&title=Where+did+the+Black+Death+originally+come+from%3FOriginally published by [Cosmos](https://cosmosmagazine.com/) as [Where did the Black Death originally come from?](https://cosmosmagazine.com/history/origins-of-the-black-death-revealed/)

### Resource 4 – activity 4: assessing a claim about a non-infectious disease worksheet

Select a **claim** from the following list. Then, undertake some research to find **evidence** that supports or refutes the claim. Next, write a one-page report assessing your chosen claim using the collected evidence, making sure you **explain how or why** the evidence does or does not support the claim.

Examples of claims:

* Vaping is less dangerous than smoking.
* Non-infectious diseases are a bigger problem in developed countries than developing countries.
* Australian children should stay out of the sun.
* Pregnant women should take folate supplements.
* One glass of red wine per day is good for you.
* The measles vaccine causes autism.
* Coffee increases cancer risk.
* The cutting of stone kitchen bench tops is a health risk.

## 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, advice or feedback, contact the Science Curriculum team by emailing [Science7-12@det.nsw.edu.au](mailto:Science7-12@det.nsw.edu.au)

**Differentiation:** further advice to support Aboriginal and Torres Strait Islander students, EALD students, students with a disability and/or additional needs and High Potential and gifted students can be found on the [Planning, programming and assessing 7-12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage.

**Assessment**: further advice to support formative assessment is available on the [Planning, programming and assessing 7-12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage.

**Professional learning**: relevant professional learning is available on the [Science statewide staffroom](https://education.nsw.gov.au/teaching-and-learning/curriculum/statewide-staffrooms) and [HSC Professional Learning](https://education.nsw.gov.au/teaching-and-learning/professional-learning/hsc-pl). [Stage 6 Literacy in context](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/teaching-and-learning-resources/literacy/stage-6-literacy-in-context-writing/science) provides further advice to teachers to improve student writing.

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

**Consulted with**: Inclusive Education, Multicultural Education, Literacy and Numeracy and subject matter experts.

**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/public-schools/school-success-model/school-success-model-explained)

**Alignment to the School Excellence Framework**: this resource supports the [School Excellence Framework](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468) 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.

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

**Resource:** Classroom resource

**Creation date:** 4 July 2022

## References

[Biology Stage 6 Syllabus](https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/stage-6-learning-areas/stage-6-science/biology-2017) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2017.

NESA (NSW Education Standards Authority) (2022) ‘[Proficient Teacher: Standard descriptors](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher)’, *The Standards*, NESA website, accessed 30 Jun 2022.

Perfetto I (16 June 2022) ‘[Where did the Black Death originally come from?](https://cosmosmagazine.com/history/origins-of-the-black-death-revealed)’, Cosmos, accessed 7July 2022.

State of New South Wales (Department of Education) and CESE (Centre for Education Statistics and Evaluation) (2020a) ‘[What works best: 2020 update](https://education.nsw.gov.au/about-us/educational-data/cese/publications/research-reports/what-works-best-2020-update)’, CESE, NSW Department of Education, accessed 30 Jun 2022.

State of New South Wales (Department of Education) and CESE (Centre for Education Statistics and Evaluation) (2020b) ‘[What works best in practice](https://education.nsw.gov.au/about-us/educational-data/cese/publications/practical-guides-for-educators-/what-works-best-in-practice)’, CESE, NSW Department of Education, accessed 30 Jun 2022.

Wiliam D and Leahy S (2015) *Embedding formative assessment: practical techniques for K-12 classrooms,* Learning Sciences International, US.

### Further reading

State of New South Wales (Department of Education) (2022) [*Literacy and numeracy priorities*](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/priorities), NSW Department of Education website, accessed 24 February 2023.

State of New South Wales (Department of Education) (2022) [*Literacy and numeracy*](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy), NSW Department of Education website, accessed 9 March 2023.

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