Big History – Topic 2: Big Bang Theory

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The following lesson sequences are designed to supplement the materials and activities available through the [Big History School](http://www.bighistoryschool.org/core-200/) website. There is no requirement to use all (or any) of the following activities, as they are suggestions only. These sequences are not intended to be used as a complete teaching and learning program.

It is strongly recommended that science trained teachers support the delivery of this unit.

## Focus

This unit will shed light on the universe's origin from the Big Bang, 13.8 billion years ago, to the release of Cosmic Microwave Background, 380,000 years later. Students will explore collective learning, through which humans have steadily gained a greater knowledge of the universe over thousands of years, along with interdisciplinarity and how everything links up to these cosmological origins. One key concept is the ‘thresholds of increasing complexity’, the cosmic pattern stretching all history and uniting all things.

## Outcomes

A student:

* **BH5-1** identifies and describes terms and concepts in appropriate contexts
* **BH5-2** evaluates a range of differing claims of knowledge and perspectives
* **BH5-4** explains and assesses the role of evidence and discipline-based claims of knowledge of the universe used in addressing essential questions
* **BH5-6** analyses differing perspectives and claims of knowledge using sources and evidence
* **BH5-8** evaluates the usefulness of sources and evidence across a range of disciplines to respond to essential questions and assess claims of knowledge
* **BH5-9** assesses claims of knowledge across a range of disciplines.

Outcomes referred to in this document are from the [Big History Course Document](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/big-history#/asset2) © NSW Department of Education for and on behalf of the crown in the State of New South Wales (2021).

## Learning sequence 1

Students:

* explore the thresholds of increasing complexity, and the Big Bang as the first threshold of complexity
* use claim testing to assess a claim as knowledge.

### Thresholds of complexity and the Big Bang

**Teacher note:** Use the vocabulary tracker lessons as new terms are introduced to build student vocabulary. Encourage EAL/D students to include an extra column with the word or phrase in their dominant language.

Glossary terms can be found on the Macquarie University [Big History School](http://www.bighistoryschool.org/) website for each unit of work.

* Whilst working through the modules of Big History, students will continue to be introduced to specific vocabulary, with some words and phrases being used differently than they are in everyday speech, or in other subjects and modules within this course. As you work through each unit, complete a vocabulary tracker with the keywords and phrases you encounter.

Table 1 – Vocabulary tracker

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Word or phrase | Definition | Synonyms | Antonyms | Use in a sentence |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

* Watch [Introduction to Thresholds of Increasing Complexity | Big History Project (2:03)](https://www.youtube.com/watch?v=4CgsDk8zeIs). As a class, discuss the term ‘thresholds of complexity’ in the context of Big History and discuss why the Big Bang is considered the first threshold of complexity. Write a paragraph in response to the discussion.

**Teacher note**: It may be useful to provide students with the lyrics to the [Big Bang Theory theme song](http://www.lyricsondemand.com/tvthemes/bigbangtheorylyrics.html).

* Watch [Big Bang Theory (2:00)](https://www.youtube.com/watch?v=TzhIfN4UQv8). Do you think this is likely to be an accurate representation of the Big Bang to now? Explain your reasoning.
* Watch [Origins of the Universe 101 | National Geographic (5:49)](https://www.youtube.com/watch?v=HdPzOWlLrbE) and [The beginning of the universe, for beginners - Tom Whyntie (3:41)](https://www.youtube.com/watch?v=DmUiCweDic4) on the origin of the universe. Using both clips as stimulus, and your own thoughts, complete a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645#.YbAeRuMCXVE.link) addressing the questions below.
* What are some of the challenges we face when searching for knowledge on the origins of the universe?
* What is human bias and how can it affect the way we understand the origins of the universe?
* Why is it important to decide if we trust information as knowledge, and what criteria would you use to evaluate the information?

**Reflective question:** Do you agree with the statement that the Big Bang is the first threshold of complexity, and why?

## Learning sequence 2

Students outline key points and concepts in the understanding of the universe, including:

* connections between changing views of the universe as an example of collective learning
* the discovery of gravitational waves and the LIGO detector and its significance
* the different perspectives of scientists’ understanding of the universe and their significance.

### Changing views of the universe

**Teacher note:** The image linked below or a similar image of the Big Bang timeline can be used as a stimulus for activities. The purpose of this activity is to think of the direct and indirect contributions made to the big bang theory from a range of scientists over a period of time.

* Use the [Big Bang timeline poster](https://thinker.education/experience/what-are-the-limits-to-scientific-inquiry/when-does-the-scientific-method-fail/) to brainstorm different pieces of scientific understanding that are required to understand the development of the big bang theory.

**Teacher note:** The list of the scientists is only a suggestion and can be adjusted based on the class interest and teacher expertise.

* Complete the table below by researching the major contributions of 5 scientists to the big bang theory. Rank the scientists in order of who made the most significant contribution to the understanding of the big bang theory. Present your findings and justify to the class who you ranked as number 1.

Table 2 – Big Bang scientists

|  |  |
| --- | --- |
| Scientist | Contributions to scientific knowledge |
| Robert Wilson | Discovered cosmic microwave background radiation, evidence supporting big bang theory. |
| Arno Penzias |  |
| Albert Einstein |  |
| Steven Hawking |  |
| Georges Lemaitre |  |
| Edwin Hubble |  |
| Vera Rubin |  |
| Christian Doppler |  |
| Fred Hoyle |  |
| Alexander Friedmann |  |
| Alan Guth |  |
| Cecilia Payne-Gaposchkin |  |
| Annie Jump Cannon |  |
| Emmy Noether |  |

**Reflective question:** How important is collective learning to the development of scientific theories such as the big bang theory?

### Discovery of gravitational waves

**Teacher note:** Whilst the focus of these activities is not understanding gravitational waves and why Einstein predicted them, it can be an area of interest to some students to provide extension activities. The purpose should focus on the significance both the predication and discovery has had on cosmology in the context of Big History.

* Watch [Gravitational Waves Hit The Late Show (8:20)](https://www.youtube.com/watch?v=ajZojAwfEbs) and [Gravitational waves: A three minute guide (3:22)](https://www.youtube.com/watch?v=hhbMpe17fzA). Discuss as a class the importance of the discovery of gravitational waves and how it has impacted the field of cosmology.
* Explore the [LIGO website](https://www.ligo.caltech.edu/WA) to create a small information poster or a short clip targeted at Stage 5 students as to how the LIGO detector works and why the discovery of gravitational waves was a great milestone in cosmology.

### Perspectives of scientists’ understanding

**Teacher note:** Neil deGrasse Tyson’s discussion from 9:54 to 15:40 in the [StarTalk Podcast: Cosmic Queries – Summer School with Neil deGrasse Tyson (48:57)](https://www.youtube.com/watch?v=G7rkiipf27s&t=594s) can be used as an introduction to help students to think why there is a need for different perspectives and why the big bang theory is currently the best explanation on hand.

* The list below are some alternative theories to the big bang theory. Research 2 of the alternative theories from the list below and present your findings to the class
* Theory of eternal inflation
* Conformal cyclic model
* Black hole mirage
* Plasma universe theory
* Slow freeze theory
* Steady state universe
* A theory of their own choice (with teacher approval).

Table 3 – Scientific origin theories

|  |  |  |  |
| --- | --- | --- | --- |
| Theory | Commonalities with Big Bang (if any) | Differences to Big Bang | Implications for humans |
|  |  |  |  |
|  |  |  |  |

* Given the evidence and strong support for the big bang theory, what is the purpose behind the search for other models?

**Extension activity:** Students research dark energy and dark matter and the role they can play in understanding the universe. Students are encouraged to debate why a range of ideas and perspectives are needed to better understand the universe.

## Learning sequence 3

Students explain the discipline of astrophysics and its relevance to Big History.

### Astrophysics is a humbling science

* Watch [Neil deGrasse Tyson: How to Become an Astrophysicist (3:54)](https://www.youtube.com/watch?v=UniM3txg7E0). Students discuss why or who would want a career or education in the field of astrophysics.
* Research the role of astrophysicists and create a meme that shows what they do versus what society thinks they do, as per [the popular 6-stage perception versus reality meme format.](https://teachforaustralia.org/surprising-lessons-learnt-teaching/)
* Investigate NASA’s summary of the [latest discoveries made around the Big Bang](https://science.nasa.gov/astrophysics/focus-areas/what-powered-the-big-bang) and explain the relevance they have to building our understanding of the origins of our universe.

**Reflective question:** Students evaluate the following statement: ‘Only the field of astrophysics can contribute to our understanding of the big bang theory and questions related to the origin of the universe’.

## References

**Links to third-party material and websites**

Please note that the provided (reading/viewing material/list/links/texts) are a suggestion only and implies no endorsement, by the New South Wales Department of Education, of any author, publisher or book title. School principals and teachers are best placed to assess the suitability of resources that would complement the curriculum and reflect the needs and interests of their students.

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