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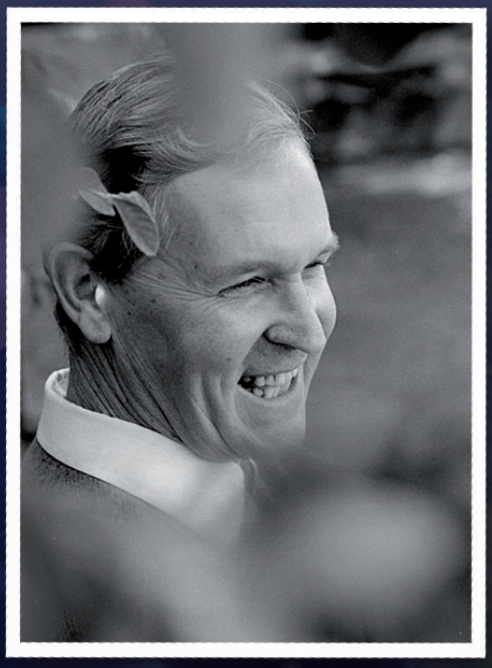
MICROBES TO MACROBES



The Story of Frank Fenner

A **STUDY GUIDE** BY CHERYL JAKAB

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Microbes to Macrobes

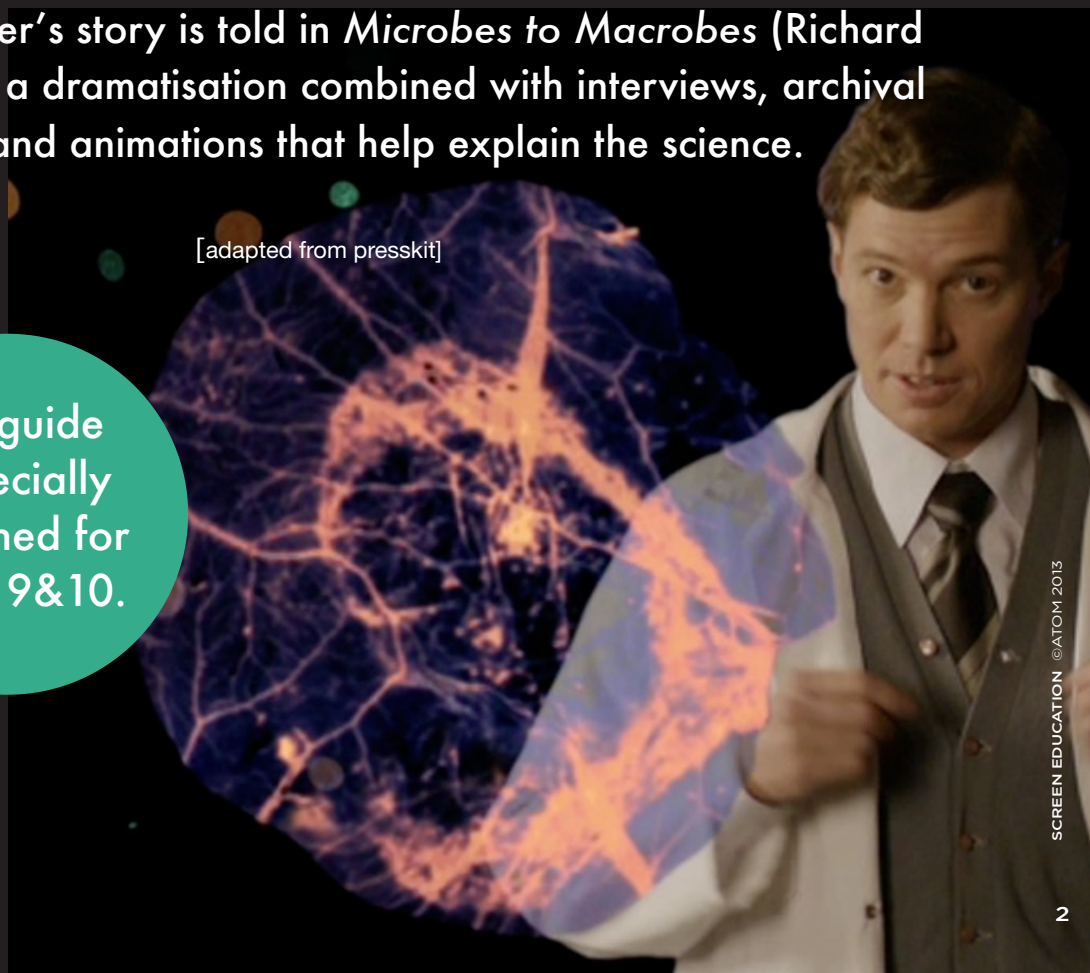
THE STORY OF FRANK FENNER

A study guide by Cheryl Jakab

In the twentieth century, infectious diseases that had long been a scourge were finally understood and controlled. Viruses had come to the attention of science, and an understanding of their role as disease vectors was being put to good use. The great Australian microbiologist Frank Fenner contributed to major medical and public health breakthroughs in this period, affirming his status as one of Australia's great scientists, who deserves to be better known, not least for his predictions of current global problems caused by people's unwillingness to accept that we too are part of Earth's ecologies. Fenner's story is told in *Microbes to Macrobes* (Richard Jasek, 2011) as a dramatisation combined with interviews, archival footage and animations that help explain the science.

[adapted from presskit]

This guide is specially designed for Years 9&10.



CONTENTS

THE PROGRAM AT A GLANCE

Running time:

63 minutes

Synopsis

Microbes to Macrobes is a significant Australian science history documentary. Frank Fenner was a great Australian scientist who deserves to be a household name for his contributions to twentieth-century microbiology, though he remains far from well-known to most people. The film tells Fenner's story as a great Australian scientist whose works contributed to the well-documented biological control of rabbits with myxomatosis and eradication of smallpox. It also gives fascinating glimpses into the life of this remarkable Australian scientist. Studying *Microbes to Macrobes* will help the next generation to appreciate the nature of scientific work and the man who devoted his life to learning more about microbes, contributing significantly to the fight against the diseases they cause.

Summary of curriculum relevance

Age appropriateness: this guide is specially designed for Years 9 and 10. Activities could be adapted for Years 7 and 8 and Senior Biology, Media Studies and History.

Science/Biology – Science as Human Endeavour; Microbiology; Evolution; Disease

Environmental Studies/Science – Ecology

History – Historical Skills

Media Studies – Narrative Documentary

General Capabilities – Literacy; Critical and Creative Thinking; Ethics

CREDITS

Production

Richard Jasek – Writer/Director/Creative Producer
Linda Cooper – Executive Producer/Science Advisor
James Moody – Producer
Aaron Gully – Director of Photography

Cast

Duncan Graham – Frank Fenner
Emily Branford – Bobbie Fenner
Paul Blackwell – Charles Fenner
Eileen Darley – Peg Fenner
Sam Davies – Young Frank Fenner

INTRODUCTION

The emergence of virology was a major breakthrough in twentieth-century science, combating many devastating and deadly diseases. This fight against pestilence is contextualised through one person's life-works. The documentary *Microbes to Macrobes: the Story of Frank Fenner* explores the many scientific achievements of one man that still have importance and relevance for us today. Fenner should be a household name in Australia, as should other prominent Australian scientists such as Howard Florey, Frank McFarlane Burnett and Gustav Nossal.

The film is a good demonstration of science as neither democratic nor dogmatic, but rather a process of finding out more about the world through observation, experimentation, theorising and developing models to test theories. What is tackled and discovered is greatly influenced by imagination and effort.

One strength of this film is the presentation of science in comic sketches and visual graphics to help the viewer interpret the emerging sciences of virology and immunology. Dramatisations and interviews create the biographical narrative of Frank Fenner's life and works, outlining this great scientist's achievements. How Fenner's scientific breakthroughs eventuated within his life story is explained, putting his scientific and public health achievements into their historical context.

BEFORE VIEWING

Discuss with students their prior knowledge of microbes, viruses, infectious disease and immunisation, great Australian scientists, and film techniques to get a message across.

Learning focus 1: Science – Understandings of viruses, virology, diseases and disease control developed rapidly during the twentieth century. (Relates to Activity 4)

1. What do you think a virus is?
2. Can you name any diseases that are caused by viruses?
3. Has anyone heard of the disease malaria? Myxomatosis? Smallpox?
4. What is a vaccine and vaccination?
5. Who gets immunised in Australia today and against which diseases?

Learning focus 2: Culture and History – Scientists as heroes in society and the importance of the story of *Microbes to Macrobes*. (Relates to Worksheet 3)

6. Who is your own personal Australian hero? What makes that person heroic? Who are the heroes of Australian culture?
7. Did anyone in the class choose a scientist? Do you know the names of any great scientists, or an Australian scientist? How are scientists regarded in Australian culture?
8. Has anyone heard of Frank Fenner?
9. Ask students to note any information that is new to them while they view the film.

Learning focus 3: English and Media – Identify film techniques and how they work on audiences. (Relates to Activity 4)

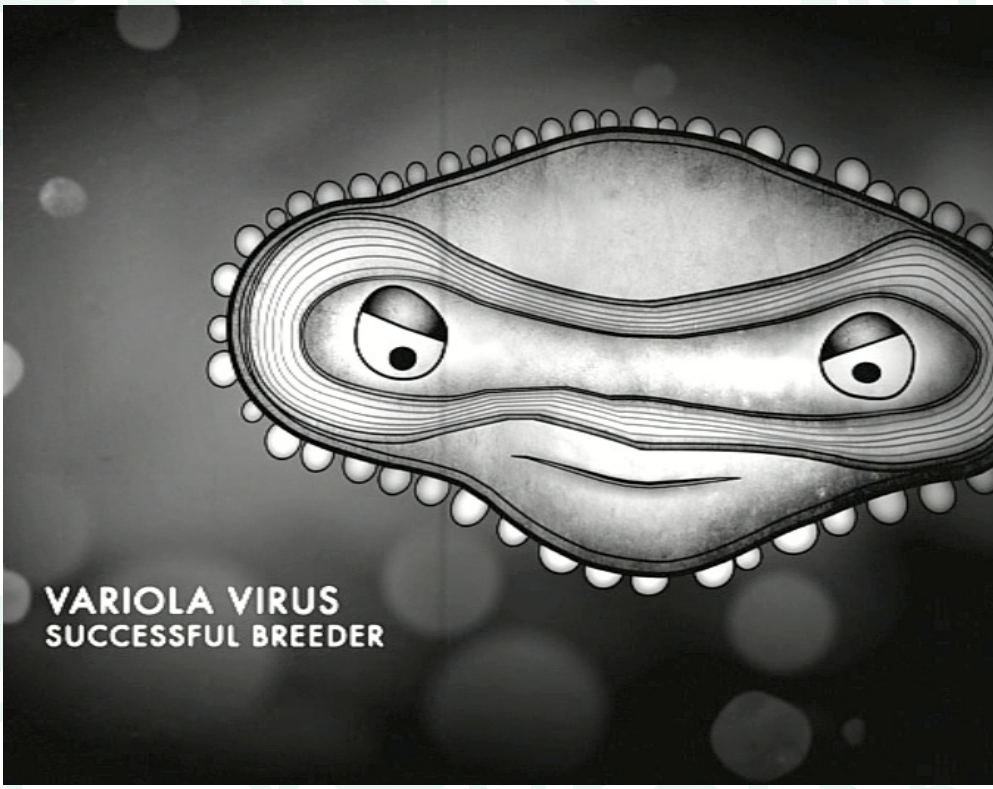
10. What do you think the film title *Microbes to Macrobes* might mean?
11. What modes of presentation are usually used in documentaries?
12. What are the advantages of CGI and animations in getting information across?
13. What are docudramas?
14. How are the different techniques intended to influence how you think (logos), feel (pathos) and believe (ethos)?

VIEWING QUESTIONS AND DISCUSSION STARTERS

The following is a list of possible discussion starters divided into groups, each covering about 10–15 minutes of the program and connected as a theme through a learning focus statement. The questions are timecoded for ease of reference, allowing efficient review of pertinent sections. These starters link directly to the activities that follow in this study guide.

The question lists could be given as a handout with spaces for students to record responses during viewing, with students working together in groups of five.

NB: Asking students to add dates next to questions would be useful in creating the timeline in Activity 2 below.

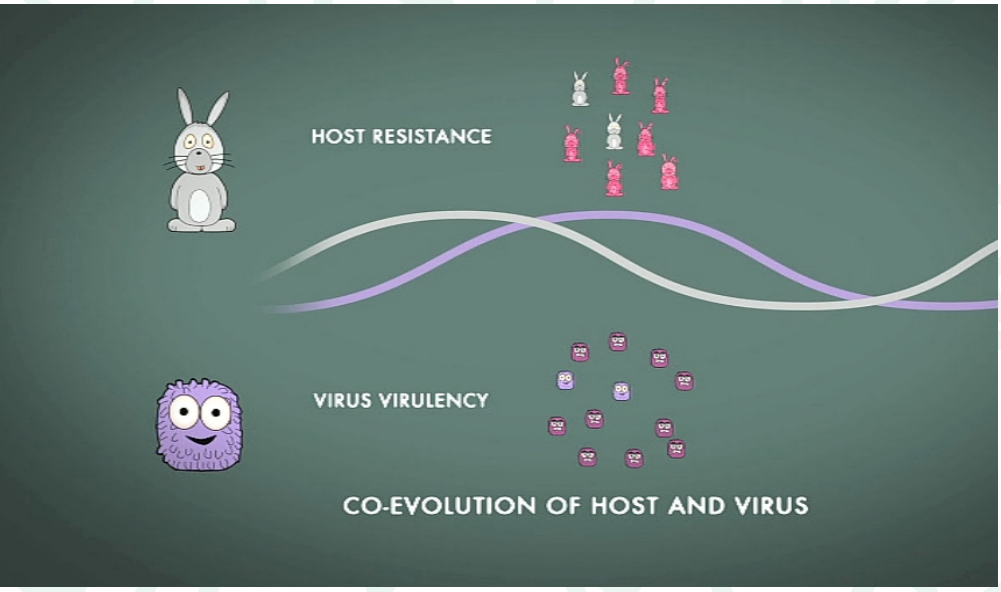


Responding to the film

Section 1 (0:00–13:00mins): an introduction to young Frank Fenner and his science

Learning focus 1: how does an interest in science develop and grow in children?

1. Why do you think the makers decided to start the film with the rabbits' cartoon segment and how does the 'Bunnytone News' influence how you think and feel about the film? (1:08–3:15)
2. How do you think Fenner's father and upbringing contributed to his future work? (3:15–12:08)
3. What did science communication involve in Frank's father's time (1930s), and what does it involve today? (7:45)
4. In what ways is Frank's love of science supported by his father when he was a boy? (10:00–13:00)
5. What do you think about Frank's father encouraging him to pursue medicine rather than geology? (10:20)



Section 2 (13:00–21:30): Fenner's first research on a tropical killer – malaria

Learning focus 2: What first helped Fenner's interest in microbes and disease to develop?

6. What are the symptoms of malaria? (13:08)
7. How did Fenner's work contribute to understanding and controlling malaria? (14:20)

8. What causes malaria and how is it transferred? (17:00–20:00)

9. What anti-malarial precautions were taken with soldiers in Papua New Guinea? (19:10)

10. How does Fenner feel about and describe science? (21:15)

Section 3 (21:30–30:00): Fenner and the ectromelia virus, smallpox and tuberculosis

Learning focus 3: What events led to Fenner's lifeworks in scientific research?

11. What are the similarities between mouse-pox and smallpox? (23:09)

12. What does Nossal mean when he says scientists deal with simplified versions of reality? What is a scientific model? (23:44–24:28)

13. What did Fenner contribute to the understanding of infectious disease and immunological tolerance? (24:30–25:26)

14. How do you think René Dubos' encouragement of his students to speak up assisted Fenner's progress as a scientist? (26:20–25:26)

15. What did Fenner take with him to study in New York and why? (27:44)

Section 4 (30:00–41:30): A rising star in medical research

Learning focus 4: What do you think it takes to be a famous Australian scientist?

16. Who is Howard Florey and what is he known for? (30:40)

17. Do you think Fenner should have been awarded a Nobel Prize? (32:12)

18. What happened to create the rabbit problem? (33:36)

19. What is the CSIRO? (35:00)

20. How is myxomatosis described as spreading and changing? How was this studied by Fenner? (36:00)

Section 5 (41:15–61:00)

Learning focus 5: How important is understanding the history of events and people to understanding science?

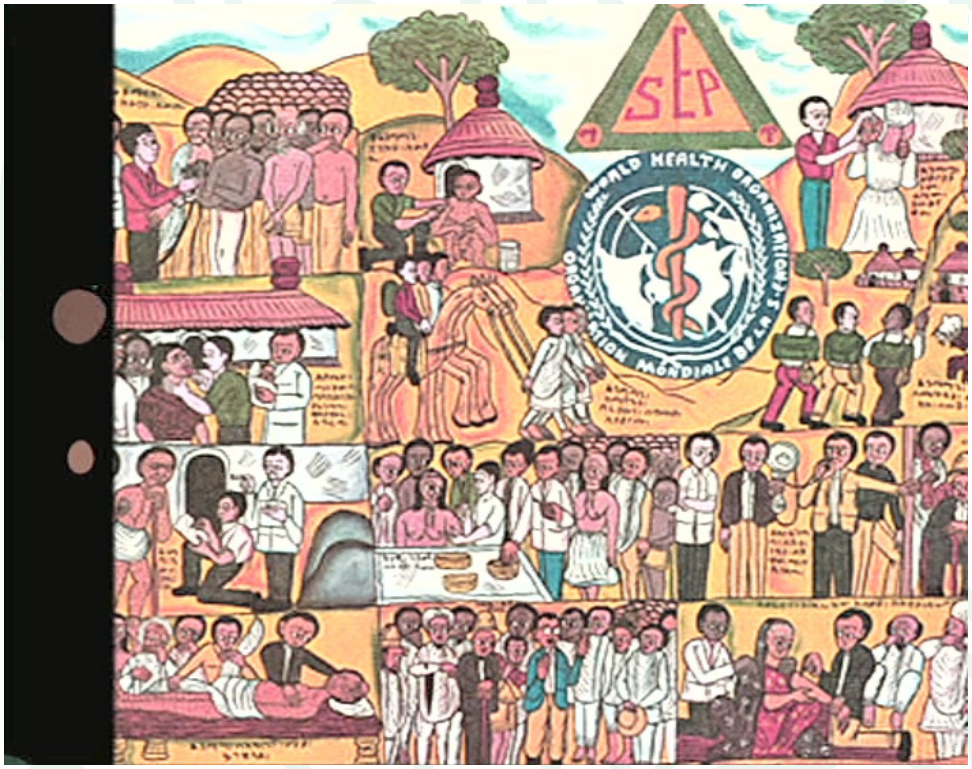
21. What did Burnett say were the worst and most successful experiments he had ever done? (41:15)

22. How do you think it would feel to be made a fellow of a scientific academic society? (46:00)

23. How would you describe smallpox and the WHO eradication program? (47:00)

24. What changes did Fenner see in medical research in his lifetime? (46:39)

25. Why do you think the makers decided to end the film with the rabbits' cartoon segment and how has the 'Bunnytone News' influenced how you think and feel about *Microbes and Macrobes*? (1:00:16–1:01:35).



ACTIVITIES

1. ‘Bunnytone News’ (Worksheet 1)

Learning purpose: To identify and review the main science ideas in Frank Fenner’s life and work and how cartoons can contribute to understandings.

Focus question: What role does the rabbit perspective play in the film?

This is a whole-class activity, with students completing worksheets individually or in pairs.

Curriculum focus:

Science as Human Endeavour;
General capabilities: Critical and Creative thinking
Suggested class time: One hour

Student task: Review ‘Bunnytone News’ to make notes on Fenner’s main achievements.

What to do: Review the ‘Bunnytone News’ segments as a class. (1:08–3:15 and 1:00:16–1:01:35)

List and discuss techniques and devices that can be used in film and written material to influence the viewer or reader, such as personal perspective, anecdotes, argument, quotes from experts, humour, imagery, figures of speech, repetition, contrast/juxtaposition, use of technical language, explanation of technical language, shock. Students could be asked to identify an example of each of these techniques or devices in the film.

Have the class complete worksheets while reviewing the segments and then discuss their impressions.

Extension activity: Display any cartoon strips that students complete.

2. Frank Fenner: One person, many achievements (Information sheet: Glossary of science terms)

Learning purpose: Identify and review the main achievements in Frank Fenner’s life and work.

Focus question: How are timelines presented and how useful are they?

Curriculum focus:

Science: Science as Human Endeavour;
History: Chronology, Terms and Concepts;

General Capabilities: Critical and Creative thinking

Suggested class time: One hour

Student task: Create a class timeline of the milestones in the life and work of Frank Fenner, starting when Fenner was born in 1914 and ending in 2010 when he died.

What to do:

a. Discuss: What do you think was Fenner’s greatest achievement as shown in the film?

b. Divide the class into five groups. Allocate one fifth of *Microbes to Macrobes* (using viewing question lists) to each group to record Fenner’s milestones in life.

c. Review each section of the film, recording dates and events to add to a class timeline.

d. Design and create the class timeline by having each student complete one milestone event to add to their group’s section of timeline. NB: Add images by taking screengrabs or other illustrations. Negotiate the amount of detail to be added for each event.

e. Review Fenner’s significant scientific contributions by having each person explain their step on the timeline to the class.

f. What do you think it takes to be and remembered as a great scientist?

3. An evolutionary arms race: Rabbits, myxomatosis, ecology and coevolution (Worksheet 2)

Learning purpose: Critically review the importance of coevolution in understanding interactions between microbes and macrobes.

Focus question: What things do you think need to be considered when introducing anything new?

Curriculum focus:

Science: Biological Sciences; General Capabilities: Critical and Creative Thinking
Suggested class time allowance: One hour

Student task: Write a group report on how reducing or removing a species in an area can affect that environment, including controlling diseases and the environmental impact of introduced species.

What to do: After handing out worksheet:

1. Discuss: What do you understand by the term coevolution?
2. Rewatch the section of the film exploring the coevolution of virus and host. (33:49–42:46)
3. Use the quote from the worksheet (René Dubos, 0:42) to explore ideas of ecology and coevolution as important processes at all levels of life from viewing the film.

Discuss:

What is the context of a living thing?

What are some differences between viruses and bacteria and their ecologies?

What can we learn about ourselves from plagues of rabbits and plagues that kill rabbits?

How is overpopulation of rabbits analogous to human overpopulation?

4. A Great Australian Scientist (Worksheet 3)

Learning purpose: Explore the achievements of a great Australian scientist, such as Frank Fenner or another who appears in *Microbes to Macrobes*.

Curriculum focus:

Science: Science as Human Endeavour;
History;
General capabilities: Critical and Creative Thinking;
Ethics

Suggested class time allowance: One hour

Student task: Choose one Australian scientist – either Fenner or someone else who appears in *Microbes to Macrobes* – to write a short biography about for the school news or local paper.

What to do:

1. As a class, review and discuss the section of film that describes Fenner as a builder, and where Nossal quotes Sir Isaac Newton: 'If I see further I stand on the shoulders of giants.' (57:54–60:00)
2. In pairs, share your thoughts to complete the worksheet and choose a scientist to research and write about and display.
3. Extension: As a class, consider how the profile of scientists could be increased. Will we ever have science heroes in popular culture?

5. Viruses, disease and vaccination (Worksheet 4)

Learning purpose: to explore vaccination programmes, their basis and their results.

Curriculum focus:

Science: Biological Sciences;
Health;
History;
Ethics

Suggested class time allowance: To be negotiated with students

Student task: The worksheet asks students to research and report on one of the following four topics:

1. The MMR vaccination program,
2. Smallpox and its eradication
3. A newly identified or emerging viral disease
4. The effects and vaccination of human papillomavirus (HPV)

What to do:

1. Before handing out the worksheet, conduct a classroom discussion about smallpox in response to the film (47:03–54:04)

a. What is smallpox? How do you react to the images of people with the disease?

How was the importance of finding out if there is an animal reservoir presented in the film?

What is monkey pox?

How did Fenner work out that it was different to smallpox?

When was smallpox eradicated (made extinct)?

Background information: the WHO Smallpox Eradication Campaign from the late 1960s was a worldwide mass-vaccination program. In 1978, a global commission found that smallpox had been eradicated, and this was declared at the 33rd World Health Assembly in 1980.

b. Review methods of structuring and presenting factual information in reports.

c. Ask students to share their own responses to the smallpox section of the film before choosing their topic from the worksheet. Consider how logos (understanding), pathos (feeling) and ethos (beliefs) are each influenced in the segment.

2. Hand out the worksheet. Negotiate the requirements of the task by having students construct a rubric which includes details of format and structuring the task, word length, references, submission dates, and possible methods of sharing their work with the class.

CURRICULUM AND EDUCATION SUITABILITY

Level: Year 9–10 Science, History, English, General Capabilities, Ethical Behaviour

Science

Science Understanding; Science as a Human Endeavour

Year 9

Biological Sciences – multi-cellular organisms rely on co-ordinated and interdependent internal systems to respond to changes to their environment (ACSSU175)

Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)

Nature and development of science – scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE157)

Year 10

Biological sciences – the theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence (ACSSU185)

Nature and development of science – scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE191)

English

Year 9

Language

Text structure and organisation – understand that authors manipulate text structures and language for specific purposes and effects (ACELA1553)

Literature

Responding to literature – explore and reflect on personal understanding of the world gained from interpreting various representations of issues in texts (ACELT1635)

Literacy

Texts in context – analyse how the construction and interpretation of texts, including visual media texts, can be influenced by cultural perspectives and other texts (ACELY1739)

Year 10

Language

Text structure and organisation – understand how paragraphs and images can be arranged for different purposes, audiences, perspectives and stylistic effects (ACELA1567)

Literature

Responding to literature – analyse and explain how text structures, language features and visual features of texts, and the context in which texts are experienced, may influence audience response (ACELT1641)

Literacy

Texts in context – analyse and evaluate how people, cultures, places, events, objects and concepts are represented in texts, including media texts, through language, structural and/or visual choices (ACELY1749)

History

Year 10

Depth study 1 – World War Two – investigate wartime experiences through a study of World War Two in depth. This includes a study of the causes, events, outcome and broader impact of the conflict as an episode in world history, and the nature of Australia's involvement. (ACDSEH108)

General capabilities:

Critical and creative thinking

Inquiring – identifying, exploring and clarifying information – explore the coherence and logic of multiple perspectives on an issue.

Reflecting on thinking, actions and processes – give reasons to support students' own thinking, show awareness of opposing viewpoints and possible weaknesses in their own positions.

Drawing conclusions and designing a course of action – identify a problem, isolate its important aspects, and use logical and abstract thinking to formulate a response

Ethical behaviour

Understanding ethical concepts and issues – identify ethical obligations and justify the need for these to be enacted

Reference: <http://www.australiancurriculum.edu.au>

RESOURCES
Online Resources for students and teachers

Frank Fenner

Australian Academy of Science:
<http://science.org.au/scientists/interviews/f/notes_ff.html#activities>

Australian scientists

ABC splash:
<http://splash.abc.net.au/media/-/m/103682/the-home-of-australian-science?source=secondary-science>

Australian Science and Technology Heritage Centre:
<http://www.austehc.unimelb.edu.au>

Famous Scientists:
<http://www.famousscientists.org/25-famous-australian-scientists-contributions/>

Science in Australia:
<http://australia.gov.au/about-australia/australian-story/science-in-australia/>

Information sheet (Note Fenner is not on this list):
<http://www.asap.unimelb.edu.au/bsparcs/guides/puzzles/science_facts.htm>

CSIRO

<http://www.csiro.au>

CSIRO's Rabbit Calicivirus Disease Factsheet:
<http://www.csiro.au/en/Outcomes/Food-and-Agriculture/RCDFactsheet.aspx>

Diseases

Virology

The big picture book of viruses:
<http://www.virology.net/big_virology/BVDiseaseList.html>

Poxviruses

Virology online:
<http://virology-online.com/viruses/Poxviruses.htm>

Encyclopaedia Britannica:
<http://www.britannica.com/EBchecked/topic/473442/poxvirus>

Smallpox

World Health Organisation:
<http://www.who.int/csr/disease/smallpox/en/>

<http://www.who.int/topics/smallpox/en/>

Malaria

World Health Organisation:
<http://www.who.int/topics/malaria/en/>

Mediline plus:
<http://www.nlm.nih.gov/medlineplus/malaria.html>

Malaria no more:
<http://www.malarianomore.org>

Centers for Disease Control and Prevention:
<http://www.cdc.gov/MALARIA/>

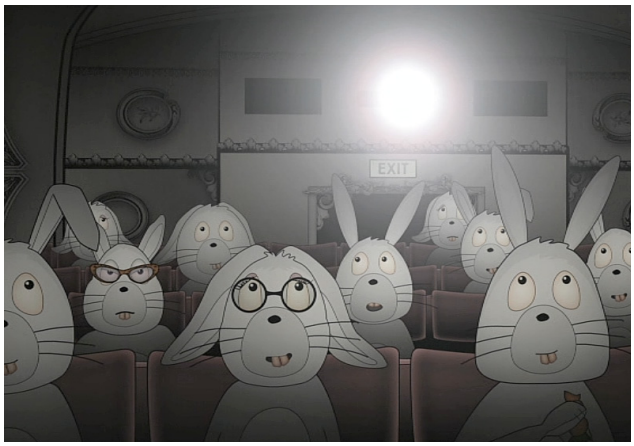
Bill and Melinda Gates Foundation:
<http://www.gatesfoundation.org/What-We-Do/Global-Health/Malaria/>

Vaccination

Centers for Disease Control and Prevention:
<http://www.cdc.gov/vaccines/>

Pet vaccination:
<http://www.future-of-vaccination.co.uk>

WORKSHEETS



THE 'BUNNYTONE NEWS'

At the beginning of *Microbes to Macrobes*, the 'Bunnytone News' item summarises Frank Fenner's life work. At the end of *Microbes to Macrobes*, when watching the 'Bunnytone News', the rabbits talk of the negative effects they were having on the environment in Australia.

Your task: Review 'Bunnytone News' to make notes on Fenner's main achievements.

Focus question: What were the main achievements of Fenner's life work?

What to do:

1. Public enemy No.1: Mr Myxomatosis AW 1.2 Bunnies in theatre

Record details of each of Frank Fenner's major achievements used in the opening Bunnytone segment (1:08–3:15)

Malaria in World War Two

The course of myxomatosis

Elimination of smallpox

Pioneering environmentalist

.

WORKSHEET 1

2. Too many of us? Discuss the importance of the closing Bunnytone segment (1:00:16–1:01:35)

3. In what ways was the 'Bunnytone News' format effective for you?

Design a six-step cartoon strip explanation of malaria, myxomatosis, smallpox or overpopulation.

Extension Activity: Make your cartoon strip to display in the classroom or school newspaper.

AN EVOLUTIONARY ARMS RACE: RABBITS, MYXOMATOSIS, ECOLOGY AND COEVOLUTION

Group Name(s)

In *Microbes to Macrobes*, coevolution is discussed as an important issue in understanding the relationships between organisms, whether fighting disease, pest species or human impacts on the planet.

The task: Working in a group of four, complete this sheet to create a group report that explains the concept of coevolution.

Focus question: What things do you think need to be considered when introducing anything new into a situation?

What to do:

1. What do you think coevolution is? Record your idea in one sentence.

_____

_____

2. Review the ten-minute section of *Microbes to Macrobes* relating to biological control of rabbits with myxomatosis and coevolution (33:36–42:46).

    a. What is biological control and how was it used against rabbits in Australia?

    b. The following is a list of keywords that were used in this section of film:

Tick the ones you think you understand and circle those for which you need more information. Use this segment of the film

myxomatosis, virus, virulent, host, transmission, infection, vector, 'the flying pin', experiment, resistance, balance, virus–host interaction, pathogen, selfish genes, coevolution, mouse-pox, Darwinian natural selection, scientific model

and the information sheet of scientific terms to assist you.

3. 'Any organism – from microbe to man – can be understood only in the context of the relationship it forms with everything else.' (René Dubos, Timestamp: 0:42)

How does this idea help you understand the 'evolutionary arms race' between the rabbit pest and the myxo virus?

4. Discuss in your group how you might structure a group report in four sections. Agree on required lengths, due dates and allocation of responsibilities to each group member.

5. Complete sections and bring your reports together to display in the classroom.

A GREAT AUSTRALIAN SCIENTIST

'If I see further I stand on the shoulders of giants' – Sir Isaac Newton

Australians have many heroes – most of them sportspeople or film and music industry celebrities. Very few of our scientists are well-known or celebrated in popular culture. A number of our greatest living Australian scientists appear in *Microbes to Macrobes* talking about Fenner and his work.

Had you heard of Frank Fenner or the scientists interviewed before watching *Microbes to Macrobes*?

The task: Choose one Australian scientist – either Fenner or someone else who appears in *Microbes to Macrobes* – to write a short biography on for the school news or local paper.

What to do:

1. As a class, discuss the meaning of the quote from Sir Isaac Newton above that was used by Sir Gustav Nossal in Microbes to macrobes. What does the statement mean to you?

2. Review and discuss the section of the film that talks about Frank Fenner as a person and as a builder of scientific institutions in Australia. (57.54–60.00)

What makes a person a famous scientist? Record your ideas.

3. In pairs, choose one of the famous Australian scientists who appear or are talked about in *Microbes to Macrobes* to research and then write a one-page biography about their life and work (see interviews at <http://science.org.au/scientists/alphabetical.html>)

Circle one or add another name:

Professor Frank Fenner

Howard Florey

Professor Suzanne Cory

Sir Gustav Nossal

Professor Peter Doherty

Professor Carola Vinuesa, MD PhD

Professor Stephen Boyden

4. As a class, consider the following question: What could we do to increase respect for and popular interest in the work and lives of scientists, great and small? Is this important in your view?

VIRUSES, DISEASE AND VACCINATION

Name(s)

One main motivation for the study of viruses is the fact that they cause many major infectious diseases, among them the common cold, influenza, rabies, measles, many forms of diarrhoea, hepatitis, yellow fever, polio, smallpox and AIDS. It is hard to imagine what life was like before modern medical developments such as antibiotics and immunisation programmes against viral diseases.

Your task: Research and report on one of the following topics:

1. The MMR Vaccination programme

Vaccination is accepted as an important way for people to maintain good health. Babies in our society today are routinely vaccinated against mumps, measles, rubella and polio. The MMR vaccination public health programme is designed to decrease the chance of a child getting these diseases and of outbreaks occurring.

Q. What is the importance of vaccinating all children?

Measles	Measles virus causes rash, cough, runny nose, eye irritation, and fever. Measles can be associated with ear infection, pneumonia, seizures (jerking and staring), brain damage and death.
Mumps	Mumps virus causes fever, headache, muscle pain, loss of appetite, and swollen glands. Mumps sometimes leads to deafness, meningitis (infection of the brain and spinal cord covering), painful swelling of the testicles or ovaries.
Rubella (German Measles)	Rubella virus causes rash, arthritis (mostly in women), and mild fever. A pregnant woman contracting rubella can lead to miscarriage or serious birth defects in the baby.

2. Smallpox and its eradication

The vaccination program that eradicated smallpox is considered one of the great achievements of twentieth-century science.

Smallpox (Variola)	A human disease eradicated by 1980. Causes respiratory or skin infection due to growth of the virus in lymphatic tissues. Symptoms include pustular rashes and fever. It was fatal in two out of every five people who contracted the disease.

Q. How was the dreadful infectious disease smallpox eradicated?

3. Newly identified or emerging viral diseases

Diseases new to science include: Ebola, HIV/AIDS, SARS, Hendra virus (HeV)

SARS	In 2002 and 2003, a SARS virus outbreak generated widespread panic. The previously unknown, airborne virus caused 774 deaths in about 8000 cases of illness. This mortality rate was very high.

Q. What is the disease and its symptoms? How does it spread and how might it be controlled? Where did this mystery virus come from?

4. Human papillomavirus (HPV) effects and vaccination

Australia has a national school-based HPV Vaccination Program. From February 2013, males and females (12–13 years) receive the HPV vaccine at school.

Human Papillomavirus	HPV, or Human Papillomavirus, is a common virus that affects both males and females. HPV causes genital warts, and can cause cancers, though people infected with the virus often do not know they have it. Vaccination is effective if given before sexual activity begins.

Q. Why is a national vaccination program considered necessary?

INFORMATION SHEET: GLOSSARY OF SCIENCE TERMS

Disease An abnormal condition, experienced subjectively as unwellness. The four main causes are pathogens, deficiency, hereditary and physiological disease. Diseases can be infectious, communicable or non-communicable.

Signs and Symptoms Signs of a disease are what can be observed, such as pustules on the skin, while symptoms are what the sufferer feels, such as pain.

Epidemic An increased incidence of a disease. Increases in infectious diseases are caused by a change in the ecology of the host population. Epidemiology is the scientific study of the causes of disease. An epidemic disease is not necessarily contagious.

Virus A very small infectious agent that can replicate only inside the living cells of an organism. Viruses are more than 100 times smaller than bacteria. Viral diseases include lesser conditions such as the common cold (rhinovirus), to deadly diseases such as influenza (flu) and HIV/AIDS.

Virology The study of viruses is part of the field of science called microbiology. Virology includes virus and prion structure, classification and evolution, and the diseases they cause, including how they infect cells and reproduce in hosts. Virologists develop techniques to isolate and culture them for research and therapy.

Malaria A human disease common in tropical areas. Today most cases occur in African (about 91 per cent). It is transferred by mosquitoes (the vector). The causative agent is a parasite called plasmodium. Symptoms include fever, chills, and flu-like illness. When untreated, severe complications can occur. In 2010, about 219 million people contracted malaria worldwide and more than half a million died from the disease.

Pox viruses A group of DNA-containing viruses including those that cause smallpox, cowpox, and other pox-like diseases in vertebrates, including myxomatosis in rabbits and mouse-pox and plum-pox in Prunus fruit trees.

Myxomatosis The disease specific to rabbits caused by the myxoma virus, transferred by fleas. Used as a biological control measure in Australia to control the feral pest numbers.

Small pox (Variola) A human disease eradicated by 1980. Causes respiratory or skin infection due to growth of the virus in lymphatic tissues. Symptoms include pustular rashes and fever. It was fatal in two out five people contracting the disease.

Prion (PrP), thought to be made up of highly aggregated prion protein. Prion diseases are a group of protein misfolding neurodegenerative diseases that includes Alzheimers, Parkinsons and Huntingtons disease.

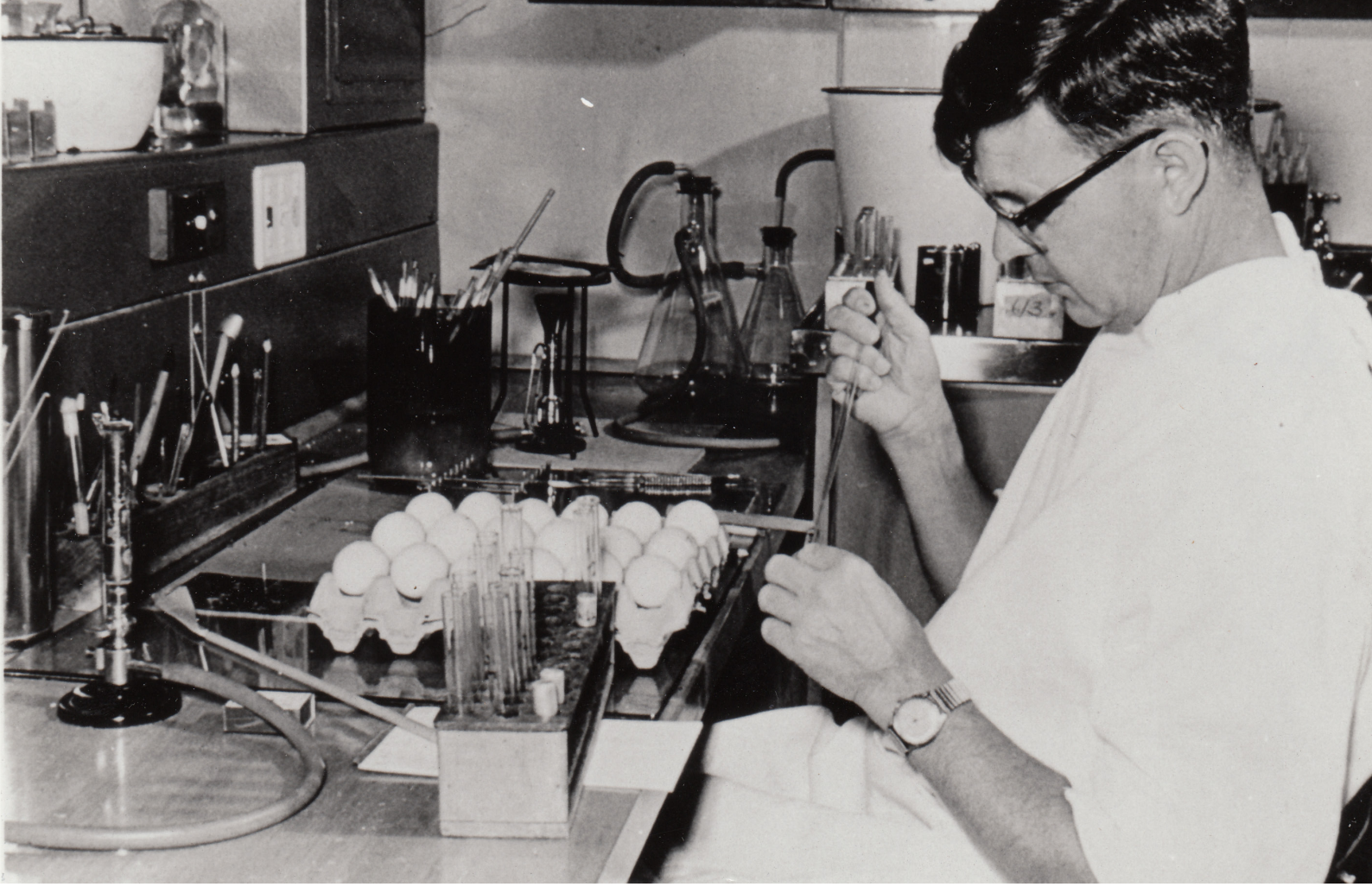
Disease vectors Organisms that transmit infections from one host to another, such as the Anopheles mosquito transmitting human malaria.

Coevolution Evolution of two or more interdependent species influencing each other's evolution. Each adapts to changes in the other as they adapt to their environments. Evolution is a process in which species change over time and develop new species. Coevolution occurs in organisms that are ecologically close such as in predator-and-prey or host-and-parasite relationships. Coevolution can lead to an evolutionary 'arms race' in which pressure is created to change as defence and counter-defence escalates the change.

Vaccination An ancient process of exposing people to small doses of a virus to develop immunity. It was first used by Edward Jenner in 1796 after he observed that milkmaids who were exposed to cowpox did not develop smallpox.

Immunisation The process of making a person immune or resistant to an infectious disease by giving a vaccine. The body's immune system is stimulated to protect against infection or disease.

Disease burden The impact of a health problem in an area measured by financial cost, mortality, morbidity, or other indicators. Disease burden is measured in years of potential life lost (YPLL), an estimate of the number of years that a person's life was shortened due to a disease.



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