Australia's National
Science Agency

Public perceptions of using synthetic biology to reduce mosquito-borne diseases

Synthetic biology technologies, such as gene editing, could prevent mosquitoes from carrying viruses, reducing disease around the world

Synthetic biology at CSIRO

Synthetic biology is an emerging field of research that combines genetics, chemistry and engineering. Scientists working in synthetic biology design, build, and test DNA to enable plants, animals and other organisms (e.g. bacteria, fungi, algae) to function in different ways. These organisms could then be used to help manage environmental and societal problems such as pollution, waste, land degradation and biodiversity loss.

The CSIRO Synthetic Biology Future Science Platform has developed a range of synthetic biology techniques, such as genetic engineering, gene editing and gene marking. But what do Australians think about these techniques? Involving the public is a critical step in the development of any new technology. By understanding Australians' needs, researchers can develop technology that is both fit-for-purpose and helpful to the community.

This brochure is part of a series that explores people's views towards several synthetic biology tools to help solve environmental, industrial and health challenges facing Australia. The full brochure series is available at: **www.csiro.au/synbiosurvey**

We surveyed the Australian public, asking for their initial impressions on using synthetic biology to reduce mosquito-borne diseases:

- What do people **think and feel** about this new technology?
- What **risks** do they perceive?
- How would people want to be **engaged** in decision-making in the future?

Assessing a technology's suitability

CSIRO has adopted a three-pronged process to explore the development and application of new technology. These three aspects include (1) problem assessment, (2) technical feasibility and (3) social feasibility.

1. Problem assessment

Identification and conceptualisation of a problem and how it fits within the broader human-environment system.

Example: Why are virus-carrying mosquitoes a health concern?

2. Technical feasibility

Assessment of current solutions to the problem and proposed new solutions (strengths, weaknesses, opportunities and threats).

Example: What is being done to manage the problem and how effective are these strategies?

3. Social feasibility

Assessment of user and stakeholder perceptions, and acceptability of a range of solutions.

Example: What do communities think of the proposed solutions and what are their views on how the problem is best managed?

Synthetic biology to reduce mosquito-borne diseases

Mosquito-borne diseases such as malaria, dengue, chikungunya and yellow fever can cause joint pain, nausea, fever, rash and even death, in humans and primates. Most prevalent in tropical and subtropical areas, mosquito-borne diseases disproportionality affect the poorest populations.

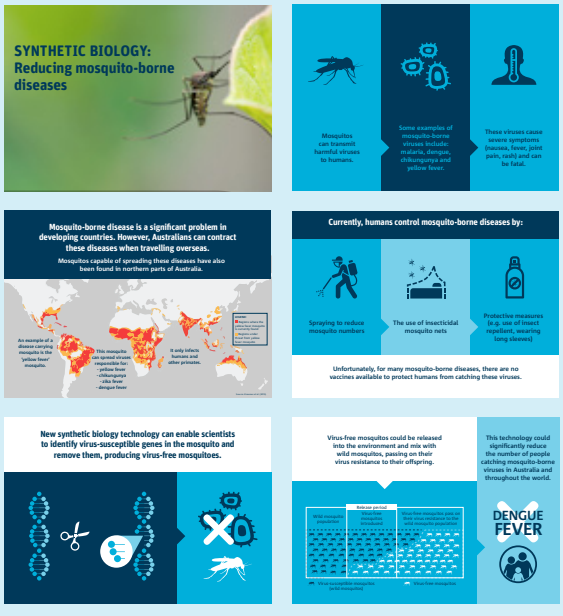
Mosquitoes can transmit diseases due to their genetic make-up, which enables them to carry various viruses and parasites, without becoming ill. While not all mosquitoes can do this, mosquitoes capable of spreading these diseases have been found many places across the globe, including northern Australia. Australians travelling to these places around the world are also, therefore, at risk.

Mosquito-borne diseases are currently managed by reducing contact with the insect. Chemical sprays and natural, herbal deterrents are used to reduce mosquito populations in the environment. Mosquito nets, insect repellents and protective clothing aim to prevent personal exposure. These methods have their limitations though and millions of people worldwide still get infected with mosquito-borne illnesses every year.

There are currently no vaccines available to protect humans from some of the more common mosquito-borne diseases such as malaria and dengue, and other solutions are being considered.

Synthetic biology technologies, such as gene editing, have the potential to offer new solutions by targeting genes related to disease susceptibility in mosquitoes. Gene editing involves changing an organism's genetic information by deleting, replacing or inserting a DNA sequence. Scientists have the potential to remove or change genes so that mosquitoes can no longer carry viruses and parasites. If these mosquitoes are then released into the wild, to mate with wild mosquitoes, it would allow the disease resistance genes to be passed onto wild mosquito offspring. Over generations, this would produce more disease-free mosquitoes and reduce the number of disease-carrying mosquitoes. The number of people who come into contact with disease-carrying mosquitoes would also reduce, potentially lowering the risk of human infection.

Story board sequence shown to survey participants, before they were asked their thoughts about reducing mosquito-borne diseases using synthetic biology.



Public attitudes towards using synthetic biology for reducing mosquito-borne diseases

Awareness of mosquito-borne diseases

Our research found most Australians (about 95%) were at least moderately aware that many diseases can be transmitted by mosquitoes. The majority of people (73%) also thought this was a moderate to very big problem.

Initial impressions of gene editing in mosquitoes

After viewing a storyboard presentation on the use of gene editing to reduce mosquito-borne diseases, Australian participants reported being moderately-to-strongly supportive of the development of this technology.

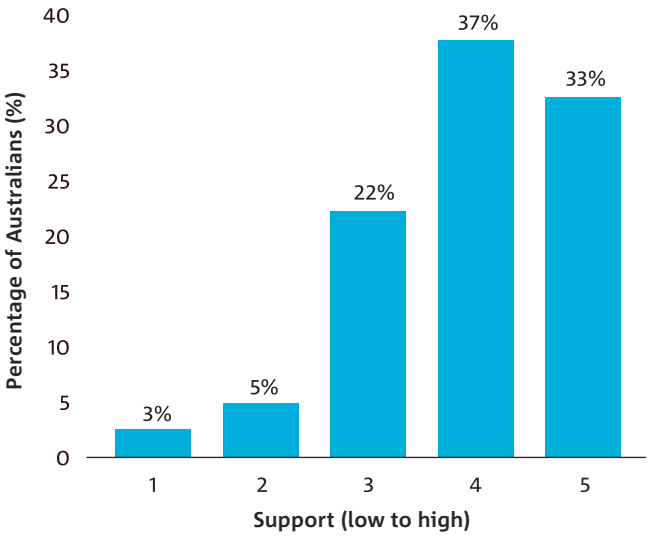


Figure 1 Australians' support of gene editing to help reduce mosquito-borne diseases.

When asked to consider the use of this technology in their local area, more than half (53%) of Australians indicated that they would not be bothered if this technology was implemented in their own community. Approximately 28% indicated being moderately bothered by local implementation and 19% indicated that they were more than moderately bothered. This public concern is important to know and understand, as it helps scientists shape how the technology will be developed.

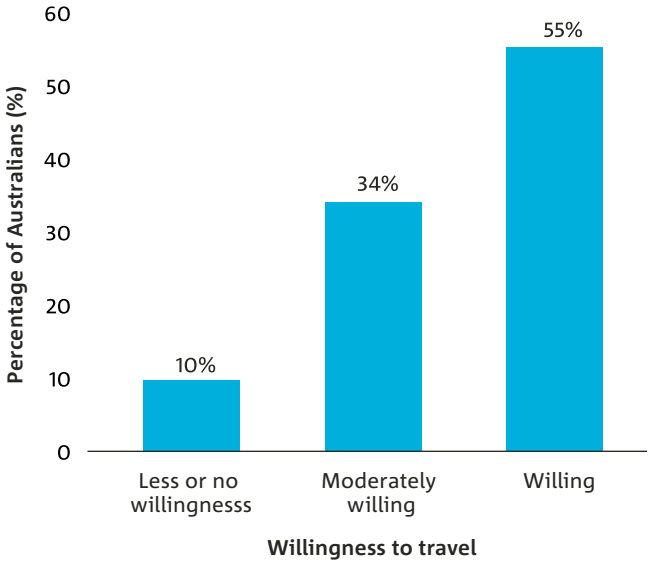
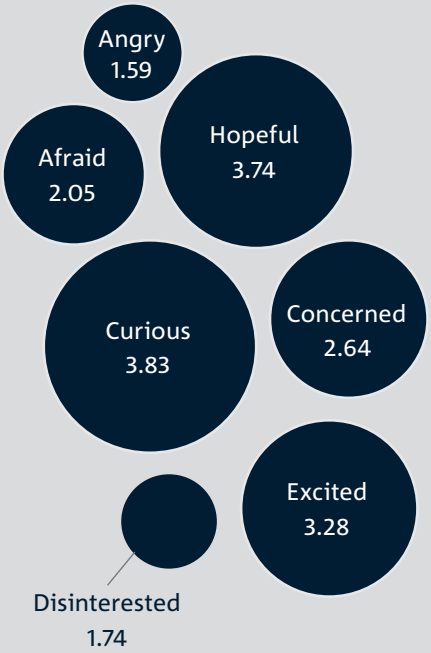


Figure 2 Australians' willingness to travel to countries where mosquitoes have been gene edited.

How do Australians feel about synthetic biology?

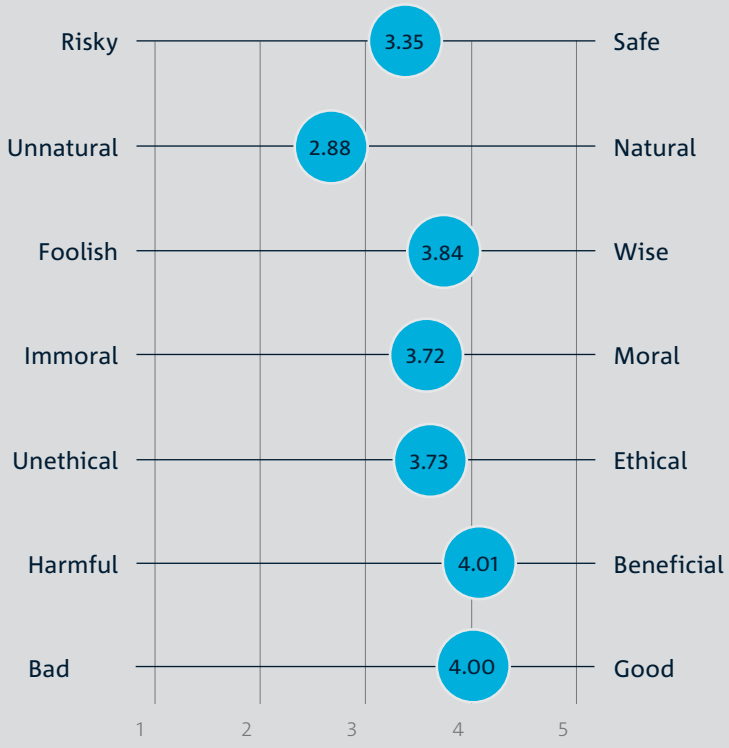
Gene editing in mosquitoes

Emotions indicated by Australians*



*Data range: 1 – 5

Attitudinal pairs*



Perceptions of benefits and risks associated with the technology

The majority of Australians (around 95%) rated synthetic biology technologies as moderately to very helpful in managing the problem of mosquito-borne diseases. Most Australians (69%) also agreed, or strongly agreed, that this technology would be better than current methods of reducing mosquito-borne diseases.

Despite their support, Australians did have some reservations about the technology. Most were concerned that gene editing could have negative long-term consequences:

- 74% were at least moderately concerned about the consequences for humans and animals
- 81% were at least moderately concerned about the risks to the natural environment
- 83% were at least moderately concerned about whether consequences arising from this technology could be controlled or managed.

Trust and regulation

The majority of Australians (90%) moderately-to-strongly trusted scientists to develop this technology responsibly. However, 72% of people were at least moderately concerned about the possibility of the technology being used for 'bad' purposes. Additionally, (77%) were at least moderately concerned that such misuse could lead to unintended negative consequences.

Most Australians (80%) held at least moderate trust towards the government agency responsible for approving and regulating the technology. On average, people moderately agreed that legislation and regulation would ensure the technology would be developed in a safe way – 48% agreed strongly that both the technology would be well regulated and that legislation would ensure its safe development.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Tropical
Strength

Public engagement in future

Most Australians (about 86%) indicated they were keen to know more about this synthetic biology technology. They said they wanted to know more about:

- the possible risks
- what is being done to regulate and control the technology
- who will benefit and who will bear the risks.

Most Australians (83%) indicated that the public should have access to an easy-to-read summary of scientific results, and 74% agreed that risk documentation should be made available.

About 39% of Australians thought it was important to consult the public, so their opinions could be considered when making decisions about this technology. Slightly more people (43%) thought it was necessary for the public to be kept informed of decisions made about synthetic biology.

Around 14% of Australians indicated that they did not need, or want, to know anything more about this technology than was already provided within the storyboard presented. Our survey also suggests that people may be more interested in understanding the risks and the process of managing these risks, than understanding the benefits of the technology.

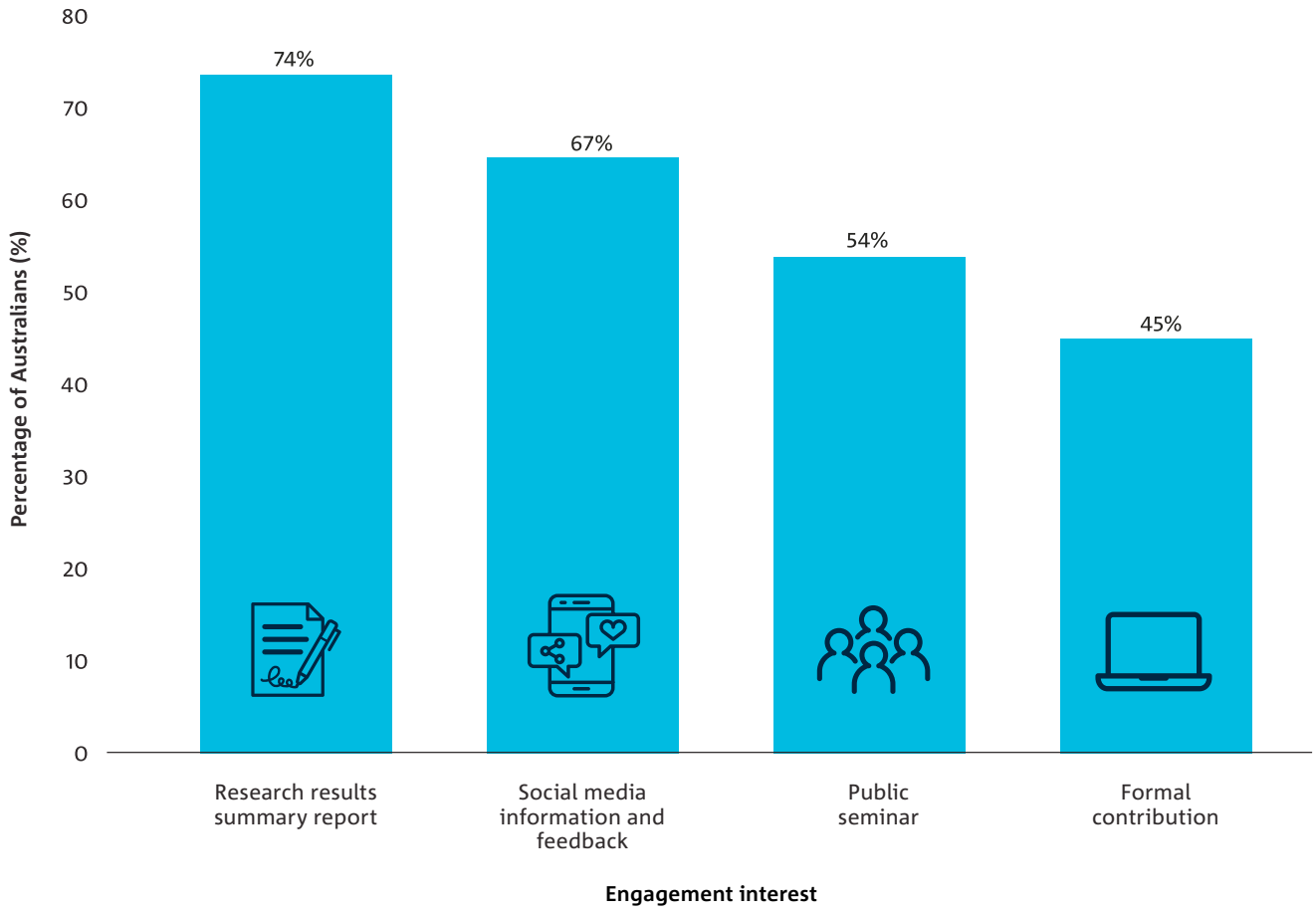
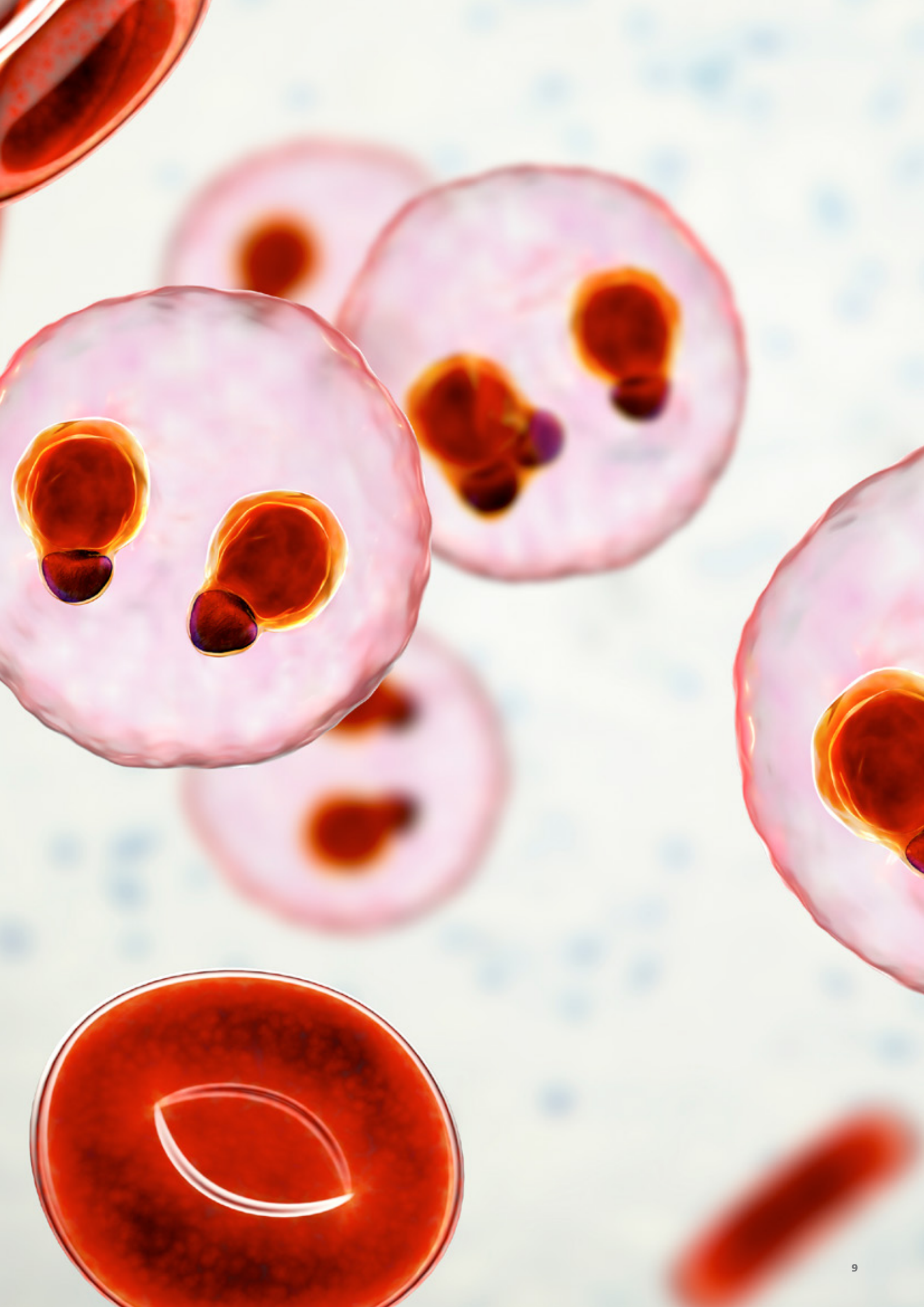


Figure 3 Personal preferences for further engagement with technology development.



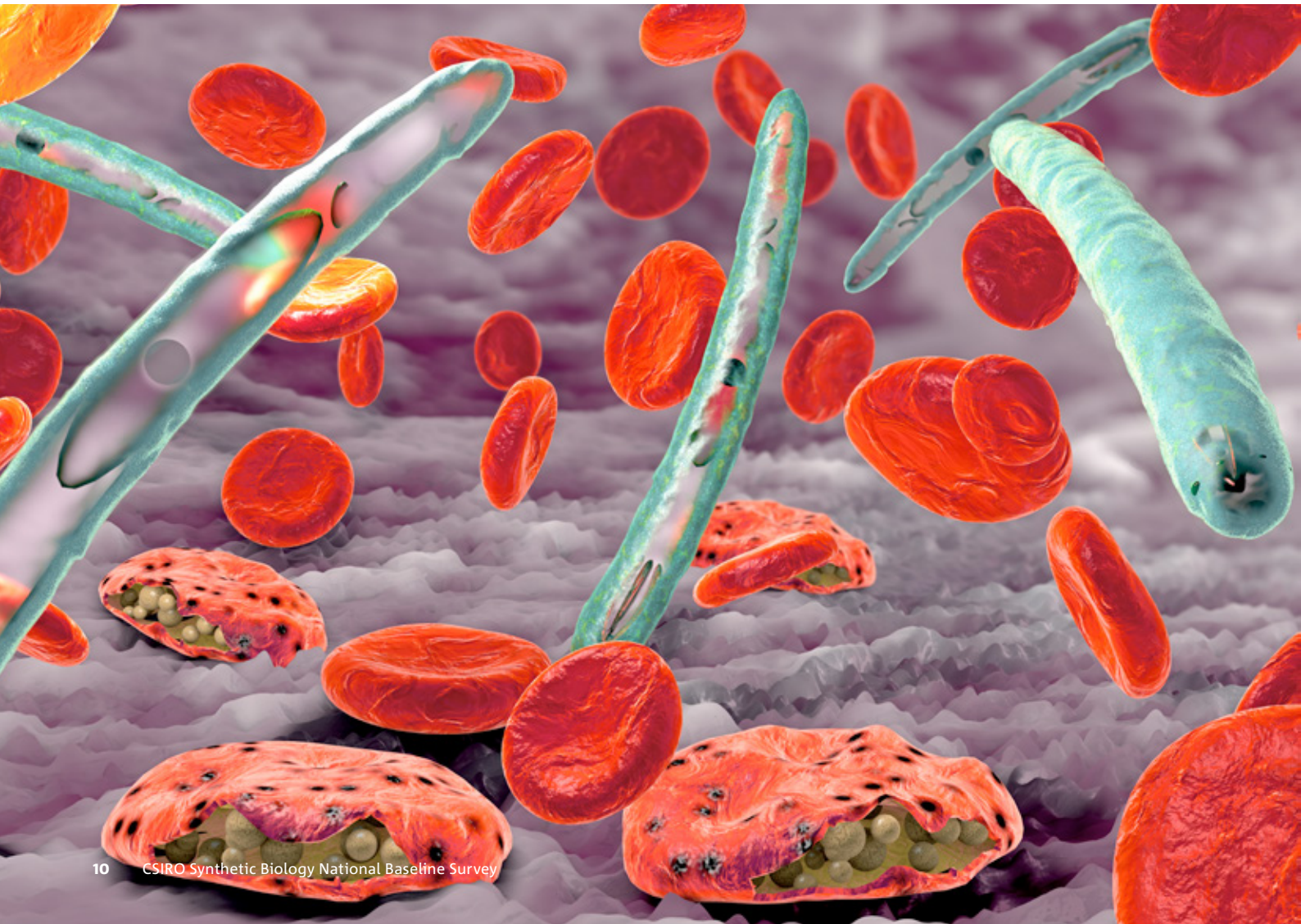
Impact

Understanding Australians' attitudes to synthetic biology can help scientists and research organisations to decide how to approach the development and implementation of new technologies.

Our survey findings have many applications and can be used in a variety of ways.

1. By government: to inform policy and regulatory decision-makers on how new technologies will be perceived by the public and how best to engage people.

2. By the science community: to inform scientists on how they can develop and plan future science activities in ways that address users' needs. This approach supports a responsible science agenda and acts as a quality-control measure to ensure that technology is being developed in a worthwhile and meaningful way. The survey findings also build the capacity of scientists to reflect on the social and ethical considerations of their work. Understanding the science and technology needed by Australians to solve current issues can lead to greater and more effective scientific innovation.



3. To benefit society: surveys provide insights into the public's understanding and perceptions of Australian science. Survey data can highlight the extent of society's trust in science and identify knowledge gaps. Increased understanding can shape future science directions and inform better ways for communities and scientists to work together.

This is one of the world's first comprehensive national surveys examining public perceptions across a range of synthetic biology technologies.

Research methods

The study involved presenting an online public opinion survey to a representative sample of 8,037 Australians. It examined how novel synthetic biology technologies could help address a range of important issues facing Australia.

In the survey, we presented information on one of seven environmental, industrial or health challenges in Australia:

- **Reducing mosquito-borne diseases**
- **Changing the properties of natural fibres**
- **Eliminating the culling of male chicks in the egg-laying industry**
- **Protecting endangered species**
- **Managing invasive pest species**
- **Reducing pollution in waterways**
- **Restoring the Great Barrier Reef**

The survey sample was representative of the Australian population in key demographics including age, gender, and location, including representation of Aboriginal and Torres Strait Islander peoples.

The research methodology for this CSIRO study was externally reviewed by a panel of three Australian social and behavioural science experts:

- Professor Kelly Fielding (The University of Queensland)
- Professor Catherine Waldby (Australian National University)
- Professor Iain Walker (Australian National University)

Information was presented to participants in the form of a PowerPoint-style slideshow, known as a 'storyboard'. The storyboards had a standard format with similar sequencing of information, language, use of visuals and length.

Social scientists teamed up with biotechnology scientists and professional science communicators to develop the storyboard content and visuals. The storyboards were validated and tested in seven public focus groups to ensure they were easy to understand and included the necessary information.

The Online Research Unit (ORU) hosted the online surveys throughout October and November 2018 and recruited a representative sample of Australians. Participants received a small standard payment from the ORU for participation. Research participants were randomly assigned to view just one of the seven storyboards.

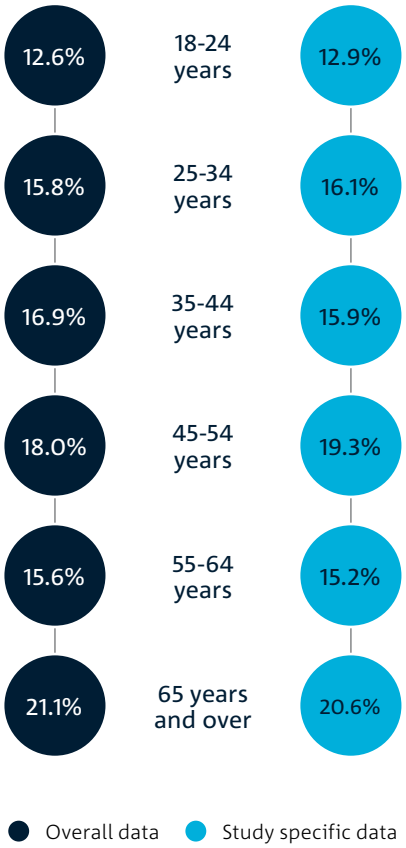
The survey asked participants how they felt about the development of the synthetic biology technology, what concerns they had about the technology, and if they would like to receive more information and be involved in further surveys.

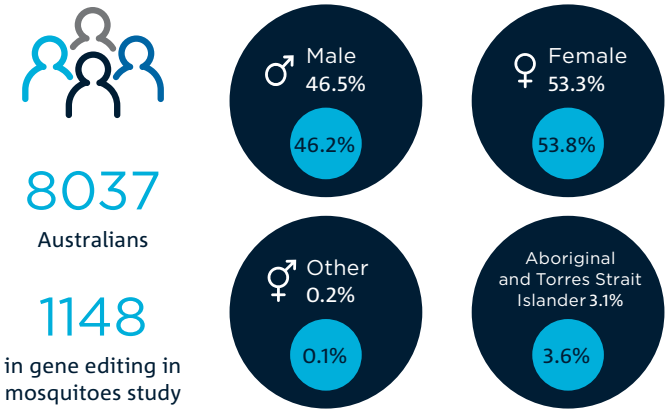
The survey has provided CSIRO with important insights into Australian attitudes. It is a powerful new contribution to decision making in Australia about issues facing the country.

This research was approved by the CSIRO Social and Interdisciplinary Research Human Research Ethics Committee (Ethics Clearance 013/18).

Australian demographic data

All surveys and this specific survey





Next steps in understanding public perceptions of synthetic biology

Our study incorporated a representative sample of the Australian public. However, some topics may be more relevant to particular communities. Future community- or place-based research will therefore be more targeted. It will involve identifying places where a particular synthetic biology technology could help in addressing a problem.

Researchers would engage with local people to understand their views about using new technologies to tackle problems directly affecting them.

This direct engagement will help communities, government and researchers decide whether, and how best, to deliver evidence-based programs to manage global health.

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1300 363 400
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