Please note: the substantive content of the 2026 NRI Roadmap Survey begins at Question 20 (with prior questions dealing with administrative and other information).

As such all submissions that are published include the responses submitted from Question 20 onwards only.

Q20.

Part 2: Research themes

2.1 NRI comprises the assets, facilities and associated expertise to support leading-edge research and innovation in Australia and is accessible to publicly and privately funded users across Australia and internationally. We are seeking your input on possible directions for future national-level investment - i.e., where the requirements are of such scale and importance that national-level collaboration and coordination are essential.

The 2021 Roadmap used a challenge framework to support NRI planning and investment. With this in mind, consider likely future research trends in the next 5 - 10 years, and with respect to one or more of the 8 challenge areas identified in the 2021 Roadmap as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or not at sufficient scale and
- describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities.

Q21.

Resources Technology and Critical Minerals Processing

Q22.

Food and Beverage

In the 2021 NRI Roadmap, cellular agriculture sits at the intersection of two priority areas - Food and Beverage and Frontier Technologies and Modern Manufacturing, but is not explicitly referred to in either. In Food and Beverage, there is a mention of non-meat based proteins, which is not traditionally how cellular agriculture products would be categorised, although there are some linkages. Food systems represent a significant economic opportunity for biomanufactured products, like those created using cellular agriculture technologies. These technologies - particularly cell cultivation, precision fermentation and gas fermentation - have the potential to play a critical role in building sovereign capability while diversifying food production, strengthening food security, and helping to meet the growing global demand for protein and other products, sustainably. Investments in biomanufactured food production can build supply chain resilience in a time of increasing food system vulnerability. Boston Consulting Group (link) projects this global market could be worth USD $100 billion by 2040— surpassing that of other emerging biomanufacturing industries like specialty chemicals and chemical precursors. As mentioned, McKinsey predicts that by 2050 the global market for fermentation-derived protein (including plant blends) and cultivated proteins (including plant blends) to be between USD$130-$180bn and USD$100-$140bn respectively annually. [link] McKinsey and BCG also identified a number of key research-related challenges that need to be addressed, of which, accessible and specific infrastructure will be essential: Process improvements and redesigned bioreactors could drive yield improvements, reduce bioreactor costs, and lower production costs by approximately 50 percent; new bioreactor technology could also expand the global market opportunity for Original Equipment Manufacturers (OEMs). Upgraded formulation and food design could result in a wider variety of high-quality offerings, particularly as companies improve product taste and texture. New business models could help the industry mitigate risks and finance more than $250 billion in expected infrastructure scale-up. CAA is pleased to note that targeted support for growing Australia’s novel food and beverage industry is a recommendation of the House of Representatives Standing Committee on Industry, Science and Resources inquiry into Food and Beverage Manufacturing in Australia. [link] Combined, we believe this indicates that both market and political momentum for biomanufactured foods is growing, but translation of research, at new scales, is critical to success.

Q23.
Medical Products

Q24.
Defence

Q25.
Recycling and Clean Energy

Q26.
Space

Q27.

Environment and Climate

Q28.

Frontier Technologies and Modern Manufacturing

The absence of an explicit reference to cellular agriculture as a priority in the 2021 NRI Roadmap means there has been no signal from the Government to catalyse investment into nationally significant research infrastructure for the sector. That said, there was NCRIS-funded infrastructure dedicated to synthetic biology managed via BioPlatforms Australia that contributed to the research needs of cellular agriculture companies. However, stakeholders have advised that the infrastructure available is expensive to use, not fit-for-purpose and the scale available does not meet the sector's needs anymore. The sector's main research questions now coalesce around the transition from laboratory scale to commercial technology transfer and scale-up. The sector's main research questions now coalesce around the transition from laboratory scale to commercial technology transfer and scale-up. While Australia excels in early-stage research and development (TRL 1-4), there is a significant gap in accessible infrastructure and commercial/regulatory support for scaling up production from 25 litres to 2000L. This gap hinders: critical product testing and prototyping developing and optimising bioprocessses demonstrating feasibility to be able to engage with commercial facilities preparing for regulatory assessment. In turn, this impacts the understanding of economic viability of products and limits the ability to raise investment, potentially forcing companies to seek opportunities offshore or halt projects altogether. A bottleneck around access to laboratories and infrastructure at a pilot-scale and demonstration-scale is the most commonly cited barrier to research innovation across the sector. Existing small/laboratory-scale research infrastructure has supported the sector's progress to a proof-of-concept stage, but more research is needed to test products and processes at a larger scale to prepare for regulatory requirements and real-world applications. Australia's Food and Beverage Accelerator (FaBA) in their 2024 White Paper, "Precision Fermentation: A Future of Food in Australia", [link] states that a 20-fold increase in fermentation capacity is needed by 2040 to satisfy the projected market demand for precision-fermented ingredients. CAA's precision fermentation network includes six Australian companies and 20 companies based in Southeast Asia, where the consensus is a research infrastructure gap exists between proof-of-concept (25 litre) and 2000L for the sector to then transition successfully to commercial scales of 10,000 litres+.

Q29.

2.2 The 2024 statement of National Science and Research Priorities (NSRPs) includes outcomes linked to each priority to assist in identifying critical research needed in the next 5 to 10 years.

Consider the priority statements and, with respect to one or more of the 5 priority areas as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or
- not at sufficient scale and describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities, and where relevant, refer to the underpinning outcomes and research identified in the NSRPs document.

Q30.

Transitioning to a net zero future

Q31.

Supporting healthy and thriving communities

Q32.

Elevating Aboriginal and Torres Strait Islanders knowledge systems

Q33.

Protecting and restoring Australia’s environment

Q34.

Building a secure and resilient nation

Q35.

2.3 The case for a new NRI capability, or enhancements to existing capabilities, typically emerges through advocacy from research communities clustering around rigorously identified needs and goals. Such a concept could respond to a requirement for novel or expanded capacity within a domain, or across domains, and must be such that it could only be made available with national-level investment.

If you have identified such a requirement, briefly describe the need, the proposed infrastructure capability, the medium-term goals, impacted research communities, and the timeframe over which you advocate its establishment. Your response can include links to relevant existing reports.

CAA submits that the 2026 NRI Roadmap should nominate biomanufacturing as underpinning the bioeconomy, as a new NRI capability. This would build on the recognition in the 2021 NRI Roadmap of the importance of the bioeconomy in the Synthetic Biology research theme, which stated "The resulting research-innovation pipeline is also set to create new, disruptive bioindustries that will ensure future prosperity by underpinning a strong and sustainable bioeconomy that supports Australian net zero strategies and targets." (p 85) CAA also submits that the biomanufacturing of ingredients and food products should be one of the priority bioindustries looking forward. The Need Publicly funded and accessible infrastructure to support research and development is a key requirement to advance the Australian bioeconomy. CAA's focus is food as a new bioindustry, and so provides the following information on the needs of the cellular agriculture sector. While private investment in cellular agriculture globally has grown over recent years, public research in the sector is disproportionately underfunded. As a result, scientific discoveries and breakthroughs are locked up in incumbent private companies, which widens the so-called "valley of death" between basic research and research translation for product commercialisation. This makes it increasingly difficult for new start-ups to enter the sector and, paradoxically, hinders innovation. In addition, the lack of objective academics and rigorous peer-reviewed research in these new technologies makes it more difficult to build consumer trust. Fundamentally, the need can be defined as: Pilot and demonstration infrastructure and associated upstream and downstream processing linked to research programs to optimise bioprocesses production systems etc. which could lead to up to a 50% reduction in unit costs Research to underpin the redesign of bioreactors that are designed and optimised specifically for food production. This has the potential to support process optimisation whilst also driving down capital investment requirements as the sector scales. Process optimisation and tech transfer capabilities to other bioindustries such as fuel, fibre etc. Multi-use and modular facility design to facilitate the range of manufacturing technologies being developed in Australia The proposed infrastructure capability While current synthetic biology infrastructure exists, it is not at a scale required, nor is it designed for food production. Currently, cellular agriculture research must be undertaken in bioreactor infrastructure that is not fit-for-purpose, creating cost inefficiencies and imperfect outcomes. The key immediate research infrastructure required to develop, prototype and scale the manufacture of cultivated meat and precision fermentation products includes: Research infrastructure consisting of 25L - 2000L fit-for-purpose bioreactors is required. This allows upstream and downstream processing that can be customised to mimic the process at scale allowing optimisation of the standard operating processes and equipment that will be used at scale. Without this step, there is little way to know if production can be replicated in large fermentation tanks that perform in different environments and at different optimal conditions. Microbial strains - the development of microbial strains that have been developed with media formulations and demonstrated at scale is where research infrastructure will play a key role. Cell line repositories - existing cell lines are often proprietary and difficult to obtain, creating a high barrier to entry for researchers and companies. Ensuring these cell lines have been developed with media formulations and demonstrated at scale is where research infrastructure will play a key role. Scaffold databases - scaffolds made from biomaterials fit for human consumption have been used in the development of structured meats like steak or fish fillets. However, most existing scaffolds are made from human-derived proteins and used for regenerative medicine purposes. Whether these scaffolds can continue to underpin cultivated meat production requires more research. The cellular agriculture sector also requires a research uplift in HASS disciplines and resulting infrastructure. In order to translate research into real-world applications, research that supports regulatory frameworks and approaches, the development of global safety standards for new foods, and determining consumer attitudes to new foods is critical. The medium- term goals Infrastructure that can support the development of new bioindustries, including food, fibres, materials, chemicals and fuels. Specifically, the following impact could be realised: Scale existing laboratory research capability to better prepare for commercial-scale production processes Enable product testing, economic viability assessment, and customer prototyping within research environments Retain Australian companies and projects within the country, supported by fit-for-purpose research infrastructure Attract foreign direct investment in the biomanufacturing sector Position Australia as a top global destination for cellular agriculture research This, in turn would translate to the following: Create jobs and export opportunities Enhance supply chain resilience and adaptability Support Australia's circularity and environmental goals Impacted research communities Those research communities serving food in the bioeconomy include: Synthetic Biology Cell and tissue biology Microbiology Food (nutrition)science Food science (product formulation) Food regulation Plant science Agricultural science Bioprocess engineering Mechanical engineering (infrastructure design) Timeframe This infrastructure can be supporting innovation in 1-3 years

Q36.

Part 3: Industry perspectives

This section is seeking input specifically from industry-based respondents. Other respondents can skip this section.

Recommendation 6 of the 2021 Roadmap related to improvements in industry engagement with NRI. To complement work on this topic that has occurred since then, we are seeking additional advice on NRI requirements as perceived by current or potential industry-based users.

Q37.

3.1 Have you (or your organisation) interreacted with or used Australia's NRI?

- ○ Yes
- ◉ No

Q38.

3.2 If so, please briefly outline the NRI capabilities you (or your organisation) have interacted with or used. Do not limit your response to NCRIS capabilities.

This question was not displayed to the respondent.

Q39.

3.3 Please indicate your (one or more) primary reasons for interacting with NRI:

This question was not displayed to the respondent.

Q40.

3.4 If you answered no, please indicate your (one or more) primary reasons:

- [ ] I did not know about it
- [ ] Other facilities suit my needs better
- [ ] I would like to, but cannot get access due to geographical location
- [ ] I would like to, but believed that access was only available to academic researchers
- [ ] I am not aware of any capability that meets my needs
- [x] Other (please specify) We are an NFP

Q41.

Part 4: Other comments

4.1 Please elaborate on any of your above responses or add any other comments relevant to the development of the 2026 Roadmap. Your response can include reference or links to existing reports that you recommend be considered during the 2026 Roadmap development process.

CAA submits that recognising biomanufacturing, including cellular agriculture, for critical infrastructure investment is strongly aligned with the NRI priority to make investments that drive economic outcomes, national security, social wellbeing and environmental sustainability. Aminetzah, D, Levene, J, Brennan, T and Toews, K (2025) “Ingredients for the future: Bringing the biotech revolution to food” McKinsey, 13 March 2025 https://www.mckinsey.com/industries/agriculture/our-insights/ingredients-for-the-future-bringing-the-biotech-revolution-to-food Bobier, J, Cerisy T, Coulin, A, Bleecher, C, Sassoon, V and Alexander, B (2024) “Breaking the Cost Barrier in Biomanufacturing” Boston Consulting Group, February 2024 https://web-assets.bcg.com/b6/15/6a10d22c481e8bebaf0c2fab8294/bcg-breaking-the-cost-barrier-on-biomanufacturing-rev.pdf CSIRO “Protein - A Roadmap for unlocking technology-led growth opportunities for Australia”, in CSIRO Futures. 2022, CSIRO: Canberra. https://www.csiro.au/en/work-with-us/services/consultancy-strategic-advice-services/csiro-futures/agriculture-and-food/australias-protein-roadmap CSIRO and Main Sequence Ventures (2023) “Synthetic Biology: National Progress Report.” CSIRO, Canberra. https://www.csiro.au/en/work-with-us/services/consultancy-strategic-advice-services/csiro-futures/future-industries/synthetic-biology-roadmap FAO (2024) “Bioeconomy for sustainable food and agriculture: a global opportunity” Position paper. Rome. https://doi.org/10.4060/ cd1976en https://openknowledge.fao.org/items/08505fa1-4cca-49ec-8019-3d320479cfb5 House of Representatives Standing Committee on Industry, Science and Resources inquiry into Food and Beverage Manufacturing in Australia (2024) “Food for Thought” Final Report https://www.aph.gov.au/Parliamentary_Business/Committees/House/Industry_Science_and_Resources/FoodandBeverage/Report Marcellin, E, Bansal, N, Ebert, B, Gumulya, Y, Johnson, H, Peng, H, Turner, M, van der Pols, J. (2024). (eds.) Precision Fermentation: A Future of Food in Australia, White Paper, Innovative Ingredients Program, Australia's Food and Beverage Accelerator (FaBA), The University of Queensland https://faba.au/wp-content/uploads/2024/11/Precision-Fermentation-A-Future-of-Food-in-Australia.pdf Pretorius, S, Paulson, I, Dixon, T (2023) “The Australian bioeconomy market is more than medicine” Innovation Australia, 17 November 2023 https://www.innovationaus.com/the-australian-bioeconomy-market-is-more-than-medicine/ Van der Kley, D, Santos, D and Pavlich D (2024) “A Future (Bio)Made in Australia? An industrial biomanufacturing plan to enhance economic security” National Security College, Australian National University https://nsc.anu.edu.au/sites/default/files/2024-08/NSC_POP_Future%20Biomade%20in%20Australia_web.pdf World Economic Forum (2024) “Accelerating the Tech Driven Bioeconomy” Insights Report https://www3.weforum.org/docs/WEF_Accelerating_the_Tech_Driven_Bioeconomy_2024.pdf