

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

Step change innovations in agriculture are likely to be driven by advancements in biotechnology. Improvements to crop yield, food quality, enhanced breeding programs, and pest and disease resistance are being seen through the adoption of molecular life science approaches. Australian agriculture accounted for 11% of goods and services exports in 2019–20 and 1.9% of GDP. The Australian Farmers Federation has a goal to grow Australia's agricultural sector to 100b per annum, realising this vision will require the adoption of new technologies. Emerging technologies in the biomolecular sciences have a critical role to play in the support, advancement and protection of Australia's agriculture industry. From enhancing genetic gains in yield and quality, to pest and disease reduction and improved biosecurity the benefit of applied genomics is estimated to be in the billions of dollars. Researchers and industry stakeholders across Australia, and internationally, are already integrating 'omics data into developing resistant varieties, chemical and biological controls, and biosecurity surveillance programs. Yet, their progress is impeded by large gaps in the referential data that is available, particularly over space and time, and existing data can be difficult and time consuming to find and access. In the report "Accelerating Precision Agriculture to Decision Agriculture: Enabling digital agriculture in Australia" the CRDC estimates that genetic gains through objective data will be worth \$2.9B to the industry, by proving improvements in animal and variety selection. "Major improvements in plant and animal genetics have been achieved using genetic benchmarking and genomics tools By achieving better breeding, genetic selection and rotation decisions through the application of decision agriculture, economic modelling estimated an improvement in GVP of \$2.9 billion." Over the next decade, targeted 'omics for agriculture, including genomics, proteomics, metabolomics, synthetic biology and phenomics has the potential to:

- achieve better breeding, genetic selection and rotation decisions through the application of decision agriculture
- fast-track fundamental research through the creation of a referential 'omics data resource of key pathogens and their strains and how they vary over time and space;
- consolidate and extend national knowledge and capabilities in plant and livestock protection and biosecurity preparedness
- bolster a national network for the identification and monitoring of agricultural pathogen populations that affect a broad range of agricultural sectors
- improve the balance of environmental sustainability – more efficiencies in crop and livestock production have the potential to lead to more efficient and sustainable land and water use.

Q23.

Medical Products

It is hard to quantify the impact genomics has had on human health. "Since its emergence, genomic sequencing has become one of the most influential tools in biomedical research." In the decades since the completion of the human genome project, advances in genetic sequencing and genomics analyses are changing the way we understand, treat and prevent human disease. Every year in Australia, more than 1000 children and adolescents are diagnosed with cancer. The Zero Childhood Cancer Program (ZERO) is Australia's first-ever personalised medicine program for children and young people with high-risk cancer. Using cutting-edge science, the latest technology, and expertise in research and clinical care, it is changing the model of care for children with cancer. As soon as a child is enrolled on the ZERO national clinical trial, a sample is taken of their cancer and sent to the labs at Children's Cancer Institute. There, scientists use the latest science and technology to examine the molecules inside the cancer cells, looking for vital clues about what is likely to be driving the growth of the cancer, and how it might best be treated. The results of all this testing and analysis are then made available to an expert team of clinicians and scientists, who develop a potential treatment plan tailored to that child – a personalised treatment plan that offers the best possible chance of cure. Zero was the first scaled precision medicine trial - there are now many more. Over the next decade, targeted 'omics for biomedicine and medical products research, including genomics, proteomics, metabolomics, synthetic biology and phenomics will:

- Research, development, clinical trial, precision medicine (omics has impact across this lifecycle)
- Drug discovery, vaccine development
- Better health screening for genetic risk factors including arthritis, diabetes and cardiovascular disease
- Understand gene and cell function
- Better understand the impact of the environmental factors on human health through the epigenome
- Protein structure and function including recent advances in AI (AlphaFold)
- Re-engineer and manipulate biological processes through CRISPR
- Personalised medicine. Sequencing-based assays can now identify disease-specific drivers, mutational signatures, tumour mutational burden and neo-antigens, offering tremendous promise to guide personalised patient care . The penetration of 'omics into healthcare is pervasive and recently acknowledged with the Commonwealth Government announcing a new Health function "Genomics Australia" with a soon to be appointed commissioner overseeing the adoption of this transaltion science.

Q24.

Defence

Q25.

Recycling and Clean Energy

Q27.
Environment and Climate

Australia is home to more than one million known species of plants and animals and more than 80% of mammals and 90% of frogs are unique to Australia. The value of Australia's rich and unique biodiversity is significant both globally and nationally. Our native flora and fauna are not only key to our national identity but play an important role in supporting human health and wellbeing, and is economically important to a wide range of industries including tourism, agriculture, and pharmaceuticals. However, the State of the Environment report found that due to a number of pressures "that Australia's biodiversity is under increased threat and has, overall, continued to decline," and that "most jurisdictions consider the status of threatened species to be poor and the trend to be declining. Invasive species, particularly feral animals, are unequivocally increasing the pressure they exert on Australia's biodiversity, and habitat fragmentation and degradation continue in many areas. The impacts of climate change are increasing." In these uncertain times new technologies have come to the fore to support national efforts to document and describe our biodiversity, support conservation efforts and enhance our biosecurity measures. There has been a step-change in the availability of genomics data and analysis tools which are being utilised by conservation managers, taxonomists, biosecurity agents, urban planners and researchers. Over the next decade, targeted 'omics for environmental research, including genomics, proteomics, metabolomics and phenomics has the potential to: • Providing data driven decision making for conservation managers who are working at the coalface to save our global species when they are undertaking critical actions such as translocations, captive breeding, or responding to natural disasters such as bushfires. • Supporting a new workforce of scientists: genome biologists, population biologists, bioinformaticians, population geneticist and zoologists who are able to not only manage the genetic diversity in our most threatened species. • Enhancing our understanding of our biodiversity by creating a comprehensive reference library of DNA sequences of all known Australian species. In the Academy of Science's decadal plan one of their strategic actions call for a "curated, vouchered reference library of DNA sequences covering the breadth of the tree of life in our region". This is now more critical than ever with the reality of AI and need for high quality data assets to train models. • Building the phylogenies (evolutionary trees) on which modern classification systems are built • Providing new methods for the discovery of new species through environmental DNA (eDNA) studies. By sequencing and analysing DNA in soil, water, air and other bulk environmental samples new species are regularly discovered which are enhancing our understanding of our ecosystems.

Q28.
Frontier Technologies and Modern Manufacturing

Synthetic biology is a disruptive technology which is rapidly reshaping many industries internationally. New customised molecules and designed biological pathways generated through synthetic biology will underpin applications as diverse as biocontrol, biofuels, drought resistant crops, improved nutrition and human therapeutics for diseases such as Alzheimer's and cancer. Australia already has enormous expertise in basic and translational research across these disciplines and boasts a world-leading regulatory framework for gene technology. Synthetic Biology also provides an essential capability to basic research, allowing exploration of biological systems on an unprecedented scale through automated assembly and testing. These approaches have yielded insights into biological systems that were previously not possible to examine. However, critical gaps in technology platforms and informatics remain a serious impediment for Australia to realising economic and health benefits worth billions of dollars. Lateral extension of the NCRIS Synthetic Biology to plant science and human cells will permit focused enablement of key national challenges and with partnership and investment to scale up manufacturing will directly support industry development and growth. We will operate within a global scientific ecosystem and market, and a step-change inclusion of national capability in ethics and regulatory understanding, legal and intellectual property freedom to operate, together with systemised access to private investment and business partnership will accelerate Australia's science commercialisation. Scale up into pilot manufacturing remains unmet, notably for industrial biotechnology and is a sited impediment to the realisation of commercial opportunity developing through Australia's leading synthetic biology capability.

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

Synthetic Biology is a disruptive technology which is rapidly reshaping many industries internationally. New customised molecules and designed biological pathways generated through synthetic biology will underpin applications as diverse as biocontrol, biofuels, drought resistant crops, waste recycling in a circular economy, reduction of agricultural carbon emissions such as methane from livestock, and sustainable replacements for fossil fuel by-products such as oils and dyes. Australia already has enormous expertise in basic and translational research across these disciplines and boasts a world-leading regulatory framework for gene technology. However, critical gaps in technology platforms and informatics remain a serious impediment for Australia to realising economic and health benefits worth billions of dollars. Ensuring preparedness and might look like: • Extension of the core Synthetic Biology capability supported through NCRIS as a consequence of 2023 investment, to ensure currency and meet the demand trajectory. • Continued investment in world class fermentation labs to ensure access to latest instrumentation, methods and techniques • To enhance fundamental synthetic biology capacity continue to collaborate and co-invest in the development of accessible state biofoundry infrastructure through NCRIS and other processes. • To address the challenge of limited private investment in fermentation capacity, consideration of investing in fermentation capacity to de-risk appropriate investment in critical infrastructure at pilot scale and create the translational pathways.

Q31.

Supporting healthy and thriving communities

Meeting a predictable trajectory of scale Population scale research refers to research studies that generate, hundreds if not thousands of genomes. Technology advancements and reduced sequencing costs have made these types of studies possible. However, ensuring Australia has the appropriate infrastructure, expertise and capacity in place is critical to ensuring we are able to drive discovery and innovation in supporting these types of studies locally and can participate as first class global citizens on international collaborations. Ensuring preparedness and might look like: • Access to appropriate skills and expertise with experience in working on large programs, expertise in the domain being studied, • Operational maturity – accepted standards and methods described, agreed and in place, accreditation, and standardised quality control • Sophisticated laboratory network capable of scaling to cope with the quantity of samples required, standards and policies in place to cope with rare or delicate samples, • Established bioinformatics pipelines, analysis methods and computational infrastructure capable of coping with the scale and complexity of the data involved to ensure fast and accurate interpretation of results. • Development of a translation strategy to ensure greater translation and commercialisation of research by allowing industry and other research end-users to engage more effectively

Q32.

Elevating Aboriginal and Torres Strait Islanders knowledge systems

Improving health and social equity for Aboriginal and Torres Strait Islander people is one of Australia's most significant and enduring challenges. In Australia, substantial and increasing investments are being directed towards Indigenous health research through initiatives such as the MRFF and the NHMRC, among others. Additionally, the nation boasts NRI capabilities, such as those provided through NCRI. However, despite the presence of these valuable resources, a notable gap persists in both the accessibility and integration of these capabilities. This lack of connectivity hampers the seamless utilisation of available resources and exacerbates the fragmentation of data emerging from these platforms. As a consequence, the potential for a cohesive, comprehensive approach to Indigenous healthcare is compromised, hindering efforts to bridge the health gap between Indigenous and non-Indigenous populations. The Australian Medical Research and Innovation Priorities underscore the urgent need to accelerate and advance innovation to drive meaningful advancements in health outcomes. This requires us to direct our efforts to leveraging the opportunities presented by novel or emerging tools and technologies, such as personalised and precision medicine, which hold the potential to revolutionise health and medical research, interventions, and care delivery. The integration of large-scale health infrastructure and the ensuing harmonisation of datasets are pivotal components in catalysing this transformative leap forward. To accomplish this, a number key infrastructure components are necessary: 1. Indigenous leadership with responsibility for budget appropriation, community engagement and prioritisation of indigenous health and biomedical research collaborations. This leadership function will have the means to recruit existing and new research infrastructures on a needs basis that underpin the national indigenous health research agenda. 2. Dedicated embedded scientific and technical staff that are directed by and for the program leadership. This will ensure culturally sympathetic protocols and approaches are normalised and in time distributed through the broader staffing complement. 3. Meet technology gaps that are deemed critical to indigenous health and medical research translation. 4. Drive cross-disciplinary workflows that lower the barriers for researchers and health and industry practitioners to access services across multiple capabilities. This provides a unified capability for users to access a variety of complex and otherwise disparate services. 5. Integration of these data into a Precision Medicine for Population Health platform, allowing health and disease to be examined at an increasingly fine-grained resolution, attuned to the complexities of both individual biology and variation within the Aboriginal and Torres Strait Islander population.

Q33.

Protecting and restoring Australia's environment

Australia is considered one of 17 mega biologically diverse countries, that collectively support over 70% of the world's biodiversity, including many species that are unique to each nation. It is estimated that Australia is home to between 600,000 and 700,000 native species. This irreplaceable diversity underpins vital ecosystem services such as air, water, and climate regulation, and has substantial economic implications across industries like natural resource management, tourism, agriculture, and biotechnology. However, much of Australia's biodiversity remains undiscovered or poorly understood, data required to understand complex biology of Australia's biodiversity. The development of Australian-focused national scale genomic data is also required. To enable this ambitious objective of generating a sector-wide data creation and management framework that support the discovery, management, and utilisation of Australia's biodiversity, life science researchers need: 1. Streamlined biodiversity data creation capabilities and processes that reduces unit operation costs and supports technical expertise required for existing high throughput sequencing operations. 2. Streamlined metadata processes including efficient recording, automated curation, enhanced delivery of FAIR and CARE principles, including connection to digitised specimen collections. 3. Enhanced systematic approaches to referential data creation to meet the demand of national scale genomic data resources across vast and uniquely diverse taxonomic groupings in Australia's biodiversity. 4. National biodiversity genomic data storage and linkage to physical collections, ensuring trusted accesses, permissions, data sovereignty and security including protection of First Nations rights. Creation and utility of national scale genomic data across Australia's mega-biodiversity will enable Australia's world leading scientists, industries and government to inform the policy and actions required to understand and mitigate Australia's greatest challenges. Biodiversity genomic data has applications across a broad range of nationally important themes, and therefore, the associated thematic research communities will drive the prioritisation, creation and application of data that can also be leverage across other interconnected themes and applications, including -Biodiversity – foundational identification of species to enable biodiversity economic assessment and management -Preservation and Conservation of our precious and threatened species -Biodiscovery of new medicines and molecules -Biosecurity and Surveillance across one health risks -Health – prevent illness and diseases linked to pollution as well as communicable and foodborne disease -Indigenous knowledge – value, protect and reinforce indigenous understandings, skills, and philosophies - Primary Industries (Agriculture, Forestry, Fisheries and Food) – safeguarding Australia's food security and export markets

Q34.

Building a secure and resilient nation

Defence Science and Technology Group initiated the Safeguarding Australia through Biotechnology Response and Engagement (SABRE) Alliance that includes participation from defence, defence industry, non-defence industry, CSIRO, academia and critically - NCRIS (Bioplatforms, ARDC, APPN). The core mission of SABRE is to draw, leverage, and grow capability, capacity and expertise from across the Australian biotechnology research and development ecosystem to address Defence and National Security needs and prepare for future threats. This mission is executed through targeted funding initiative, facilitating synergistic collaborations, and forward thinking that pre-empts future needs. SABRE Vision To enable Australia's biotechnology ecosystem to innovate, collaborate, and secure the Nation's future through advanced research, workforce development, and Industry engagement. SABRE Mission To create and sustain a dynamic alliance between Academia, Industry, and Defence and National Security sectors that leverages biotechnology advancements, fosters talent, and accelerates the translation of breakthroughs into real-world applications for a safer and more prosperous Australia. SABRE Focus Areas Human Performance and Decision-making, Genomics, Bioinformatics, Synthetic Biology Agriculture, and Biosecurity This dual purpose initiative depends upon NRI (high performance compute, data creation (APPN, Bioplatforms), synthetic biology, data management and analysis (ARDC) with an aim of identifying and engaging with critical skills and workforce that can support the transition of priority capability into behind defence firewalls as required.

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.

A collaborative, AI-enhanced research ecosystem that advances Australian life-science across disciplines, from healthcare to biodiversity, ecology, and agriculture, enabling researchers to address complex challenges and contribute to societal and environmental wellbeing. Artificial Intelligence, in the form of machine learning and now generative AI, offer transformative improvements in the biological insight achievable from increasingly complex, multi-modal and scaled data. While AI will impact all research, life sciences with its complex and diverse data, often approximate in nature and requiring experienced interpretation, is particularly amenable to the possibilities that are emerging. This opportunity can be pursued in an accelerated manner using the foundation stone provided by previous NCRIS investment in the Australian BioCommons via Bioplatforms Australia. The application of AlphaFold to predict protein structures and resolve the spectrum of fundamental biology through to precision drug targeting, is the most advanced example of AI in Life Science. This invention was awarded the 2024 Nobel Prize in Chemistry. More generally, the prospect of improved analytics combined with a vastly improved ability to describe, relate, compare and re-use the enormous holding of life science data being created today, is being made real by progress in AI. This will bring 1. Productivity uplift through automation, data handling and recalling knowledge from the vast scientific literature 2. New Science uplift through modelling and “seeing” associations and insights that are not possible with existing methods. Bioplatforms embarked on a 12 month consultation into the needs, possibilities and delivery mechanisms for the introduction of an AI platform into an Australian setting. More than 50. Consultations, workshops with AWS and Nvidia, and culminating with the recent tour to Australia by Professor Ewan Birney, Director of EMBL-EBI. This proposal responds to those learnings. AI is not dependent upon new skills, computational environments, availability of data or delivery of unique code – it is dependent upon the rational convergence of all of these things in the context of research sectors and users. Indeed AI is not a singular capability, rather a collection of categories and methods that research infrastructure is well positioned to make accessible not only to experts, but place in the hands of innovative scientists asking probing questions of biology and its application. These categories include 1. “Recall” deep learning – analogous to ChatGPT that we are all familiar with, but tailored to respond to the presentation of scientific (genomic, image) features and recall data, literature, subsequent studies, trials and interventions that associate with the features of interest. 2. “Labelling” deep learning – able to automate the association of identifiable features with existing knowledge – for instance the functional annotation of a genome or image – and indeed provide opportunities for multi-modal correlation of data at scale. 3. “Modelling” deep learning – use proximity metadata to generate in silico representations of biological molecules and systems. AlphaFold is the first and highest profile example and has reduced protein structure predictions from thousands of years of laboratory time to computational simulations, permitting advanced studies in drug associations and functional assessment. WHO WILL BENEFIT Whilst the application of AI will be penetrative to much research across human health and medicine, agricultural security and productivity, and biodiversity analysis and conservation, the delivery mechanism will be patently via research infrastructure – the convergence and integration of NDRI outcomes into accessible AI packages and services. Delivery via user centric Flagship Initiatives, that are somewhat AI ready, discretely valuable programs in their own right and prove the technology in readiness for broader access will ensure the dual benefits of immediate value and longer term generalised access. Examples may include a national AlphaFold capability, multi-modal data interpretations (such as ACEMID Melanoma Screening - imaging, 'omics, population health), population biobanking and data integration (PX4/OMICS3), Australian Tree of Life (Biodiversity Genomics). SOLUTION Underpinning research infrastructure and capability will include 1. Fit for purpose integrated computational environments delivered through NDRI participants at NCI, Pawsey, institutional “tier 2” facilities and commercial providers such as AWS and Nvidia. This does not currently exist. 2. Data engineering capability to inform, manage, recruit and synthesize national and global 'omics datas (in the context of other capability data, eg. imaging) into a form and scale that permit advanced AI analytics. 3. Recruitment and deployment of relevant models and software, often adopted from global sources and collaborators. 4. Significant skills enhancement, both in delivering AI research infrastructure and in support of researchers ability to pose AI relevant queries. TIMELINES AI is developing and impacting science and workforce right now. An immediate response, before Australia falls behind the likes of the US and China is necessary to maximise our opportunity and respond to unique Australian challenges and opportunities. Indeed AI will be necessary across the Challenge Framework and National Science Priorities as queried in this survey. Further, the interoperability of NRIs (eg. 'omics, imaging, population health) can not be readily achieved without AI/ML.

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.

ANSTO AIMS NCI Pawsey AaRNET ARDC Phenomics Australia NIF Therapeutic Innovation Australia APPN PHRN EMBL Australia IMOS TERN ALA Microscopy Australia ANFF AuScope Northern Australia Quarantine

Q39.

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

- ☒ For expertise or advice
- ☒ Access to research resources or products
- ☒ Access to equipment for research
- ☒ Access to equipment for operational reasons
- ☒ Help in translating research
- ☒ Access to data
- ☒ Support for clinical trials
- ☒ Other (please specify)

Our collaborators need solutions that transcend individual NRI

Q40.

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

This question was not displayed to the respondent.

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.

The NRI has been resourced is a compact between the Australian Government and providers whereby on a collaborative basis NRI providers work closely with and on behalf of the Australian Government to - act as persistent knowledge banks in deep technology fields that government itself would struggle to keep abreast of state and change - ensure the rational investment of technology currency that enables the breadth fo the research system to have access to RI without the risk and vagrancies of the competitive grant system - ensure capacity needs match systemic demand originating from the grant system (NHMRC, ARC, MRFF, other), PFRAs, government agencies, universities, independent research institutes and industry. Understanding current demands and aspirational strategy (national science priorities, CSIRO missions, MRFF missions, ARC Centre of Excellence etc.) ensures fit for purpose technology and scale - minimise wasteful duplication of capital acquisition and enhanced productivity of scale - supporting a highly skilled technical workforce that often falls outside the direct remit and focus of academic pursuit - collaborative cross cutting clusters (NEESF, Health, Made to Measure) where collaborators are deliberately supported with solutions that transcend individual providers - a deliberate focus on data retention, quality, management and access. This is not performed routinely at the individual researcher or project level but NRI has FAIR and CARE as central pillars to operations. The value of quality data can not be underestimated with the disruptive advent of AI - industry has always been a key audience to NRI and the focus through government policy and metrics has only accentuated the need for NRI to not only engage with industry but to identify commercial opportunity, de-risk early stage opportunities and nest spinouts and startups in environments that are not economically affordable for most companies