

**INQUIRY INTO USE OF PRIMATES AND OTHER ANIMALS
IN MEDICAL RESEARCH IN NEW SOUTH WALES**

Organisation: NSW Government

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NSW Government Submission

NSW Parliamentary inquiry into the use of primates and other
animals in medical research in New South Wales



The NSW Government welcomes the opportunity to make a submission to the NSW Parliamentary inquiry into the use of primates and other animals in medical research in New South Wales.

The NSW Government promotes national standards in the ethical, humane and responsible care for and use of animals for scientific purposes. The use of animals in scientific research is governed by rigorous state-based legislation (*Animal Research Act 1985* and *Animal Research Regulation 2021*), as well as the National Health and Medical Research Council's Code (*Australian code for the care and use of animals for scientific purposes*) and guidance (*Best practice methodology in the use of animals for scientific purposes*).

The key principles of the National Code are those of replacement, reduction and refinement (the 3Rs) and are applied as the standard in planning all studies in NSW facilities. They refer to the responsibilities of institutions, animal ethics committees, investigators and animal carers.

Consideration must be given to the implementation of alternative approaches that do not use animals (replacement). This includes the use of epidemiological data, physical and chemical analysis, computer, mathematical and inanimate synthetic models, simulations, in vitro systems, non-sentient organisms' cadavers and clinical cases. If there is insufficient evidence to support the validity of an animal model, its use must and will be rejected by the responsible animal ethics committee. While such alternative approaches can often be used together to support research, in some cases they are not complete substitutes for essential animal use.

In addition to observing complex cellular and whole-of-body responses, there are regulatory conditions for which the use of animals is essential to obtain the necessary information. For therapies untested in humans, approval from the Therapeutic Goods Administration is received only once efficacy is demonstrated through animal testing in a clinical trial setting. Where animal use is essential, it must be ensured that studies are of the highest quality, designed to involve the smallest number of animals necessary to achieve the study's aims and to satisfy good statistical design (reduction), and to support and safeguard animal wellbeing (refinement).

Effective and transparent reporting of animal-based studies also informs future scientific studies and policy. As part of the National Code, reporting includes:

- how studies are designed and conducted
- access to data
- negative impacts on animal wellbeing during the conduct of the study
- results of previous or related work
- adverse outcomes.

Detailed responses addressing each of the Inquiry's Terms of Reference are set out below.

a) the nature, purpose and effectiveness of medical research being conducted on animals in New South Wales, and the potential public health risks and benefits posed by this research

Background

The use of animals still remains essential in very many areas of medical research. Animal studies contribute to the discovery of the causes of human disease, to improving diagnostic accuracy and to optimising treatment of disease. The goal of the research is to make advances which lead to reduction of suffering in humans and to also contribute to animal health improvement. Within NSW, the conditions being researched in health establishments are predominantly common conditions facing the community. Some globally important

neglected diseases and/or rare conditions, in which there is research expertise locally, are also subject to research.

Research requiring the use of animals is largely focused towards the major killers in the population such as, but not limited to:

- cardiovascular diseases
- stroke
- serious neurological disorders
- liver disease
- respiratory, inflammatory and immunological disorders
- cancer of solid organs and blood.

NSW has particular expertise in the study of the effects of age, both at the newborn and the older age end of the spectrum and has contributed important advances to understanding the effects of age and pregnancy-related changes in the physiology of humans and animals. The common conditions are responsible for robbing our community of hundreds of thousands of productive and healthy years of life annually and adding significantly to the demands on our health system for acute and chronic care.

Improvements in medical and surgical care built on the foundations of scientific advances in basic science and validated in animal studies have delivered impressive impact on reducing infant and maternal mortality and extending by decades since the 1960s the life expectancy in NSW. In addition to mortality impact, morbidity has been reduced and human psychological suffering has been ameliorated. Invasive interventions have been made safer and new techniques of minimally invasive surgery pioneered in animal studies have been successfully transferred to human surgery, dramatically reducing operative trauma and reducing post operative morbidity and days in hospital.

Society at large has benefitted beyond those individuals whose health has been improved thanks to research involving animals, as the impact of illness on families can destroy quality of life of multiple members of families and communities. In addition to these general issues the current COVID-19 pandemic provides an important example of the importance of undertaking basic research that can be applied with state of the art techniques to deliver advances in rapid timeframes. With COVID-19 cases in Australia now topping three million and with deaths in NSW in excess of 1000 citizens, there is compelling evidence that animal facilitated research has both delivered important effective vaccines and the range of specific newly developed drugs and biologicals for the treatment of COVID-19. In the years ahead animal research is needed to explore new treatments that are only now coming under scrutiny. This highlights the impact of emerging infectious diseases and the need for a flexible research response and appropriate facilities to develop new vaccines and therapies.

Primate research is regarded as having the highest impact in terms of validating and establishing safety of important new therapies. It is reserved for those new developments which cannot be adequately performed in other lower order species. Animal experimentation remains an integral part of biomedical research geared towards finding ways of preventing, treating and curing human disease. There are many situations where no viable alternatives to animal experimentation currently exist and non-human primates (NHPs) with physiologies comparable to humans must precede first use in humans. The capacity to study new therapies across a range of species adds a dimension to NSW and Australian research that may not currently be found elsewhere.

Nature of use of animals:

The uses of animals in medical research are diverse, such as in physiology characterisation of the function of the genes identified from classical genetics and physiology utilising pharmacological, gene knockout and transgenic approaches of genetically homogeneous and or mixed strains.

Further specific areas are:

- pharmacology of natural, synthetic (including RNA/ microRNA / DNA) and other biological agents when used with therapeutic intent
- ageing
- developmental stages of embryogenesis and adverse effects on embryos
- effects of bearing mutations as the cause of congenital disorders
- effects of modifying factors on disease phenotype
- injury and wound healing
- capacity of synthetic or cultured materials to impact on disease course and outcome
- degenerative conditions
- cancer studies
- transplantation studies
- pregnancy and fertility studies
- interventional and surgical techniques
- diagnostic methods – detection of biomarkers
- studies of infections – affecting animals; zoonotic and those pathogenic in humans and animals
- generation of xenograftable tissues/ tissue engineering
- prosthetic material studies in vivo
- determinants of graft tolerance and survival of transplanted tissues
- study of monoclonal antibodies engineered in vitro and produced in vitro and studied in vivo as preclinical assessment
www.uptodate.com/contents/overview-of-therapeutic-monoclonal-antibodies
- development of effective immunotherapies for previously untreatable cancers
- chimeric antigen receptor T-cells, a revolutionary new immunotherapy for cancer based on animal research
- regenerative medicine
- vaccine studies
- anaesthesia and pain management
- pregnancy and prematurity.

The last two years have seen a significant expansion of studies directed at vaccination for COVID-19 and other coronaviruses.

Below are examples of some diseases in which NSW Health researchers and their collaborators have made major contributions through animal-utilising research or training in the last 20 years.

Children's Medical Research Institute

- Cancer oncogenesis, childhood cancers
- Genetic disorders

- Gene regulation and gene therapy

Centenary Institute / ACRF

- Physiology of skin immune interactions and pathology of skin infections
- Understanding the physiology of liver resident immune cells and contribution to the development of liver cancer
- Blood vessel development and biology
- Sudden cardiac death
- Cancer biology including melanoma, pancreatic cancer, lung cancer
- Vaccine responses to new and modified existing vaccines
- Tuberculosis - development of new vaccines and therapies
- COVID-19 animal models to test new vaccines and anti-viral therapies
- Smoking-related lung diseases
- Gene therapy
- Neurological disorders
- Alcohol related liver disease - models of cirrhosis
- Venoms and toxins as therapeutics
- Diagnostic methods / biomarkers of disease
- Discovery of a new type of naturally occurring mouse virus that causes kidney damage in mammals and man
- Discovery of physiology of transport of certain amino acids
- New approaches to drug discovery

ANZAC Institute

- Endocrine causes of infertility in male and females
- Bone metabolism / osteoporosis
- Approaches to accelerate healing of wounds
- Ageing studies and pharmacology of new drugs and delivery pathways
- Atherosclerosis

Heart Research Institute (HRI)

- Atherosclerosis
- Physiology of the brainstem in hypertension studies
- Effect of diet - hypercholesterolaemia
- Lipid transport
- Platelet disorders / thrombosis and thromboembolism
- Pulmonary hypertension
- Cardiac valve studies
- Candidate pathways for vascular biology regulation

University of Sydney Central Clinical School staff and affiliates

- Diabetes and its complications diabetes / wound healing
- Treatment for diabetes
- Dementias – molecular pathways and prognostic biomarkers
- Motor neurone disease
- Multiple sclerosis
- Effect of diet on lifespan
- Transplantation of kidney tissue
- Solid organ preservation
- Studies of blood cancers

- Treatment of graft versus host disease
- Cardiovascular disease - aortic valve disease, pulmonary hypertension
- Skin disorders - sun damage / sunscreen efficacy / effect of sun on immune systemfunction
- Skin cancers
- Head and neck cancers
- HPV related cancers (female cervical cancer and oral and anal cancers)
- Diagnostics - including new immunoassays
- Nuclear medicine PET / MRI developed studying animals
 - Micro CT
 - MRI
 - Radiotherapy - other techniques; dosimetry and targeting of therapy
- Radiosensitivity
- Technologies that allow phototherapy for graft verses host disease
- Training:
 - Refined methods of animal surgery / intervention
 - Robotic surgery
 - Keyhole surgery
 - Microsurgical techniques

The Garvan Institute

- Work in cancer especially prostate and solid cancers
- Metabolic bone disease
- Immunodeficiencies

The Kirby Institute

- HIV
- hepatitis C

Victor Chang Institute

- Cardiovascular disease
- Heart failure

b) the costs associated with animal research, and the extent to which the New South Wales and Federal Government is commissioning and funding the importing, breeding and use of animals in medical research in New South Wales

In general animals used for research in Australia are bred in specialised breeding facilities which are appropriate for the species involved. In NSW the major universities and medical research institutes undertake breeding as well as research. Breeding animals for research is also subject to the 3Rs, rather than being dominated by commercial considerations. Breeding of research animals with high genetic integrity within NSW minimises the costs to NSW research establishments and their funders.

Most breeding of non-human primates for medical research occurs within the colonies established to maintain and study them long term. Genetic homogeneity in rodents provides great advantages in biomedical research investigating the pathways and factors associated with disease and treatment response. Conversely, genetic diversity is an important consideration in primate work. It would be potentially cheaper for researchers to import non-human primates into Australia in most cases, however community attitudes favour the

breeding of research animals ahead of wild capture. Advantages include minimising the risk of novel pathogen importation, security of supply in the face of international travel limitations, and the ability to minimise duration of transport in confinement. Non-human primates can be subjects in serial studies in some cases and may participate in both breeding and research activities.

c) the availability, effectiveness and funding for alternative approaches to animal research methods and technologies, and the ability of researchers to meet the 3 R's of Replacement, Reduction and Refinement

Research involving animals is tightly regulated in NSW and Australia through uniform adoption of the *Australian Code for the Care and Use of Animals for Scientific Purposes* and the provisions of specific NSW Acts and regulations that determine the processes for governance and approval of research facilities, supply and use of animals for research. Sites of animal research are thus limited, and Animal Ethics Committees (AECs) have a responsibility to implement measures in their review and approval processes that adhere to the 3Rs principles (Reduction, Refinement and Replacement). This applies to the commonly used rodents but also to non-mammalian species through to the use of non-human primates.

AECs are comprised of individuals appointed in view of their expertise in animal health, animal husbandry, animal research, animal welfare and community attitudes. Included are lay members and members with a track record of contribution to animal welfare. AECs fulfil an important role in providing community input and transparency in the approval of animal research.

The aim of the AEC is to implement the 3Rs in the conduct of medical research that involves animals. This includes the goal of reducing in the number, period of use and level of development of animals required to rigorously examine hypotheses that are under test. For example, the use of Zebrafish enables short experiment times and as a result, produces a rapid flow of information to the research community. Furthermore, the AEC has encouraged the use of infrastructural support, such as the use of cell lines to support Gene Transfer, cell cultures through human samples and stem cell repurposing, which reduces the use of animal work and/or does not involve animals.

In NSW, a majority of all AEC reports in 2018 and 2019 reported strategies that involve improvements. The range of strategies include in-vitro, av replacement, human replacement, simulation, historical controls.

The 3Rs underpin the requirements in the Code including the responsibilities of institutions, AECs, investigators, and animal carers. All those involved have a responsibility to ensure the consideration and implementation of alternative approaches that do not use animals (Replacement). This includes the use of:

- epidemiological data
- physical and chemical analysis
- computer, mathematical and inanimate synthetic models
- simulations
- in vitro systems
- non-sentient organisms
- cadavers
- clinical cases.

These current alternative approaches can often be concurrently used to support research, but in some cases are not complete substitutes for essential animal use. In addition to

observing complex cellular and whole-of-body responses, there are regulatory conditions in which the use of animals is essential to obtain the necessary information. For therapies untested in humans, approval from the Therapeutic Goods Administration is received only once efficacy is demonstrated through animal testing in a clinical trial setting. Where animal use is essential, studies must be of the highest quality, designed to involve the smallest number of animals necessary to achieve the study's aims and to satisfy good statistical design (Reduction), and to support and safeguard animal wellbeing (Refinement).

d) the ethical and animal welfare issues surrounding the importing, breeding and use of animals in medical research

With respect to the approvals of animal research protocols, the AEC ensures protocols are subjected to great scrutiny ahead of approval and frequent amendments are required by the AECs to ensure the protocols use best practice and are adequately powered to achieve scientific validity. The AECs supervise any further modifications that are proposed during the course of the fixed-time approvals. Annual reviews of progress and inspections are also undertaken. Furthermore, AECs occasionally reject protocols outright, based on scientific or animal welfare considerations or due to logistic considerations. The AEC ensures quality assurances by assessing the competence of researchers relevant to the procedures being carried out and requiring animal research training.

e) the adequacy of the current regulatory regime regarding the use of animals in medical research, particularly in relation to transparency and accountability

Regulatory framework

- In NSW the use of animals for research and teaching is regulated by the *Animal Research Act 1985* and the *Animal Research Regulation 2021*.
- The Act and Regulation incorporate the requirements of the *Australian Code for the Care and Use of Animals for Scientific Purposes*.
- The NSW Department of Primary Industries (NSW DPI) is the regulator responsible for compliance under the Act and Regulation.
- Only qualified veterinarians can be appointed as inspectors under the Act.
- The Act outlines a co-regulatory framework where establishments carrying out animal research, and those supplying animals for use in research, must be accredited and licensed with NSW DPI.
- Animal research authorities to carry out animal research can be issued to individuals by accredited establishments or by the Secretary of the Department.
- Animal research authorities can only be issued on the recommendation of an Animal Ethics Committee (AEC), established under each accredited establishment. All animal research must be carried out under the approval and monitoring of that committee.
- All AECs are required to maintain a balance of membership that includes at least one independent community representative.

ARRP (Animal Research Review Panel)

- The Animal Research Review Panel, is a 12 member statutory body, ministerially appointed under the Act.
- Industry, government and animal welfare sectors have equal representation.
- The Act defines the functions of the Panel which include:
 - oversight of the efficacy of the Australian Code
 - assessment of applications for accreditation as Animal Research Establishments and licences as Animal Suppliers

- investigation of complaints
- participation in inspections of animal research establishments.

Transparency and accountability in animal research

- Each application to an AEC must include detailed information including:
 - the justification for the use of animals
 - the impacts of all parts of the research project on the animals
 - how these impacts will be minimised.
- The Australian Code is based on the 3Rs of Replacement, Reduction and Refinement.
 - Replacement relates to methods which avoid or replace the use of animals in research
 - Reduction relates to methods to minimise the number of animals used
 - Refinement relates to methods which alleviate or minimise potential pain and distress and enhance animal welfare.
- In making applications to AEC for research projects, the 3Rs must be addressed including the reasons that animals need to be used, and the reasons that non-animal alternatives are unsuitable.
- Information on examples of implementation of the 3Rs is provided to NSW DPI by research establishments.
- The Regulation requires accredited research establishments to report to the Secretary of the Department of Regional NSW (DRNSW) annually on their activities in an approved form.
- Reporting is due by 31 March each year and refers to animal use statistics for the preceding calendar year. The report includes data on animal species and numbers used, and procedure categories. The animal use statistics are published by NSW DPI on the Animal Ethics Infolink website.

Complaint handling

- The Act prescribes the process of making, handling, investigating, and determining complaints about animal research. Complaints under the Act must be lodged with the Office of the Secretary of the Department.
- The Act provides the grounds that complaints may be made about corporations operating animal research establishments, holders of animal supply licences and individuals conducting animal research under an animal research authority.
- These complaints are referred to as 'statutory complaints'. Statutory complaints are those that are made pursuant to the Act and must meet the prerequisites for a complaint to be lodged. They follow a strict process for handling, investigation, and determination.
- All statutory complaints must be referred to the Panel for investigation and the preparation of a report, which must be furnished to the Secretary of DRNSW.
- After considering the Panel's report on a complaint, the Secretary must determine the complaint by cancelling or suspending the relevant accreditation, licence, or authority, cautioning, or reprimanding the relevant accreditation, licence, or authority holder, or dismissing the complaint.
- 'Statutory complaints' made under the Act, cannot be made anonymously due to the requirements imposed by the Act.
- NSW DPI also accepts 'general complaints' about animal research, which can be made anonymously.

- There is no prescribed process under the Act for managing these complaints. They are investigated by NSW DPI where sufficient information is provided. These types of complaints do not result in formal determinations by the Secretary of DRNSW.

Use of non-human primates in animal research

- Accredited animal research establishments and the holders of animal supplier licenses with permission to use non-human primates in animal research are subject to additional regulatory requirements and compliance monitoring.
- As a special condition of their accreditation and/or license, all are required to comply with the *NHMRC's Principles and guidelines for the care and use of non-human primates for scientific purposes*.
- An additional special condition requires the maintenance of an escape and recapture plan for non-human primates, and this plan must be subject to 12-monthly AEC review and approval.
- Through its risk-based inspection program, DPI has determined that the use of non-human primates in medical research is a higher risk activity because the Australian Code identifies the use of non-human primates as requiring additional justification, and there is increased community concern around the use of these species. NSW DPI has therefore applied an increased frequency of verification of establishments using primates in animal research.
- Establishments and suppliers with permission to use non-human primates are subject to an increased frequency of inspection to verify compliance. Inspections are conducted by a veterinary inspector appointed under the Act and the inspector may be accompanied by members of the panel.
- There are currently two establishments (that are also the holders of animal supplier licences) with permission to use non-human primates for the purposes of medical research. Both establishments were subject to inspections in 2020 and 2021.

Animal welfare reform

- In 2018, the NSW Government released the first ever NSW Animal Welfare Action Plan, which contained a commitment to modernise and streamline NSW's animal welfare legislative framework.
- In line with this commitment, the NSW Government has developed a draft Animal Welfare Bill 2022 (the draft Bill), which is intended to replace the ageing *Prevention of Cruelty to Animals Act 1979*, *Exhibited Animals Protection Act 1986* and *Animal Research Act 1985* with a single contemporary animal welfare law.
- The draft Bill is currently being considered by the Standing Committee on State Development, through the Inquiry into animal welfare policy in NSW. This process allows stakeholders and the community to provide feedback on the draft Bill before its finalisation and introduction into Parliament. More information on the draft Bill is available on the [NSW DPI website](#) and the [NSW Parliament website](#).

f) overseas developments regarding the regulation and use of animals in medical research

Comparison can be made with similar research environments such as the United States of America. The National Institute of Environmental Health Sciences (NIEHS) regulatory and

research framework are parallel to the Australian environment and adopt similar strategies in the promotion of alternatives to animal research.

<https://www.niehs.nih.gov/health/topics/science/sya-iccvam/index.cfm>

The National Primate Research Centers (NPRCs) have played a crucial role in some of the most important medical breakthroughs of the past 50 years. NPRC research with non-human primates (NHPs) is highly regulated, provides unique insights not available with other models and often precedes clinical trials in humans. This list highlights 10 of the most significant recent NHP research breakthroughs that are helping people across generations and the world live longer, healthier lives.

The self-nominated top 10 recent achievements of the U.S. National Primate Research Centers are notable for:

- a) their highlighting of novel and emerging infectious diseases for which there was extreme urgency in developing understanding and treatment
 - b) their listing of a range of neurological disorders in which translation to human studies has been rapid and
 - c) the ability to use emerging technologies in important studies to validate feasibility to proceed to human studies:
1. **Zika** – When Zika was identified in Brazil in 2015 and associated with severe birth defects, the infectious disease expertise of NPRC researchers was at the forefront of the scientific community's response and early understanding of the disease's pathology. Researchers are also working to:
 - identify antiviral drugs that are effective against Zika in lab cultures and then test these drugs in NHPs; and
 - determine if and how Zika infection in pregnant animals results in defects of the fetal central nervous system.
 2. **Ebola** – One of the most potent viruses to infect humans, Ebola is the subject of intense study by researchers at the NPRCs and around the world with the goal of developing preventive vaccines and novel therapies. The disease course in macaques and marmosets is very similar to that in humans, and many vaccines and therapies have been tested in these animals, some of which have advanced to human trials.
 3. **HIV/AIDS** – The emergence of HIV/AIDS in the early 1980s was one of the greatest public health crises in American history, and NPRC researchers were crucial in the effort to address it. Results from NHP studies on the ability of pre-exposure dosing of antiretroviral medicines to prevent infection with SIV or SHIV (the primate versions of HIV) informed the design of subsequent human clinical trials that provided clear evidence such pre-exposure dosing was effective in preventing infection.
 4. **Hepatitis** – Hepatitis C virus (HCV) affects more than 3.5 million people in the U.S. and more than 170 million people worldwide. Chronic HCV infection frequently progresses to cirrhosis and liver cancer, which has a five-year survival rate of only 10 per cent. Intensive research efforts involving NHPs have resulted in a cure for HCV infection.
 5. **Parkinson's disease** – Parkinson's disease is a progressive neurodegenerative disorder that produces motor symptoms, such as tremor, walking difficulty and muscle stiffness, as well as many non-motor problems. NHP research led to an innovative

surgical procedure called deep brain stimulation (DBS), which uses an implanted, battery-operated device to deliver electrical stimulation to specific brain areas that control movement. This blocks the abnormal nerve signals that cause the symptoms of Parkinson's disease. NHP research also contributed to the development of autologous stem cells as a potential therapy for Parkinson's and other neurodegenerative diseases. In 2007, researchers transformed skin cells from humans and monkeys into induced pluripotent stem (iPS) cells, and subsequently transformed the monkey iPS cells into dopamine neurons. Because transplanted neurons are able to differentiate into multiple different neural cell types and provide long-term increases in dopamine-producing neurons, such cells can be used to partially restore motor function in people who have Parkinson's disease.

6. **Brain-machine interfaces** – This therapy combines neural recordings, computer representations of movement and robotics to allow monkeys and humans to manipulate their environments without the use of their arms. This research, which is dependent on NHPs, holds great promise for people who are paralysed or who have suffered brain damage from stroke. Researchers have developed a brain-machine interface that enables monkeys to control robot arms with brain activity coded through a computer.
7. **Huntington's disease** – Although the genetic defect responsible for this neurodegenerative disease is well known, the specific mechanisms by which the mutation induces the condition are not as well understood. NPRC researchers have developed a transgenic NHP model of Huntington's disease by introducing a portion of the mutant human gene responsible for Huntington's into fertilized macaque eggs. The result is transgenic animals that reproduce many of the key features of Huntington's disease.
8. **Stem cell research** – This pioneering discovery, which NPRC scientists advanced from rodents to NHPs and then into humans in the 1990s, is already in early human clinical trials for macular degeneration, spinal cord injury, heart disease, ALS and more. There are approx. 30 clinical trials around the world involving embryonic stem cells and their derivatives. At least 40 trials involve the use of induced pluripotent stem cells. Pluripotent stem cell research has ushered in a new era of science and medicine that is dramatically expanding our options for pursuing cures and treatments.
9. **Transplantation** – NPRC researchers have developed a novel approach to suppressing immune responses to kidney transplants. The technique involves creating a fusion protein of a molecule that is involved in the stimulation of T cells, which sometimes reject transplanted tissue. This research paved the way for successful human clinical trials and FDA approval of belatacept, the first new transplant drug since 1999.
10. **Mitochondrial disease** – No treatment or preventive measures exist for this group of devastating human disorders, which present shortly after birth and can affect multiple organ systems to cause diabetes, deafness, blindness, dementia or epilepsy. Mitochondrial replacement therapy, or correcting dysfunctional mitochondria in the egg of a woman who previously delivered a child with mitochondrial disease, offers her the chance to have a typically developing child. NPRC researchers were the first to establish this process in NHPs by demonstrating the feasibility of replacing mitochondrial DNA in an egg with donor mitochondria from another egg, followed by in vitro fertilization and the development of typically developing offspring.

<https://nprc.org/research/top-10-research-accomplishments-at-the-nprcs/>

Nobel Prize in Medicine and Physiology

100 of the 118 Nobel Prizes awarded in Medicine since 1901 have involved experimentation in animals or insects (very few involved insects and most common were rodents).

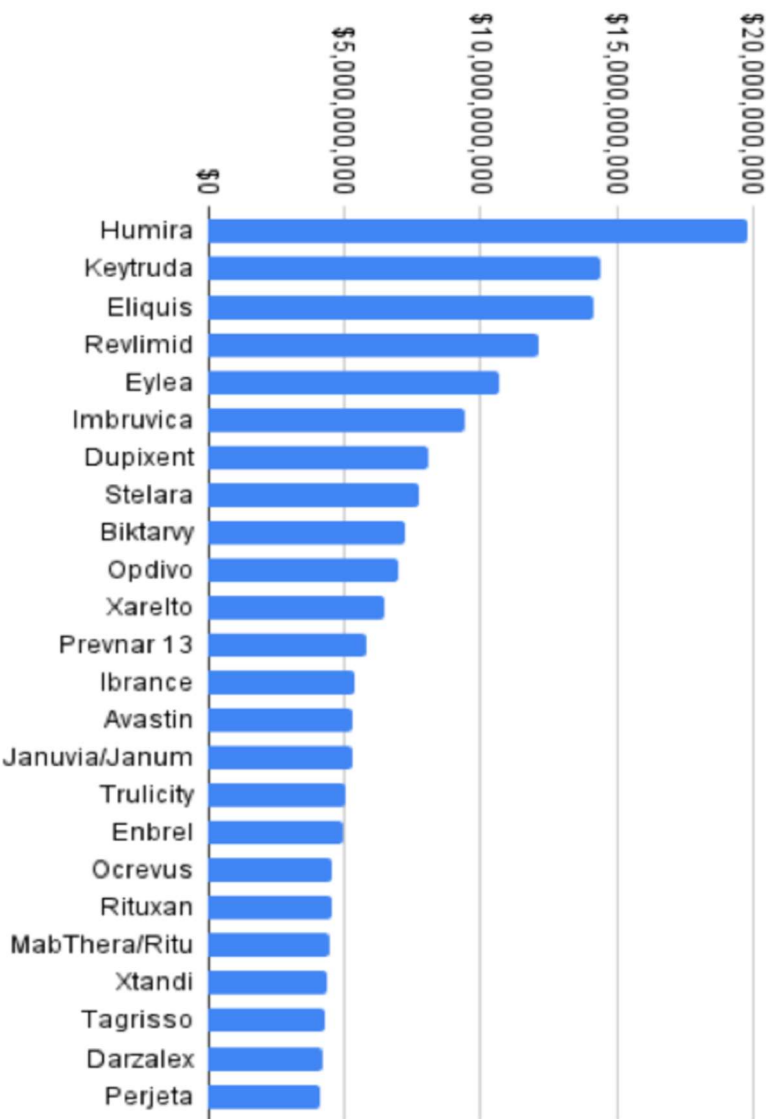
- 19 awards in infectious diseases - diphtheria, malaria, tuberculosis, polio, *Helicobacter pylori*, HIV, hepatitis C, prion diseases, antibiotics and antivirals
- 20 awards in metabolic and endocrinology - insulin, hormones controlling fertility, vitamin B12, vitamin K, energy metabolism
- 13 awards in immunology – anti-toxins, vaccines, inflammation, transplantation tolerance, monoclonal antibodies, anaphylaxis, allergy
- 16 awards in neurological physiology and diseases - nerve cells and electrical transmission, vision, hearing, smell, and sensory nerve function
- four awards in origins of cancers - viral and oncogenes, X-ray induced mutations
- 18 awards in embryology / cell differentiation and genetics - DNA, inhibitory RNA, protein coding, cell differentiation, CRISPR
- six awards in cardiovascular diseases - capillaries, ECG, cardiac catheterization, cardiac function transmitters
- two awards in imaging (CT and MRI)
- one award in pharmacology
- one award in population behaviour.

<https://www.animalresearch.info/en/medical-advances/nobel-prizes/>

Other considerations:

According to recent data, of the top 10 selling drugs (price value) in the world, nine were dependent on recent developments related to advances in monoclonal antibodies and engineered biologicals / inhibitors tested or developed in animals in initial or late phase studies. These drugs ranged in annual sales from \$36 billion globally for the leading agent to \$7 billion for the 10th listed agent. The conditions for which they provided huge advances (sufficient to justify their cost and subsidised funding in most countries) spanned a vast range of common and, in most cases, life or vision threatening disease such as:

1. COVID (prevention vaccines)
2. Inflammatory arthritis and inflammatory bowel disease
3. Cancer immunotherapy (lung / melanoma)
4. Blood cell malignancy and myelodysplasia
5. Macular degeneration leading to blindness
6. Thrombotic conditions
7. Chronic leukaemias
8. HIV



www.drugdiscoverytrends.com/50-of-2020s-best-selling-pharmaceuticals/

g) any other related matters

Areas requiring investment by NSW Health / Commonwealth in a sole or shared funding pathways to ensure viability and continued excellence in animal research are detailed below:

1. Resourcing of personalised medicine wherein a genetic mutation likely to be blamed as the cause of a person's or family's disease to be tested by gene knockout and CRISPR gene technologies in an animal model to confirm pathogenicity and enable possible therapies to be tested before use in the patient / family/ pregnancy
2. Enhanced facilities for the in vivo study of highly infectious diseases - not located in just one location (this is important lesson from COVID-19)
3. Maximising yield from animals studied in research through tissue banking of experimental animal tissues
4. High throughput proteomics to enable mass data to be aggregated and recorded for future analysis (add on funding of projects involving animals) to value add
5. Funding of primate colonies to ensure sustainability into the future and availability of captive bred animals to support future needs and remove need to import wild caught animals, which would risk introduction of zoonoses
6. Funding for embryo freezing to minimise need to maintain lines to preserve genetic base
7. Expanded access to PET/MRI for rodents to enable studies with new ligands to be used minimising need for histological multiple timepoint analysis
8. Funding of an annual conference in which state of the art technologies are disseminated, in particular those which allow direct hypothesis testing and reduce reliance on indirect studies and which identify means of reduction, refinement and replacement

9. Industrial awards in which animal care is given due recognition of the skills and training level achieved in previous employment
10. Requirement that veterinary staff view face to face the performance of invasive procedures periodically and funding to enable such review
11. Funding of exchanges / secondments of researchers and animal technicians to refine techniques
12. Annual travelling fellowship to enable administrators of animal research to visit and report on developments in North America, UK, Europe and Asia
13. Support for the industry producing high quality healthy animals for research which are genetically accurately described, pathogen free, ready for acclimatisation
14. Utilise state of the art devices for:
 - a. animal identification
 - b. monitoring animal health
 - c. metabolic analysis
 - d. behaviour studies by image analysis
15. Support capital works which provide:
 - a. staff friendly work environments for animal attendants
 - b. environmental enrichment appropriate to the species.

End of submission