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Traversing Uncharted Territory? The Legislative and Regulatory Landscape of Heritable Human Genome Editing in Australia

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Abstract

In 2018, the birth of the world's first 'CRISPR Babies' rendered the global community in disbelief. This was the catalyst for an international moratorium on Heritable Human Genome Editing ('HHGE'). For the first time, the international community was prompted to consider a pathway forward to regulate HHGE. In light of the evolving maturity of Clustered Regularly Interspaced Short Palindromic Repeats ('CRISPR') as a biotechnology, it is timely to evaluate Australian federal legal and regulatory frameworks governing human genome editing. The response to HHGE must carefully balance the need to prevent unethical applications, against the progress of research to improve and refine the technology. This article argues Australia's federal legislative regime must be reviewed to ensure it has the necessary capabilities to effectively regulate HHGE. It applies three schools of thought which offer an instructive theoretical lens to understand how Australian law has responded to advancements in technology. In addition, an analysis of the governing federal legislation reveals three regulatory gaps — complexity, operational ambiguity and inconsistent legislative objectives. Together, these gaps may be indicative of a legislative and regulatory landscape that is no longer fit for purpose.

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I Introduction

In 2018, the birth of the world's first 'CRISPR Babies' rendered the global community in disbelief. This 'reckless ethical disaster' was the catalyst for an international moratorium on Heritable Human Genome Editing ('HHGE').[1] This disaster was said to be caused, in part, by 'a failure of self-

1. Henry T Greely, 'CRISPR'd Babies: Human Germline Genome Editing in the 'He Jiankui affair' (2019) 6(1) *Journal of Law and the Biosciences* 111, 113.

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regulation by the scientific community, [due to] a lack of transparency'.[2] For the first time, the international community was prompted to consider a pathway forward to regulate HHGE, to avoid another CRISPR Babies event.

In light of the evolving maturity of Clustered Regularly Interspaced Short Palindromic Repeats ('CRISPR') as a biotechnology,[3] it is timely to evaluate current legal and regulatory frameworks governing human genome editing in Australia. The development of a regulatory framework requires the examination of unique bioethical and legal issues through a future-oriented lens, to foster a robust, effective mechanism for the application of CRISPR in humans.

The legal and regulatory response to HHGE must carefully balance the need to prevent unethical applications, against the progress of research to improve and refine the technology. Bioethics, particularly in the context of emerging biotechnologies, is arguably the foundation of an effective regulatory regime. It provides a guide to forecast and navigate some of the challenges a regulatory regime will be required to address, manage and possibly resolve. The application of CRISPR technology in human germline cells is a controversial area, confronting society's well-established norms and expectations concerning the relationship between law, science and ethics.

This article argues Australia's legislative regime must be reviewed to ensure it has the necessary capabilities to effectively regulate HHGE. The intent of this article is twofold. First, it explores how history has led to Australia's regulatory approach, by focussing on one aspect: the relationship between law and science. Second, it identifies the regulatory shortcomings of Australia's current legal governance framework.

This article is confined to a discussion of HHGE and does not consider somatic genome editing or mitochondrial donation.[4] While significant developments have been made in somatic genome editing,[5] this article intends to advance a discussion concerning the regulation of HHGE, which remains in need of greater interrogation and consideration. As noted by Giovanni Rubeis and Florian Steger '[a]lthough there are no clinical applications of [germline genome editing] available at the moment, it is important to have an intense ethical debate at this early stage in order to be prepared for coming developments'.[6] While this article does not offer an ethical evaluation of HHGE, this conclusion remains relevant. This article serves to contribute to the literature concerning the regulatory approach to HHGE.[7]

Part II discusses the connection between history and technology, as a means to illustrate the ongoing fraught relationship between the two disciplines. It is through this historical and theoretical lens that we can gain a better understanding regarding the law's response to emerging technologies.

2. Ibid 138.
3. For the purposes of this article, the terms 'technology' and 'biotechnology' will be used synonymously.
4. Somatic genome editing refers to genetic edits that are not heritable.
5. Robin Lovell-Badge et al, 'Statement from the Organising Committee of the Third International Summit on Human Genome Editing' (Statement, International Summit on Human Genome Editing, 8 March 2023).
6. Giovanni Rubeis and Florian Steger, 'Risks and Benefits of Human Germline Genome Editing: An Ethical Analysis' (2018) 10(2) *Asian Bioethics Review* 133, 134.
7. Giulia Cavaliere, Katrien Devolder and Alberto Giubilini argued an emerging biotechnology is accompanied by ethical questions that arise at two levels. The first level raises 'substantive ethical questions', which consider the moral identity of the technology and its associated ethical concerns due to its application. The second level refers to 'how we should regulate [the technology] and who should decide about how to regulate it': Giulia Cavaliere, Katrien Devolder and Alberto Giubilini, 'Regulating Genome Editing: For an Enlightened Democratic Governance' (2019) 28 *Cambridge Quarterly of Healthcare Ethics* 76. For the purposes of this article, its focus would fall within the second level of ethical questions. The authors also argue that '[l]imited attention has been devoted to questions regarding [the emerging technology's] regulation': see Giulia Cavaliere, Katrien Devolder and Alberto Giubilini, 'Regulating Genome Editing: For an Enlightened Democratic Governance' (2019) 28 *Cambridge Quarterly of Healthcare Ethics* 76, 77.

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It is argued Australia's legal approach to HHGE reinforces various theories concerning regulatory discourse in areas involving law and science. This discussion provides context to the development and introduction of Australia's response to gene editing technology.

Part III provides a policy and legal overview of the relevant federal statutes governing gene editing in Australia, the *Gene Technology Act 2000* (Cth) ('*GT Act*'), *Research Involving Human Embryos Act 2002* (Cth) ('*RIHE Act*') and *Prohibition of Human Cloning for Reproduction Act 2002* (Cth) ('*PHCR Act*'). The role of the *Therapeutic Goods Act 1989* (Cth) ('*TGA Act*') has also been raised to highlight the legislative interaction for gene editing regulation, particularly in a clinical context. This article will solely focus on federal statutes. However, it is acknowledged that each state jurisdiction has introduced similar legislative instruments, which raises considerations in relation to the interaction between state and federal laws. For the purposes of this article, the role of state law falls outside the scope of this discussion, which aims to identify key gaps in Australia's governing triad of federal statutes.

Following an analysis of these federal statutes, Part IV reveals three regulatory gaps. First, there is no single legislative instrument which explicitly addresses HHGE and its potential uses in a clinical and/or research context. This article does not argue for a single legislative instrument. Rather, the current governance approach produced by multiple interacting statutes contributes to its regulatory complexity. As a result, this complexity threatens the adequate regulation of HHGE as it matures as a biotechnology. Second, legislative ambiguity in the governing legislation raises concerns regarding its practical application for researchers engaged in research involving CRISPR technology. This refers to the interpretation and subsequent enforcement of relevant laws. Third, the appropriateness of each statute as an instrument of HHGE regulation is questionable. In this context, there are two primary considerations: the intention of legislators in crafting the statutes and the legislative objectives identified in the statutes. Together, these regulatory gaps foster a regime that may no longer be fit for purpose.

Part V concludes Australia's regulatory regime reinforces the notion that the law adopts a reactionary response to advancing technology, which is exacerbated by the lack of communication and understanding between disciplines. Heritable Human Genome Editing challenges current perceptions of the relationship between the law, science and ethics. The legal and regulatory response requires a re-working of this conceptual intersectionality in order to make provision for a robust pathway forward.

II Theoretical Foundation of a Regulatory Response to Emerging Technologies

The concept of a technology has evolved considerably over time. The relationship between technology and history is now regarded as a distinct, flourishing research discipline,[8] which serves an important educative role in the context of modern, emerging biotechnologies. It is argued that the regulatory response of a biotechnology is informed by a number of factors, including historical perceptions of the sciences and humanities.

The underlying relationship between history and science offers an instructive lens through which we can understand how the law has responded to advancements in technology. This article firstly applies David Hume's is/ought theory as evidence of the complex relationship between law and science.[9] Using

8. Howard P Segal, 'Technology, History, and Culture: An Appreciation of Melvin Kranzberg' (1998) 74(4) *The Virginia Quarterly Review* 641.
9. See David Hume, *A Treatise of Human Nature* (1740); see also Scott J Shapiro, *Legality* (The Belknap Press of Harvard University Press, 2011) 47.

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Hume's Law as the foundation for regulatory discourse in the context of emerging technology, two additional schools of thought will be discussed: the 'two cultures', as identified by CP Snow and Melvin Kranzberg's laws of technology. It will be argued that Hume's Law is evidence that reinforces Snow's two cultures and Kranzberg's truism.

Further, these theories will be applied to the identified gaps in Australia's regulatory approach to genome editing. It is argued the very existence of these gaps is evidence of an amalgamation of these theories operating in an environment whereby the relationship between the law and science remains largely disconnected. One of the consequences of this disconnection is the reactionary response adopted by the law when scientific advancements occur.

Hume's starting proposition notes that value cannot be derived from nature. For example, the way in which CRISPR technology works or its technical limitations represent statements of fact. Hume's theory argues that a normative conclusion cannot be drawn from statements that report a particular fact.[10] Consequently, Hume's Law states 'one can never derive an ought from an is'.[11] If this is applied to genome editing, scientific facts/evidence relating to CRISPR technology represent examples of an 'is'. In contrast, the law and regulation of CRISPR technology may be characterised as enforceable 'oughts'. Non-compliance with the law enables punitive action to be pursued, given its enforceable authority. Science may identify the technical limitations of the technology, namely its capabilities, but it cannot determine what is an acceptable or unacceptable application or regulatory approach. It is the role of the law to determine these boundaries. This reflects a truism innate within the relationship between law and science — a 'descriptive-normative divide'.[12] Science is descriptive, the law is normative. Hume's Law recognises that a statement of fact may derive authority if this 'descriptive-normative divide' is bridged. This firstly acknowledges that science cannot dictate the law; however, it may provide instruction. It also recognises that law and science are separate entities or 'cultures' that require syllogism in the context of formulating a regulatory response to emerging technologies. This, in turn, further perpetuates the law's reactionary stance towards technological advancements, as it relies on science to factually instruct and describe the relevant development requiring regulation.

In the 1959 Rede Lecture, CP Snow, a scientist and writer, argued society divides sciences and humanities into two separate cultures.[13] The scientists are placed on one pole and literary intellectuals representing the humanities, on the other. This has, in part, been caused by a 'passion for specialisation' within an established professional or academic discipline.[14] For the purposes of this article, humanities and law will be regarded as synonymous, in which law and science may be referred to as two cultures. The gradual development of two separate cultures has created a significant gap, whereby these two disciplines largely operate as independent siloes, in both an academic and practical sense. As a result, Snow argued '…the pole of total incomprehension of science radiates its influence on all the rest [of society]'.[15] In a society that tends to allow social perceptions regarding the relationship between technology and law to crystallise,[16] this may contribute to the regulatory gap observed in human genome editing.

Snow's argument held that western society's separation of science and humanities as two cultures was evident through the disinterest in one another's culture. Over time, this has led to the

10. Scott J Shapiro, *Legality* (The Belknap Press of Harvard University Press, 2011) 47 ('*Hume's Law*').
11. Ibid.
12. Ibid 48.
13. See generally CP Snow, *The Two Cultures and the Scientific Revolution* (Cambridge University Press, 1961).
14. Ibid 36.
15. Ibid 11.
16. Ibid 18.

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polarisation and incomprehension of each other's discipline and role.[17] It may also be argued that the two cultures contribute to a reactionary regulatory approach adopted by the law. More generally, Australia's precautionary response is also indicative of uncertainty relating to scientific development and its potential applications.

Adopting Snow's school of thought, a legal and regulatory response to HHGE falls within the remit of both cultures. The longstanding establishment of these separate cultures has led to greater rigidity[18] in public perceptions of science and its relationship to the humanities. If this were to be the starting point for a regulatory response to human genome editing, it is evident that science and law cannot operate in a vacuum. This is especially true in the context of emerging biotechnologies. In an age of technological advancement, a comprehensive understanding of the relationship between science and law will be a highly valued commodity. Snow highlighted the importance of bridging this gap, noting it is a 'necessity in the most abstract sense, as well as in the most practical. When those two senses have grown apart then no society is going to be able to think with wisdom'.[19] It is argued this gap is evidence of Hume's Law, in relation to the innate 'descriptive-normative divide' present within the law/science relationship.

Professor Dan Burk expanded Snow's thesis, arguing the law ought to be characterised as a third culture.[20] Professor Burk defined the culture of science as 'outward looking knowledge' about the world that is 'predictive, advisory and explanatory'.[21] In contrast, the humanities involved 'inward looking knowledge' pertaining to the human condition.[22] According to Burk, the law falls between the two, concerned with process and discourse. While the law may be influenced by scientific evidence or objective knowledge, Professor Burk argued that 'science cannot dictate the law'.[23] Generally, the presence of a third culture has little impact in relation to Hume's Law, as science in isolation cannot assume the identity of an enforceable 'ought'. It requires the law, which for the purposes of this article, has been identified as the enforceable 'ought' which carries the authority of compliance.

If Professor Burk's thesis is applied to HHGE, it would follow that the legal and regulatory response cannot be solely dictated by scientific developments.[24] It must also be informed by social, moral and ethical factors which require 'inward looking knowledge'. Consequently, science may complement the law, by identifying the technical limits of the technology's capabilities, thereby offering instruction in relation to what the law should allow or disallow. As a result, it is argued that both Snow and Burk's positions merely reinforce Hume's Law.

In light of the unprecedented potential brought by CRISPR technology, one must consider whether it is time to rely on the 'external', 'outward looking knowledge' of science,[25] to guide the legal and regulatory response for HHGE. This reinforces the role of science as a 'factual instructor' guiding the law. The uncertainty created by the unforeseen and unknown long-term effects of HHGE may require a new and different approach to legal and regulatory discourse. As a result, it

17. Ibid 12. Snow noted that many literary intellectuals have no idea of basic scientific principles, such as the Second Law of Thermodynamics: see 16.
18. Ibid 18.
19. Ibid 53.
20. University of Lucerne Institute for Interdisciplinary Studies, *Annual Report 2014* (Report, 2014) 37 ('*Annual Report 2014*').
21. Ibid.
22. Ibid.
23. Ibid 37–8.
24. This is also consistent with *Hume's Law*.
25. *Annual Report 2014* (n 20) 37–8.

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may be an opportune time to re-establish the relationship of law and science to one which is symbiotic. In light of the social, legal and scientific complexity associated with emerging biotechnologies, it is imperative that the law rely on both cultures. This will require greater efforts to bridge the gap between the two cultures, to enable clear communication and understanding of each other's roles.

Coined the founder of the history and technology discipline, historian Melvin Kranzberg explored the nature, role and impact of technology on society.[26] Kranzberg's infamous laws of technology represented a set of 'truisms' about the nature of technology.[27] Most notably, Kranzberg's first law of technology stated: 'Technology is neither good nor bad; nor is it neutral'.[28] This context-specific characterisation of technology remains relevant today. It so follows that societal perception of a technology is dictated by its use or application.[29] In contrast, 'defenders of technology' endorse a consequentialist view,[30] whereby at its conception, technology is a 'value neutral' tool.[31] This status of neutrality may be subsequently compromised based on its development and use. Therefore, the 'goodness or badness' of a technology is contingent upon the 'goals or ends for which it is used'.[32] Kranzberg challenged this position, noting '*to say that technology is not strictly neutral, that it has inherent tendencies or imposes its own values, is merely to recognize the fact that, as a part of our culture, it has an influence on the way in which we behave and grow*'.[33]Kranzberg's characterisation supports the notion that technology has a moral identity capable of shaping societal culture, perception and progress. This also accorded with Snow's conclusion '…there is a moral component right in the grain of science itself, and almost all scientists form their own judgements of the moral life'.[34]

Despite Kranzberg's opposition to the consequentialist position, his argument retained principles of utilitarianism, as he advocated for the influence of a technology to be 'directed toward goals worthy of [human]kind'.[35] This characterisation of a technology is rooted in utilitarianism; the context, which refers to a particular use or application, will determine whether it complies with moral and ethical standards. Further, the context in which a technology is used should retain its utility in promoting desirable outcomes for society.[36]

Ethical theory, as a school of thought, attempts to rationalise our innate convictions of moral rights and wrongs. As Peter Singer noted, an individual lives in accordance with ethical standards 'if they believe, for some reason, that it is right to do as they are doing'.[37] Therefore, our ethical judgement or convictions will 'guide practice'.[38] If this view is applied specifically to CRISPR

26. See generally Segal (n 8) 641.
27. Ibid 649.
28. Ibid.
29. See Melvin Kranzberg and Carroll W Pursell Jr, 'The Importance of Technology in Human Affairs' in Melvin Kranzberg and Carroll W Pursell Jr (eds), *Technology in the Western Civilization* (Oxford University Press, 1967) vol 1, 3, 11.
30. Ibid.
31. See Ronald L Sandler, 'Introduction: Technology and Ethics' in Ronald L Sandler (ed), *Ethics and Emerging Technologies* (Palgrave Macmillan, 1st ed, 2014) 1, 22.
32. Ibid [1.1].
33. Kranzberg and Pursell Jr (n 29) 3, 11.
34. Snow (n 13) 14.
35. Kranzberg and Pursell Jr (n 29) 3, 11.
36. This may be referred to as a hedonic utilitarian argument — in which the utility of a technology must promote pleasure and avoid pain: Robert E. Goodin, 'Utility and the Good' in Peter Singer (ed), *A Companion to Ethics* (Wiley Blackwell, 1991) 241, 242.
37. Peter Singer, *Practical Ethics* (Cambridge University Press, 3rd ed, 2011) 9.
38. Ibid 2.

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technology, our moral convictions of appropriate use/s of HHGE will guide its development and application over time. Moreover, its use to prevent and treat fatal genetic disorders or diseases such as cancer promotes a utilitarian agenda, whereby public health becomes the focus of CRISPR technology. This arguably reinforces Hume's Law, noting the law remains normative, determining what may be right or wrong, whilst science continues to exist as a factual instructor alongside the law.

In the context of a regulatory pathway forward for HHGE, the theory underpinning the relationship between law and science must be understood and recognised. Hume's Law merely offers one rationalisation for the observed relationship between law and science. Further, both Snow and Kranzberg's theses relevantly apply to the legislative regime for HHGE, in that our current laws are largely operating independently of science and technology, which remain an 'incommunicable art'.[39] Despite this disconnect between law and science, the prevailing need to retain a utilitarian discourse for the use and regulation of HHGE is reflective of technology's moral identity. In order to promote a healthier marriage between law and science, a regulatory approach which bridges the 'descriptive-normative divide' may be an appropriate way forward.

III The Legislative Regime in Australia

Australia's current regime creates a highly precautionary and prohibitive approach to the regulation of HHGE in research and clinical applications.[40] It has been described as a 'command and control' legislative framework,[41] which restricts biological research, especially in the context of emerging biotechnologies.

Currently, HHGE is governed by a triad of federal legislation, composed of the *Gene Technology Act 2000* (Cth) ('*GT Act*'), *Research Involving Human Embryos Act 2002* (Cth) ('*RIHE Act*') and *Prohibition of Human Cloning for Reproduction Act 2002* (Cth) ('*PHCR Act*'). Together, these statutes prohibit the clinical application of HHGE in viable human embryos and significantly limit research uses. In addition, compliance with the National Health and Medical Research Council's ('NHMRC') National Statement on Ethical Conduct in Human Research and Ethical Guidelines on the Use of Assisted Reproductive Technology in Clinical Practice and Research is required. Due to the current capability of HHGE, its potential clinical application falls under the auspices of an assisted reproductive technology ('ART'). Consequently, HHGE is also captured by the regulatory and policy ambit of legislation and guidelines governing the use of ART.

Australia has a complex regulatory framework that is difficult to navigate. The interaction between each statute and relevant guidelines further exacerbates this complexity in addressing and dealing with various uses of HHGE. At the inception of these statutes, lawmakers had not foreseen

39. Snow (n 13) 47.

40. A 'clinical' and 'research' context or application must be distinguished. A 'clinical application' refers to a viable human embryo subject to germline editing, which is subsequently implanted into a woman to achieve a pregnancy. In contrast, a 'research application' refers to a researcher's or scientist's ability to undertake germline editing on viable human embryos for the purpose of expanding knowledge about the technique, its implications (both short- and long-term) and to refine the technique. See also Qingxiu Bu, 'Reassess the Law and Ethics of Heritable Genome Editing Interventions: Lessons for China and the World' (2019) 34(2) *Issues in Law & Medicine* 115, 139.

41. Dianne Nicol, 'Regulation of Human Germline Genome Modification in Australia' in Andrea Boggio, Cesare PR Romano and Jessica Almqvist (eds), *Human Germline Genome Modification and the Right to Science* (Cambridge University Press, 2020) 543, 565.

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the development of CRISPR technology. More broadly, lawmakers have been confronted with the issue of fostering lawmaking institutions which are responsive to evolving technologies. I argue that Australia's legislative framework lacks the necessary capabilities to accommodate and regulate future uses of HHGE through the identification of three regulatory gaps.[42]

A discussion of each statute will reveal the gaps in Australia's current legislative regime, strengthening the argument for a more robust, responsive regulatory discourse. These gaps are also reflective of the disconnect between the law and science, which continue to operate as two cultures.

A *Gene Technology Act 2000 (Cth)*

This section provides an overview of the regulatory scheme implemented in the *Gene Technology Act 2000* (Cth) ('*GT Act*'). The underlying catalysts prompting the introduction of this statute are instructive for two reasons. First, it clearly identifies our current regulatory system for gene editing in organisms, which enforces various parameters on acceptable uses of gene editing. This arguably reinforces Hume's Law, whereby scientific facts and development have instructed the law, by defining the technical limitations of the technology. However, it is the role of the law to determine whether a particular use of the technology is acceptable or unacceptable.[43] This is reflected in the licensing system implemented by this statute, which acts as the arbiter determining appropriate uses of genome editing techniques. Appointed decision-makers are guided by scientific information, namely the relevant technique and purpose and are vested with authority to approve such uses. Second, and more generally, it reflects Australia's approach to the regulation of an evolving technology. The development of the statute provides context and justification for our current regulatory regime. This is particularly informative when determining whether this legislation remains fit for purpose, in the context of HHGE.

1 *Development and Purpose.* Australia was in uncharted regulatory territory, faced with the task of developing a regulatory framework that was independent and transparent and promoted public engagement.[44] In the 1992 Standing Committee on Industry, Science and Technology's Report, *Genetic Manipulation: The Threat or the Glory?,* the Chairman, Michael Lee, identified the challenge created by biotechnology: '… nations around the world are grappling with the legal and institutional changes which will be required to cope with the new technology'.[45] In response to the emerging field of biotechnology, it was determined that Federal Government intervention was necessary to enforce a regulatory regime to oversee the use and advancement of gene technology.[46] At the time, in the late 1990s, Government interventions were deemed 'inadequate' to respond to the rapid growth of gene technology.[47] Following consultation with the

42. See Part III.
43. This may require syllogism between law and science, promoting greater synergy between the two cultures.
44. See, eg, Commonwealth, *Parliamentary Debates*, House of Representatives, 29 August 2000, 19550 (Fran Bailey); see also Commonwealth, *Parliamentary Debates*, Senate, 7 November 2000, 19291 (Natasha Stott Despoja).
45. Standing Committee on Industry, Science and Technology, Parliament of Australia, *Genetic Manipulation: The Threat or the Glory?* (Report, February 1992) iv.
46. Explanatory Memorandum, Gene Technology Bill 2000 (Cth) 12.
47. Ibid.

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public and relevant stakeholders, the product was a regulatory regime underpinned by a precautionary approach.[48]

The primary focus of the Gene Technology Bill 2000 (Cth) concerned genetic modification within the agriculture and food industry — which is reflected in the 'plant centric' language of the legislation.[49] For example, in its most recent review, the Legislative and Governance Forum on Gene Technology concluded '[t]he Scheme was not designed to regulate humans'.[50] Genetic manipulation of humans, such as cloning or gene therapy, did not fall within the regulatory ambit of the Bill.[51] This was raised by former Attorney-General Nicola Roxon who noted the 'legitimate focus' of the proposed law was narrow in scope, excluding the technology's potential application in humans.[52] She argued explicit and precise statutory language was required to 'ensure the [regulatory] system is appropriate not just for handling and containment of genetically modified organisms in the plant and animal world, but also in the human area'.[53] Consistent with Michael Lee's view, Ms Roxon acknowledged in the 'not too distant future, we will have to grapple with how we legislate or regulate … the treatment of human cells in other areas'.[54] We are now facing this challenge, as HHGE inevitably continues to mature as a technology.

Although an objective of the Bill was to safeguard public health and the environment, its intention in offering this protection was balanced against risks associated with genetically modified foods.[55] Whilst the Bill represented Australia's regulatory response to emerging biotechnologies, the need to future-proof the law to account for further advancements continues to be a recurring issue.

2 *Regulation of HHGE.* While this regime may have a 'plant centric' focus, there is ambiguity in relation to its application in humans, particularly in the context of clinical trials.[56] Under the current *GT Act*, a CRISPR-mediated genetic modification is classified as a gene technology and as such,[57] an organism subject to this modification is deemed a 'genetically modified organism' ('GMO').[58] Following a periodic review and amendments to the Gene Technology Regulations,[59] 'site-directed nuclease ('SDN')

48. Senate Standing Committee for the Scrutiny of Bills, Parliament of Australia, *Bills Digest* (Digest No 11 of 2000–01, 16 August 2000) 32.
49. See Legislative and Governance Forum on Gene Technology, *The Third Review of the National Gene Technology Scheme* (Final Report, October 2018) 25 ('Third Review').
50. Ibid 29.
51. Senate Standing Committee for the Scrutiny of Bills (n 48) 8.
52. Commonwealth, *Parliamentary Debates*, House of Representatives, 29 August 2000, 19555 (Nicola Roxon).
53. Ibid.
54. Ibid 19556 (Nicola Roxon).
55. See, eg, Commonwealth, *Parliamentary Debates*, House of Representatives, 29 August 2000, 19555 (Nicola Roxon); see also *Third Review* (n 49) 25.
56. See further Part D and Part III.
57. *Gene Technology Act 2000* (Cth) s 10 ('*GT Act*'); *Gene Technology Regulations 2001* (Cth) ('*GT Regs*') Sch 1A.
58. *GT Act* (n 57) s 10; see *GT Regs* sch 1B: 'An organism modified by repair of single-strand or double-strand breaks of genomic DNA induced by a site-directed nuclease, if a nucleic acid template was added to guide homology-directed repair'. CRISPR-Cas9 technology is an example of this process.
59. Third Review (n 49).

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techniques' were introduced as an example of a genetic modification technique captured under the Act.[60] Techniques including CRISPR-Cas9 systems, zinc finger nucleases[61] and transcription activator-like effector nucleases were incorporated into the definition of an SDN.[62] This change signified the need to update definitions within the *GT Act*, prompted by developments of scientific techniques.[63] A distinction in the purpose of undertaking an SDN was also addressed (see Figure 1 below). SDNs which do not incorporate the introduction of a new nucleic acid template do not constitute a GMO.[64] This is referred to as an 'SDN-1' — whereby the organism does not carry new traits resulting from gene technology, indicating a double-stranded break has been induced, without the introduction of a repair DNA guiding template.[65] This indicates that any genetic manipulation inserting a new DNA sequence, induced through a technique such as CRISPR technology, produces a GMO which is regulated under the *GT Act*.

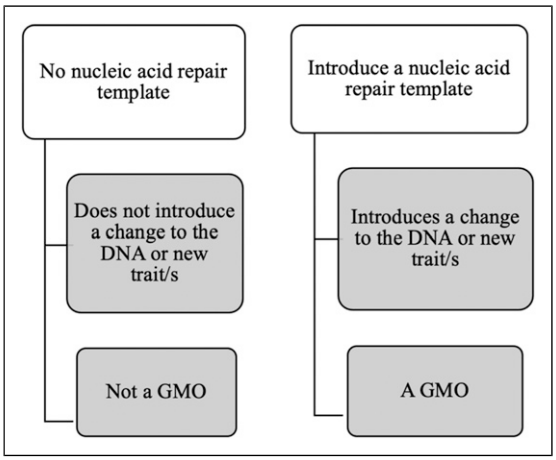

Figure 1. The classification of GMOs according to the purpose of undertaking CRISPR technology in an organism.

60. SDNs which do not incorporate the introduction of a new nucleic acid template fall outside the scope of a GMO. This is defined as SDN-1 — the organism does not carry other traits resulting from gene technology. Rather, the SDN-1 technique indicates a double-stranded break has been induced, without the introduction of a repair DNA guiding template: see Explanatory Statement, Gene Technology Amendment (2019 Measures No. 1) Regulations 2019 (Cth) 9 ('Explanatory Statement Gene Technology Amendment Regulations'); ibid 8.
61. A restriction enzyme which can be programmed and synthesised to recognise and cut specific sequences within DNA: Benjamin A Pierce, *Genetics: A Conceptual Approach* (Freeman, 5th ed, 2014) 537; Bruce Alberts et al, *Molecular Biology of the Cell* (Garland Science, 6th ed, 2015) 269; National Academies of Sciences, Engineering and Medicine, *Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values* (Report, 2016) 30; National Academies of Sciences, Engineering and Medicine, *Human Genome Editing: Science, Ethics and Governance* (Report, 2017) 64.
62. Another type of restriction enzyme: see ibid; Benjamin A Pierce, *Genetics: A Conceptual Approach* (Freeman, 5th ed, 2014) 537–9; Explanatory Statement Gene Technology Amendment Regulations (n 60) 8.
63. Legislative and Governance Forum on Gene Technology, *Modernising and future-proofing the National Gene Technology Scheme: Proposed regulatory framework to support implementation of the Third Review of the Scheme* (Consultation Regulation Impact Statement, December 2020) 9.
64. Explanatory Statement Gene Technology Amendment Regulations (n 60) 9.
65. Ibid.

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3 *Governance and Regulatory Framework.* The *GT Act* establishes a governance framework, enforced through the Gene Technology Scheme. The overarching body responsible for the operation of the regulator and the practical enforcement of the *GT Act* is the Legislative and Governance Forum on Gene Technology ('LGF'), established by an intergovernmental agreement.[66] The LGF is a Ministerial Council, composed of Ministers from each state jurisdiction, managing portfolios relevant to gene technology.[67] The Gene Technology Regulator ('GTR') sits below the LGF in the governance framework. The GTR is an independent[68] statutory body which oversees the use of gene technology and ensures compliance with the regulatory regime.[69] As a result of the governance structure, the GTR sits within the purview of the LGF's oversight function.[70]

The GTR is responsible for administering and operating the licensing system enforced by the *GT Act*.[71] In addition, when dealings with GMOs serve a therapeutic purpose or a therapeutic good contains a GMO, this requires collaboration between the GTR and the Therapeutic Goods Administration ('TGA').[72] The TGA retains sole responsibility to regulate therapeutic goods, ensuring their safety, quality and efficacy for use in humans.[73] The interactive effect of the *GT Act* and *Therapeutic Goods Act 1989* (Cth) ('*TGA Act*') raises important considerations relating to the delineation of jurisdiction according to the nature and use of the GMO/product and the appropriateness of the appointed regulator.

Two statutory committees are also established under the *GT Act*: the Gene Technology Technical Advisory Committee ('GTTAC') and the Gene Technology Ethics and Community Consultative Committee ('GTECCC').[74] The GTTAC is composed of members with skills or experience in science, medicine and public health.[75] Their primary function is to provide scientific or technical advice to the GTR on matters relating to gene technology (including biosafety aspects), GMOs, genetically modified products, applications submitted to the GTR for proposed dealings with GMOs and the development of policy/procedural guidelines, principles and practice.[76] In contrast, the GTECCC offers diversity in its opinion, with members drawing upon experience or skills in a number of areas, such as law, ethics, religious practices, risk communication, community consultation, business and consumer affairs.[77] The Committee also provides advice to the GTR on ethical concerns pertaining to gene technology, the development of policy or procedures/guidelines and codes of conduct and community consultation.[78]

Australia's governance approach aims to centralise day-to-day regulation and enforcement of statutory obligations to one federal regulator, the GTR. Guidance and oversight is facilitated by the LGF and Committees, which serves two purposes. First, it enforces accountability on behalf of the GTR to

66. Third Review (n 49) 91.
67. Ibid. In addition to the LGF, the Gene Technology Standing Committee supports the Forum, by providing advice, facilitating community and stakeholder consultation and recommending policy reforms: see ibid.
68. *GT Act* (n 57) s 30.
69. Ibid pt 3.
70. Third Review (n 49) 91.
71. See *GT Act* (n 57) s 27.
72. *Therapeutic Goods Act 1989* (Cth) ss 30C, 32DS ('*TGA Act*'); *GT Act* (n 57) s 27(e).
73. Office of the Gene Technology Regulator, 'Governance Arrangements' (Web Page, 13 July 2020) <https://www.ogtr.gov.au/internet/ogtr/publishing.nsf/Content/governance-1>.
74. *GT Act* (n 57) pt 8. The constitution of these committees illustrates the importance of moral/ethical debate and reflection in the law's response to evolving technologies.
75. Ibid s 100(5).
76. Ibid s 101.
77. Ibid s 108. The GTECCC must include a member of the GTTAC and a member of the Australian Health Ethics Committee: ibid s 108(4).
78. Ibid s 107.

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comply with statutory obligations and justify acceptable dealings with GMOs. Second, the provision of advice is a means to identify different perspectives and opinions in relation to the use of gene technology. This is imperative in the context of law and policy reform in the area of biotechnology.

The primary regulatory mechanism governing the use of gene editing is the enforcement of a licensing system.[79] This licensing system characterises dealings with a GMO into two groups: an exempt dealing or a notifiable low-risk dealing ('NLRD'). A licence is required for dealings which fall outside the scope of either group.[80] In the context of HHGE, preclinical genetic modification of human cells will not be characterised as an exempt dealing.[81] However, it may be a NLRD, if physical containment is possible.[82] An Institutional Biosafety Committee (accessed through an accredited organisation) will assess the intended 'dealing' to determine whether it is one which falls within the NLRD regulatory scheme.[83] Criminal sanctions accompany a failure to obtain a licence or comply with conditions of a licence when dealing with GMOs.[84]

It is arguable the *GT Act* is an embodiment of Hume's Law and Snow's two cultures. The role of science as a factual instructor attempts to bridge the descriptive-normative divide. In light of science and law operating as two cultures, the advent of gene technology was the catalyst prompting the law to react to this development by implementing a framework for its regulation in plants. It is arguable that a precautionary approach is merely a reflection of the need for the law to monitor ongoing developments as the technology's potential remained largely uncertain. Further, the 'plant centric' nature of the statute is indicative of a regulatory response that did not adequately apply a future-oriented lens, which was only raised by one member of Parliament, the former Attorney-General Nicola Roxon.[85]

Although the *GT Act* retains primary responsibility for the regulation of gene technology, its legislative objective did not consider the application of this technology in humans (in particular, for a therapeutic or enhancement purpose). The continued operation of the scheme remains largely 'plant centric', as reinforced by the GTR, and, as a result, was not created with the intention to regulate humans as GMOs. Where does this leave Australia regarding the regulation of HHGE? Should HHGE fall within the remit of the *TGA Act*?[86]

79. Ibid pt 5.
80. Ibid.
81. Nicol (n 41) 562.
82. Ibid.
83. An organisation which obtains a licence to deal with GMOs can apply to the GTR to become an accredited organisation: *GT Act* (n 57) ss 91–8. In determining whether to accredit an organisation, the GTR considers whether the organisation has sufficient resources and established internal processes necessary for the effective oversight of work/dealings with GMOs. A mandatory requirement of accreditation is access to or the establishment of an Institutional Biosafety Committee — who are tasked with providing on-site evaluations of low-risk contained dealings, which do not require consideration by the GTR: Office of the Gene Technology Regulator, 'Accreditation process' (Web Page, 9 October 2014) https://www.ogtr.gov.au/internet/ogtr/publishing.nsf/Content/accreditation-process; Nicol (n 41) 562.
84. For example, a failure to deal with a GMO without a licence may incur a penalty of 5 years imprisonment for an aggravated offence or 2 years imprisonment for a non-aggravated offence: *GT Act* (n 57) s 32. The same penalties apply to those who breach a licence condition: *GT Act* (n 57) s 34.
85. See generally Bu (n 40).
86. Of particular concern — would genetic enhancement fall outside the scope of TGA regulation? This would require a careful examination of the distinction between a 'repair' and 'enhancement' and the definition of a therapeutic good.

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B *Research Involving Human Embryos Act 2002 (Cth)*

1 *Development and Purpose.* Advancements in research involving cloning, stem cells and ART prompted the introduction of the Research Involving Human Embryos Bill ('RIHE Bill') in 2002. The creation of Dolly the sheep in 1996 and the use of embryos and stem cells within the context of an ART in 1998 represented a new field of research with clinical and therapeutic potential in humans.[87] These developments raised a number of concerns including the possibility of human cloning, the use of cloning to treat disease and the ethics of embryo research.[88]

In the context of legislating in public policy areas that are emotionally and ethically provocative, such as biotechnology, the role of government was characterised as 'uncontroversial'[89] by John Faulkner, Federal Senator and Shadow Minister for Public Administration and Home Affairs. Rather, the 'regulatory principle embodied in [the RIHE Bill]' encourages government to play an active role in 'determining the ethical limits of medical research'.[90] Much like the introduction of the *GT Act*, this was a repeat of history. The law was reacting to another scientific advancement, prompting discussions regarding an appropriate national regulatory mechanism to govern and oversee a rapidly advancing field of research.[91]

The *Research Involving Human Embryos Act 2002* (Cth) ('*RIHE Act*'), in conjunction with the *Prohibition of Human Cloning for Reproduction Act 2002* (Cth) ('*PHCR Act*'),[92] creates a 'complex regulatory and [prohibitive] landscape for research involving genome modification of human embryos'.[93] At the time of its introduction to Parliament, the RIHE Bill was described as 'conservative',[94] 'careful'[95] and 'strict'.[96] Despite this strict approach, it was noted the Bill was designed to adopt a 'very responsible approach to licensing and monitoring' of this new research field.[97] The practical effect of the *RIHE Act* led to the continuation of embryo research in a very limited capacity.

Unlike the *GT Act*, enquiries and debates concerning the *RIHE Act* were human centric and dominated by rhetoric surrounding the moral and human status of an embryo.[98] A primary issue raised in the context of this Bill was the application of research techniques on human embryos and possible uses in ART. Consequently, many stakeholders advocated for a strict and prohibitive regulatory regime.[99] Despite the presence of two irreconcilable and polarised views pertaining to the

87. Standing Committee on Legal and Constitutional Affairs, Parliament of Australia, *Human Cloning: Scientific, Ethical and Regulatory Aspects of Human Cloning and Stem Cell Research* (Report, August 2001) 1 ('Human Cloning Report'). See also John J Mulvihill et al, 'Ethical Issues of CRISPR Technology and Gene Editing Through the Lens of Solidarity' (2017) 122 *British Medical Bulletin* 17–29.
88. Ibid 1–2.
89. Commonwealth, *Parliamentary Debates*, Senate, 11 November 2002, 5997 (John Faulkner).
90. Ibid. This also reinforces *Hume's Law*.
91. See also Community Affairs Legislation Committee, Parliament of Australia, *Provisions of the Research Involving Embryos and Prohibition of Human Cloning Bill 2002* (Report, October 2002).
92. Please see Part C below for a discussion of this statute.
93. Nicol (n 41) 553.
94. Commonwealth, *Parliamentary Debates*, Senate, 12 November 2002, 6110 (Jan McLucas).
95. Ibid; see also Commonwealth, *Parliamentary Debates*, Senate, 11 November 2002, 5970 (Kate Lundy).
96. Commonwealth, *Parliamentary Debates*, Senate, 11 November 2002, 5968 (Kate Lundy); see also Commonwealth, *Parliamentary Debates*, Senate, 12 November 2002, 6064 (Robert Hill).
97. Commonwealth, *Parliamentary Debates*, Senate, 11 November 2002, 5971 (Marise Payne).
98. Prior to the introduction of CRISPR technology, lawmakers were prompted to consider the interactive effect of law and science. Scientific advancements provided new statements of fact, which required a legal response. This is merely indicative of the need to promote greater communication and collaboration between law and science.
99. See Human Cloning Report (n 87) ch 7.

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ethics and permissibility of embryo research and its uses in ART, the 'broader duty to society' was a prevailing factor in favour of allowing research to continue.[100] The need to proceed with caution and care represented a more accurate reflection of a pluralist society,[101] which encouraged flexibility in a regulatory approach to account for differences in opinion.[102] In addition, permissibility of embryo research was informed by an assessment of the potential benefits and risks to human health.

2 *Regulation of HHGE.* The primary regulatory mechanism governing the use of embryo research is a licensing regime,[103] enforced by the Embryo Research Licensing Committee ('ERLC'), a statutory body created under the *RIHE Act*.[104] Failure to obtain a licence or adhere to licence conditions incurs criminal penalties, including imprisonment.[105]

The *RIHE Act* adopts a broad definition of an embryo,[106] which allows for research and training in ART clinics on egg culture, manipulation and maintenance, provided licence authorisation and approval is obtained. There are limited circumstances in which research involving CRISPR technology may be undertaken. First, pursuant to a licence, the ERLC may authorise the genetic manipulation of embryos to insert genetic material from a third person.[107] Second, research may be

100. Ibid 119 [7.111]. This prevailing factor further supports Kranzberg's utilitarian position, which advocates for the promotion of desirable outcomes for society.
101. For more discussion about the plurality of Australian society, see Commonwealth, *Parliamentary Debates*, Senate, 12 November 2002, 6064 (Peter Cook).
102. See Human Cloning Report (n 87) 119 [7.111].
103. *Research Involving Human Embryos Act 2002* (Cth) ('*RIHE Act*') pt 2 div 4.
104. Ibid pt 2 div 3.
105. For example, a failure to obtain a licence or declare an exempt use for excess ART embryos is an offence, with a penalty of 5 years imprisonment: *RIHE Act* (n 106) s 10(1). Further, failure to comply with a licence condition is an offence, punishable by 5 years imprisonment: *RIHE Act* (n 106) s 12. For further examples, see *RIHE Act* (n 106) pt 2 div 2.
106. For the purposes of the *RIHE Act*, a human embryo is one:(a) created through complete fertilisation of a human egg and human sperm or (b) created through any other process (most commonly, somatic cell nuclear transfer), which initiates the development of an embryo with a human nuclear genome or an altered human nuclear genome, which has the capacity to develop up to or beyond the stage at which the primitive streak appears (the creation of the two germ cell layers — endoderm (later becomes the epithelia) and mesoderm (later becomes connective and muscle tissues)).*RIHE Act* (n 99) s 7; see also Mark Hill, 'Gastrulation', *UNSW Embryology* (Web Page, July 5 2021) <https://embryology.med.unsw.edu.au/embryology/index.php/Gastrulation>; Mark Hill, 'Endoderm', *UNSW Embryology* (Web Page, 6 July 2021) <https://embryology.med.unsw.edu.au/embryology/index.php/Endoderm>; Mark Hill, 'Mesoderm', *UNSW Embryology* (Web Page, 5 July 2021) <https://embryology.med.unsw.edu.au/embryology/index.php/Mesoderm>.
107. This refers to mitochondrial donation, which requires a mitochondrial donation licence: see *Mitochondrial Donation Law Reform (Maeve's Law) Act 2022* (Cth); see also *RIHE Act* (n 103) div 4A; see also *Prohibition of Human Cloning for Reproduction Act 2002* (Cth) ('*PHCR Act*'). Pursuant to ss 28C(2), 28D(2), 28E(2), 28F(2) and 28G(2) of the *RIHE Act*, the lawful activities that may be undertaken by a mitochondrial donation licence are specified. Among these activities is the manipulation of embryos created by a means other than fertilisation. Prior to the Mitochondrial Donation Law Reform (Maeve's Law) Bill 2021 being passed by the Federal Parliament, mitochondrial donation was prohibited under s 13 of the *PHCR Act*.

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undertaken on embryos not suitable for implantation or excess ART embryos (if appropriately declared by the ERLC).[108] In order to lawfully use excess ART embryos, statutory requirements arguably impose burdensome practical barriers. For example, section 20 *RIHE Act* authorises the ERLC to grant a licence for the use of excess ART embryos,[109] on the proviso that express written authority from the woman and her spouse declares the embryos to be excess ART embryos.[110] In addition, consent must be obtained from the woman and her spouse and relevant 'responsible persons' prior to issuing the licence.[111]

Whilst these circumstances appear to facilitate a lawful avenue for embryo research involving CRISPR technology, the utility of such research is questionable, as an embryo that is unsuitable for implantation is significantly damaged.[112] The utility of any such research will be dependent on the aim of the experiment.[113] However, significant damage may limit the validity and utility of the research, as the embryo is not capable of proper functioning to sustain life.

It is clear there are significant barriers limiting CRISPR technology involving viable human embryos for research purposes. The restrictive regulatory approach inherent within the *RIHE Act* provides limited scope to lawfully create and use embryos for both clinical and basic research purposes.[114] This may be particularly problematic following the concluding statement of the Organising Committee at the Third International Summit on Human Genome Editing in March 2023. They recognised the progress of germline genome editing, which is not intended for reproduction, in the context of basic research, which uses human embryos or gametes. In light of these developments, it was concluded that basic research in this area should continue.[115] However, the Committee reiterated that the primary purpose of this research is to improve understanding of 'aspects of early human development or exploring how the methods might be used to correct gene variants leading to genetic disorders'.[116] This further strengthens the argument to re-assess

108. See *RIHE Act* (n 103) ss 8, 9(2), 20(1), 24(1).
109. Excess ART embryos are defined as:…a human embryo that:(a) was created, by assisted reproductive technology, for use in the assisted reproductive technology treatment of a woman; and(b) is excess to the needs of: (i) the woman for whom it was created and (ii) her spouse (if any) at the time the embryo was created.(2) For the purposes of paragraph (b) of the definition of *excess ART embryo*, a human embryo is excess to the needs of the persons mentioned in that paragraph at a particular time if:(a) each such person has given written authority for use of the embryo for a purpose other than a purpose relating to the assisted reproductive technology treatment of the woman concerned, and the authority is in force at that time; or(b) each such person has determined in writing that the embryo is excess to their needs, and the determination is in force at that time: *RIHE Act* (n 103) s 9.
110. Ibid s 9(2).
111. Ibid s 24(1). For the purposes of the Act, 'responsible persons' include persons who provided the egg or sperm used to create the embryo, the woman from whom the embryo was created, any person who was the spouse of the person providing the egg or sperm at the time of donation and any person who was the spouse of the woman (for whom the embryo was created) at the time of creation: *RIHE Act* (n 103) ss 8, 24(9). Note the definition of a responsible person in the context of mitochondrial donation was recently inserted: *RIHE Act* (n 103) ss 8, 28N(8).
112. Nicol (n 41) 557.
113. For example, in the context of genome editing, the efficiency and precision of CRISPR technology was investigated using human tripronuclear zygotes (a zygote containing three nuclei, instead of one): see Puping Liang et al, 'CRISPR/Cas9-mediated gene editing in human tripronuclear zygotes' (2015) 6(5) *Protein & Cell* 363. A zygote refers to a fertilised cell following egg and sperm unification: see National Academies of Sciences, Engineering and Medicine, *Heritable Human Genome Editing* (Report, 2020) 6. Further, excess embryos from IVF were used to derive human embryonic stem cells: see Benjamin E Reubinoff et al, 'Embryonic stem cell lines from blastocysts: somatic differentiation' (2000) 18 *Nature Biotechnology* 399.
114. Nicol (n 41) 560.
115. Lovell-Badge et al (n 5) 2.
116. Ibid.

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Australia's legal framework in relation to embryo research. Specifically, to reduce the burdensome practical barriers imposed by the current regulatory system.

C *Prohibition of Human Cloning for Reproduction Act 2002* (Cth)

1 *Development and Purpose.* The need for legislation to address cloning was initiated by Dolly the sheep, which marked the success of somatic cell nuclear transfer in an animal model.[117] Upon its introduction in the House of Representatives, the Prohibition of Human Cloning Bill 2002 ('PHC Bill') originally formed part of the RIHE Bill. Due to the plethora of issues raised in the context of embryo research and unanimous support for the outright prohibition of cloning, the proposed Bill was split.[118] Given the 'complex ethical and moral judgements' raised in the context of embryo research and the inevitability of varying views on behalf of elected members, the Government did not oppose splitting the Bill.[119] As Senator Chris Ellison noted:

> Quite appropriately, these bills were separated in order to allow debate on human cloning on the one hand and the merits or otherwise of stem cell research on the other. This afforded those people who had a strong view in relation to stem cell research the opportunity to vote separately on that bill and not have it tied up with the human cloning bill.[120]

Much like the RIHE Bill, the PHC Bill was described as 'conservative',[121] adopting a strict prohibitive approach to address ethical concerns regarding scientific developments within the realm of human reproduction and the use of human embryos.[122] This Burkean[123] approach to reform advocates for change to occur incrementally, by 'insensible degrees',[124] such that it is 'slow, deliberate, and measured'.[125] However, this approach must be balanced against the need to further progress research to enable refinement of technology and meet the safety threshold required for human use. This is illustrative of Hume's Law, whereby the law must rely upon science to instruct its substantive or descriptive content. Once ascertained, the law may respond accordingly, by contextualising the technology and defining its boundaries for appropriate use/s. Snow's two cultures are also reinforced, as lawmakers are tasked with responsibility to translate scientific developments into enforceable laws.

117. Human Cloning Report (n 87) 1.
118. Commonwealth, *Parliamentary Debates*, Senate, 18 September 2002, 4421 (Richard Alston).
119. Ibid.
120. Commonwealth, Parliamentary Debates, Senate, 11 November 2002, 5994 (Chris Ellison).
121. See ibid 5835 (Jan McLucas). See also ibid 5822 (Natasha Stott Despoja).
122. See *PHCR Act* (n 107) s 3; Explanatory Memorandum, Prohibition of Human Cloning Bill 2002 (Cth) 1 ('Explanatory Memorandum Human Cloning Bill'). See also Commonwealth, *Parliamentary Debates*, Senate, 18 September 2002, 4421 (Richard Alston).
123. The term 'Burkean' has been coined to reflect the ideology of Edmund Burke. See Ernest Young, 'Rediscovering Conservatism: Burkean Political Theory and Constitutional Interpretation' (1994) 72(3) *North Carolina Law Review* 620, 659.
124. Robert J Lacey, *Pragmatic Conservatism: Edmund Burke and His American Heirs* (Palgrave Macmillan, 2016) 37, quoting Edmund Burke, *Letter to Sir Hercules Langrishe* (1792), in Works, IV, 301. See Edmund Burke, *Letter to Sir Hercules* Langrishe, ed Francis Canavan (Liberty Fund, 1999) 247.
125. Lacey (n 124) 36.

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2 *Regulation of HHGE.* The clinical application of HHGE directly contravenes the *PHCR Act*. The legislation prescribes a number of outright prohibitions, which effectively criminalises HHGE.[126] There are two provisions of particular relevance. First, it is a criminal offence to undertake heritable alterations to the human genome, with a maximum penalty of 15 years imprisonment.[127] The criminalisation of heritable editing was not the focus of Parliamentary debate, only noted in passing by one Senator.[128] The effect of this provision bans germline gene therapy, which may be carried out in germ cells[129] or the cells of an early embryo.[130] Despite this ban, in the 2005 review of the *RIHE Act* and *PHCR Act*, most commonly known as the Lockhart Review, the Legislation Review Committee recommended that the creation of human embryos (by means other than fertilisation) subjected to HHGE could be undertaken under licence, for research purposes to 'increase knowledge or treat diseases'.[131] The practical impact of this recommendation is yet to be known.

Second, it is a criminal offence to place a prohibited embryo into a woman to achieve pregnancy, with a maximum penalty of 15 years imprisonment.[132] For the purposes of this provision, an embryo subject to HHGE constitutes a 'prohibited embryo'.[133] This bans the clinical application of HHGE — reinforcing the illegality of using HHGE as part of ART.

The *PHCR Act* represents a highly restrictive model of regulating HHGE in human embryos, for both clinical and research purposes. This approach is arguably consistent with Kranzberg's utilitarian position which reinforces that technology has a moral identity. In the context of the *PHCR* Act, it is evident that the clinical application of CRISPR for HHGE has been defined as an unacceptable use.[134] This is reflected in the outright prohibition of clinical uses of HHGE, within the context of ART. Research uses of HHGE appear to be permitted in human embryos created by a means other than fertilisation, pursuant to a licence. However, the statutory language of section 15 *PHCR Act* creates confusion regarding its applicability to HHGE involving the creation of human embryos for research purposes. The need for clear and unambiguous statutory drafting is vital, given the serious criminal penalties accompanying prohibited uses of HHGE.

D *The Role of the Therapeutic Goods Administration*

Heritable human genome editing involves the use of a gene technology for therapeutic purposes. As a result, it must be considered whether the *TGA Act* ought to have a place in the regulation of HHGE.

There are three 'primary pillars' for the regulation of therapeutic goods in Australia — quality, safety and effectiveness.[135] These pillars attempt to enforce adequate regulation, to achieve the 'correct balance' between protection of consumers and avoiding undue restrictions on industry.[136] Therefore, in order to attain this 'correct balance', an assessment of the risk-to-benefit ratio becomes

126. See *PHCR Act* (n 107) pt 2 div 1.
127. Ibid s 15.
128. See Commonwealth, *Parliamentary Debates*, Senate, 11 November 2002, 5822 (Natasha Stott Despoja).
129. Germline gene therapy is defined as a 'genetic modification [that is] passed on to any offspring born to the person whose cell was genetically modified and also to subsequent generations': Explanatory Memorandum Human Cloning Bill (n 122) 10.
130. Ibid.
131. Legislation Review Committee, Parliament of Australia, *Legislation Review: Prohibition of Human Cloning Act 2002 and Research Involving Human Embryos Act 2002* (Final Report, December 2005) xvii, 172 ('Lockhart Review').
132. *PHCR Act* (n 107) s 20(3).
133. Ibid s 20(4)(f).
134. See above Part I.
135. John McEwen, *A History of Therapeutic Goods Regulation in Australia* (September 2007) vi.
136. Ibid.

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an influential part of approval and regulation of therapeutic goods, to ensure the benefits outweigh its risks.

The *TGA Act* vests the TGA with responsibility for the quality control and assurance of therapeutic goods in Australia.[137] This ensures the availability and supply of goods that are safe and fit for their intended purpose.[138] Regulation is facilitated through pre-market assessments, post-market monitoring and adherence to specified standards, licensing of Australian manufacturers and verification of international manufacturer compliance with equivalent/relevant standards.[139] The primary mechanism underpinning TGA regulation is risk management. This refers to the risk-to-benefit ratio analysis undertaken by the TGA prior to the approval or use of a proposed good/product. The degree of regulatory control is dictated by the classification of the therapeutic good/product and the level of risk attributable to the specific good/product.[140]

I *The Regulation of Genome Editing in Therapeutics.* Genetically modified cells, including those subject to CRISPR technology, are classified and regulated as biologicals.[141] The regulation of biologicals was introduced in 2011 via the implementation of a new regulatory framework under the governing legislation.[142] The framework was designed and enforced to address the use of emerging technologies.[143]

Biologicals are defined as a distinct group of therapeutic goods which are made from, or contain, human cells and/or tissue.[144] Consequently, they introduce unique unforeseen risks that are not raised in the context of other therapeutic goods, such as prescribed medicines or medical devices.[145] Biologicals are regulated in accordance with a risk classification system, whereby class 1 represents 'very low' risk and class 4 'high' risk.[146] On this spectrum, genetically modified cells are characterised as class 4 high risk biologicals.[147] The *Therapeutic Goods Regulations 1990* (Cth) ('TGA Regulations') defines class 4 biologicals as products containing human cells or tissues that have been genetically modified to introduce a function that may or may not have been intrinsic to the cells and/or tissues upon retrieval from a donor.[148] Further, the purpose of the product must be used, or likely to be used, to treat or prevent disease, facilitate a medical diagnosis, inhibit, influence or modify a physiological process, test for susceptibility to a particular disease or replace/modify the

137. *TGA Act* (n 72) s 4.
138. Department of Health and Aged Care, 'What the TGA Regulates', *Therapeutic Goods Administration* (Web Page) <https://www.tga.gov.au/what-tga-regulates>.
139. Department of Health and Aged Care, 'How the TGA Regulates', *Therapeutic Goods Administration* (Web Page) <https://www.tga.gov.au/how-tga-regulates>.
140. Ibid.
141. Department of Health, 'Product Regulation According to Risk: Overview of the Way the Therapeutic Goods Administration (TGA) Considers Risks and Benefits during the Evaluation and Post-Market Monitoring of Products', *Therapeutic Goods Administration* (Web Page) <https://www.tga.gov.au/sites/default/files/product-regulation-according-to-risk.PDF> ('Therapeutic Goods Administration Product Regulation').
142. Therapeutic Goods Administration, 'The Regulation of Biologicals in Australia' (PowerPoint Presentation, Therapeutic Goods Administration).
143. Ibid.
144. Therapeutic Goods Administration Product Regulation (n 141).
145. Ibid.
146. Ibid.
147. Ibid.
148. *Therapeutic Goods Regulations 1990* (Cth) sch 16 ('*TGA Regs*'). See also *TGA Act* (n 72) ss 32A–32AA.

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anatomy of a person.[149] Biologicals confined to the parameters of the relevant legislative provisions and regulations can be used in Australia.[150]

A clinical trial involving a biological may proceed in Australia, with approval from the GTR, the TGA and relevant Institutional Human Research Ethics Committees ('HRECs').[151] This reflects the extent of the interaction between the *TGA Act* and *GT Act* with respect to the use of genetically modified products in humans. It also highlights the applicability of the *GT Act*, despite its 'plant centric' focus.[152] The *RIHE Act* and *PHCR Act* continue to operate at the periphery, to limit research uses of CRISPR technology and deter improper uses of genetically modified products in humans.

The use of a biological for special or experimental purposes is permitted under the *TGA Act*, provided the sponsor[153] adheres to the specified conditions of use imposed by the TGA Regulations.[154] These conditions may include compliance with specified HREC procedural protocols and guidelines, the National Statement on Ethical Conduct in Research Involving Humans and cessation of use if required by the HREC.[155]

The use of novel biological therapies or gene therapies in humans are subject to the TGA's Clinical Trial Approval ('CTA') Scheme.[156] The CTA Scheme operates as an evaluative process for high risk or novel treatments, including gene therapy, with limited preclinical scientific data regarding its safety, risks and efficacy.[157] It involves a comprehensive review of the scientific and ethical issues posed by the novel therapeutic, undertaken by the TGA's HRECs, prior to the commencement of a clinical trial.[158] It is the responsibility of the sponsor to submit a formal CTA application to the TGA, with the available data for review.[159] The sponsor must also ensure compliance with the relevant requirements under the *GT Act*, to obtain a licence or exemption for the use of a GMO.[160] In addition, adherence to the Guideline for Good Clinical Practice, the National

149. *TGA Act* (n 72) s 32A(1)(b).
150. Prior to use in Australia, the biological must be subject to clinical trials.
151. See Therapeutic Goods Administration, 'The Regulation of Biologicals in Australia' (PowerPoint Presentation, Therapeutic Goods Administration) 7; Science and Technology Australia, *Third Review of the Gene Technology Regulatory Scheme* (Submission, 10 November 2017) 8.
152. This arguably reinforces concerns pertaining to the complexity and appropriateness of Australia's current legal and regulatory approach raised in Part III.
153. A sponsor refers to the person who carries out or arranges for the manufacture, supply, export or import of a therapeutic good: *TGA Act* (n 72) s 3; Therapeutic Goods Administration, *Acronyms and Glossary* (Web Page, 22 July 2020) <https://www.tga.gov.au/acronyms-glossary#summary-s>.
154. *TGA Act* (n 72) ss 32CK–CL; *TGA Regs* (n 148) reg 12AD.
155. *TGA Regs* (n 148) reg 12AD.
156. Prior to November 2020, this Scheme was known as the Clinical Trial Exemption Scheme. Its new name, the Clinical Trial Approval Scheme, was said to better reflect the nature of the scheme under the *TGA Act*, which requires TGA approval for the use of an unapproved therapeutic by a sponsor: Therapeutic Goods Administration, 'Clinical Trial Exemption (CTX) Scheme Renamed as Clinical Trial Approval (CTA) Scheme' (Web Page, 6 November 2020) <https://www.tga.gov.au/clinical-trial-exemption-ctx-scheme-renamed-clinical-trial-approval-cta-scheme>; Therapeutic Goods Administration, 'Australian Clinical Trial Handbook: Guidance on Conducting Clinical Trials in Australia using 'Unapproved' Therapeutic Goods' (Handbook, August 2021) 18 <https://www.tga.gov.au/sites/default/files/australian-clinical-trial-handbook.pdf> ('TGA Clinical Trials Handbook'). See also Glenn Smith, 'Regulation, Ethics and Reimbursement of Novel Biological Therapies in Australia – an Update' (Speech, ARCS Conference, 6 August 2019) 15.
157. TGA Clinical Trials Handbook (n 156) 18.
158. Ibid 20.
159. Ibid 21.
160. Ibid 13.

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Statement on Ethical Conduct in Human Research and any relevant protocol approved by the HREC is mandated.[161]

The HREC exercises the primary oversight function, which involves ongoing monitoring of a biological subject to approval for use in humans.[162] This function involves the review of the benefit-risk ratio, trial results, progress reports, ethical acceptability of its use, amendments to protocols, breaches of conditions and safety information.[163]

2 *Contravention of the Therapeutic Goods Act 1989* (Cth). The *TGA Act* codifies a number of criminal and civil penalties relating to the import, export, manufacture, supply and use of biologicals.[164] Criminal penalties are composed of three elements:

1. The biological is for use in humans; and
2. It is not subject to exclusions or exemptions; and
3. The use of the biological:
   a. Has resulted in, or will result in, or likely to result in harm or injury to a person; or
   b. If used would result in or likely to result in harm or injury to a person.

A breach of the criminal provisions is accompanied by a term of imprisonment.[165] For example, the importation, exportation and supply of a biological incurs a penalty of 5 years imprisonment.[166] While the criminalisation of certain conduct acts as a deterrent, it also emphasises the strict regulation of biologicals, due to the inherent risks to human health. The *TGA Act* also enforces civil penalties.[167]

The potential use of HHGE must also consider the applicability of criminal and civil provisions under the *TGA Act*.

IV Australia's Regulatory Approach

'Regulation is neither static nor staid'.[168] This is especially the case when regulating novel therapeutics that are subject to ongoing advancements. Australia's legislative landscape is representative of a piecemeal approach to regulation, which invokes a number of Acts to identify the boundaries of acceptable use for genome editing.

A policy brief of each relevant statute and an examination of its role in the regulation of HHGE identifies three regulatory gaps:

1. *Regulatory complexity:* there is no single legislative instrument which specifically addresses HHGE in clinical and research contexts. Rather, regulation is administered through four statutes. This creates regulatory complexity for those involved in the use of CRISPR technology and raises questions concerning the most appropriate regulator.

161. Ibid 23.
162. Ibid 27.
163. Ibid.
164. *TGA Act* (n 72) div 2.
165. Ibid ss 32BA–BC, BI.
166. Ibid ss 32BA–BB, 32BD.
167. Ibid s 32BF.
168. McEwen (n 135) 169.

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2. *Legislative ambiguity:* the lack of prescriptive statutory language creates uncertainty with respect to the practical operation and enforcement of legislative provisions. For example, what if a researcher is charged with a criminal offence under the *PHCR Act*?[169] This raises questions regarding the purpose of criminalising HHGE and whether there are any possible uses that may not be captured within the remit of the governing statutes.
3. *Inconsistent legislative objectives:* the governing statutes are not fulfilling their legislative objective, which may indicate they are no longer fit for purpose. It is timely to re-evaluate Australia's legislative and regulatory frameworks to specifically address the inevitable use of HHGE as a therapeutic good/product.

This article attempts to provide an alternative lens through which Australia's legislative response to emerging technology may be viewed. It could be argued the piecemeal approach to regulation is a product of the law's reactionary response to advancing technology and reinforces Snow's thesis. The disconnection between law and science may further perpetuate the two cultures, compromising their relationship's ability to achieve synergism. It is further argued the complexity of the two cultures is amplified in areas that are highly politicised and raise moral, social and ethical debate which elicits polarising views. It is in these circumstances that the likelihood of communication between law and science is endangered, creating a larger disconnect between the two cultures.

In the context of emerging technology and specifically CRISPR technology, it is evident that lessons can be drawn from the theses of Hume, Snow and Kranzberg. Most notably, it provides justification for the fraught law/science relationship currently observed in the context of CRISPR technology and its application in humans. It is also integral to note that context is a significant determinative factor influencing the status of the law/science relationship. For example, one may argue the relationship is stronger in the context of climate change and the law.[170] This may also be the case in the context of genome editing within agriculture.

An interaction of the three theories can be applied to the legal and regulatory response to HHGE. First, Hume's Law is reinforced. Scientific advancement may be perceived as statements of fact that instruct the law. However, it may not dictate the substantive content of the law. Second, the moral identity of a technology, as raised by Kranzberg, is reflective of its application and defined by law. This identity is informed by 'inward looking knowledge' and public debate. It requires an interrogation of topics captured within the auspices of the humanities, such as social, moral, ethical, religious, political and economic issues. Finally, the law's response to emerging technology is illustrative of Snow's two cultures, that are separated by Hume's 'descriptive-normative divide'. This divide has led to deficiencies in communication between the two. It also highlights the need to encourage collaboration, in order to provide a robust, scientific and ethically informed regulatory discourse.

It is apparent the law is reactive to scientific advancement, adopting a highly precautionary approach. However, it is important to recognise this response is operating against the backdrop of a society that traditionally separates the sciences and humanities into exclusive siloes. The product is a

169. This refers to the legislative ambiguity present in the interpretation of section 15 of the *PHCR Act* which criminalises HHGE.

170. The adoption of the precautionary principle reveals a well-established regulatory response to scientific advancements. For example, Julian J. Koplin, Christopher Gyngell and Julian Savulescu noted the 'precautionary principle aims to influence decision-making in contexts where some human activity poses uncertain but potentially grave threats. This perfectly describes the controversy surrounding [germline gene editing]': Julian J. Koplin, Christopher Gyngell and Julian Savulescu, 'Germline Gene Editing and the Precautionary Principle' 34 (2020) *Bioethics* 49, 59.

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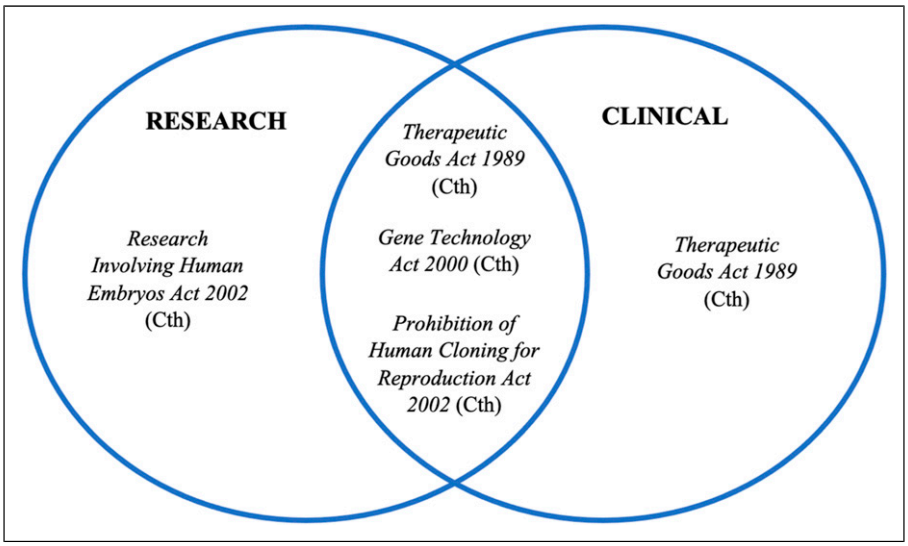

Figure 2. The interaction between four statutes creates a complex regulatory system that is difficult to navigate and adapt to rapidly evolving technologies.

significant disconnect in communication and understanding between the two disciplines. This must be addressed when determining an appropriate pathway forward.

This Part does not seek to provide solutions to these regulatory gaps. Rather, it aims to identify areas requiring further policy development and public engagement to determine an appropriate regulatory discourse.

A *Regulatory Complexity*

The product of a piecemeal approach to regulation is the absence of a single legislative instrument which solely addresses HHGE in both a clinical and research context. Australia's approach raises an important question: who are the formal regulators of HHGE in its various applications? The framework provides numerous regulators, including the GTR, TGA and HRECs. Each regulator is tasked with distinct roles and responsibilities, which are further confined to specific applications of CRISPR technology.

Heritable human genome editing is not explicitly addressed in the *GT Act* or *TGA Act* but is outrightly prohibited by the *PHCR Act*.[171] Figure 2 identifies the relationship between each governing statute, in a research and clinical context. A clinical application of CRISPR technology would invoke the GTR and/or TGA as regulators, whilst the *PHCR Act* operates to enforce the boundaries of CRISPR technology in humans. Alongside this, the *RIHE Act* has now been tasked to govern the licensing system for mitochondrial donation in ART for preclinical and clinical use, through ERLC authorisation.[172] In light of this development, the *RIHE Act* has traversed into the territory of clinical application. As HHGE progresses towards preclinical use, the role and interaction with the *RIHE Act* may be raised.

171. *PHCR Act* (n 107) s 15.
172. *RIHE Act* (n 103) div 4A.

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The lack of prescriptive legislative guidance concerning the use of HHGE in clinical and research contexts perpetuates the regulatory complexity observed in Australia. It also strengthens the case for a single statute which identifies the parameters for the use of HHGE at each stage (research, preclinical and clinical) and the relevant regulators in the translational pathway from bench to bedside.

Currently, the GTR retains primary responsibility for the governance of gene technology. However, the GT Scheme was not designed to regulate the application of gene technology in humans. This has been expressly excluded and affirmed in subsequent reviews of the GT Scheme.[173] Despite this, a sponsor who intends to apply for a clinical trial using a therapeutic product subject to CRISPR technology must obtain a licence or exemption from the GTR. This implies that a human embryo would constitute a GMO for the purposes of the *GT Act*. In addition, if the application is deemed to be of a therapeutic use, regulation is subsequently shared with the TGA. Within the CTA Scheme, primary responsibility for the ongoing management, monitoring and risk-to-benefit ratio analysis is delegated to the elected institutional HREC/s, as opposed to the TGA.[174] The capacity for HRECs to undertake this role is a relevant factor to consider when identifying an appropriate regulator.

It is implicit that the use of CRISPR technology, and specifically, HHGE, will fall within the regulatory ambit of both the *GT Act* and *TGA Act*. However, this does not preclude the operation and applicability of relevant provisions enumerated in the *RIHE Act* and *PHCR Act*. These statutes continue to limit the possible uses of CRISPR technology. The enactment of Maeve's Law also raises additional considerations which will not be explored in this article, specifically in relation to its impact on the applicability of the *PHCR Act*.[175]

Australia's legislative landscape creates an interactive effect between the *TGA Act* and the triad of governing legislation, leading to a highly complex regulatory system which is difficult to navigate for researchers using CRISPR technology. This is highlighted by the operation of the *PHCR Act* and *RIHE Act*. As noted earlier, the clinical application of HHGE is expressly prohibited by the *PHCR Act*. Most often, HHGE relies on the use of viable human embryos, which are then captured within the regulatory ambit of the *RIHE Act*. This imposes additional statutory responsibilities and obligations to undertake lawful research. If a researcher intends to undertake CRISPR technology in a human embryo, they must be aware of the constraints and obligations imposed by the triad of governing legislation and the *TGA Act*, if applicable. For example, a researcher must ensure licence applications are made to the appropriate authority (relevant HREC/s, the GTR and/or the TGA) and understand the statutory limits on acceptable research purposes provided by each governing statute. All the while, the threat of criminal prosecution continues to shadow the researcher.

Complexity may be minimised by clearly identifying a single appropriate regulator for the use of CRISPR technology in humans. However, this requires a comprehensive evaluation of Australia's current statutes to determine whether this collaborative approach to regulation is most effective. A regime which is designed to regulate the use of CRISPR technology in humans is required to alleviate unnecessary complexity.

173. Third Review (n 49) 29. See also Lisa Eckstein and Dianne Nicol, 'Gene Editing Clinical Trials Could Slip Through Australian Regulatory Cracks' (2019) 27(2) *Journal of Law and Medicine* 274, 276.
174. Eckstein and Nicol (n 173) 276. See also TGA Clinical Trials Handbook (n 156) 27.
175. These considerations are noted, but will not be explored in this article, which merely attempts to identify regulatory gaps in need of further examination.

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B *Legislative Ambiguity*

Ambiguity is a product of statutes which attempt to dovetail one another. This is evident in the operation of the *TGA Act* alongside the triad of governing legislation. Each statute governs specific applications of CRISPR technology. For example, the *RIHE Act* governs research uses of CRISPR technology in embryos. In contrast, the *TGA Act* governs potential clinical uses of CRISPR technology in therapeutic goods/products. The overall effect of this regulatory approach may create difficulties in reforming each statute as CRISPR technology continues to advance.

The *PHCR Act* provides a clear example of legislative ambiguity, which raises concerns regarding its practical enforcement. The express prohibition and criminalisation of HHGE is contained within section 15 *PHCR Act*. It is worthwhile noting the construction of this section:

> (1) A person commits an offence if:
> (a) the person alters the genome of a human cell in such a way that the alteration is heritable by descendants of the human whose cell was altered; and
> (b) in altering the genome, the person intended the alteration to be heritable by descendants of the human whose cell was altered.[176]

A plain interpretation of this section consistent with its legislative purpose[177] indicates this provision applies to both embryos and gametes created by fertilisation or some other means, irrespective of the impact of the edit (whether new genetic material is inserted or genetic material is removed without a replacement sequence).[178] Therefore, it may also apply to HHGE for research purposes, as the alteration capable of being heritable is inherent within the research project aim and method.[179] This directly contradicts the position adopted by the Legislative Review Committee in the Lockhart Review, which permitted the use of HHGE for research purposes, provided it increased knowledge or assisted in disease treatment.[180] For researchers engaged in HHGE research, this raises significant concerns. Clarity with respect to the operation of section 15 *PHCR Act* in light of the Lockhart Review's position is warranted.

This legislative uncertainty may lead to a moratorium on research, due to the threat of criminal prosecution and imprisonment. It is logical to presume a researcher would not be inclined to accept this risk.

The fault element contained within section 15 *PHCR Act* requires that the individual 'intended the alteration to be heritable'.[181] The interpretation of this element requires statutory clarification and guidance with respect to its impact on or application to research uses of HHGE. It has been argued the 'relevant intent' pertains to the creation of the heritable genetic alteration, as opposed to an intent to pass on a specific genetic alteration to future generations.[182] The absence of statutory clarity perpetuates confusion about the lawfulness of undertaking HHGE for research purposes (specifically, the methods used to create an embryo) and the operation of the *PHCR Act*. It is this uncertainty which effectively prohibits research involving HHGE, as researchers will not risk criminal prosecution.

176. *PHCR Act* (n 107) s 15.
177. *Acts Interpretation Act 1901* (Cth) s 15AA.
178. See also Nicol (n 41) 554. See also Lockhart Review (n 131) 164–5.
179. See Nicol (n 41) 554.
180. Lockhart Review (n 131) xvii, 172.
181. *PHCR Act* (n 107) s 15(1)(b).
182. Nicol (n 41) 556.

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Another example is evident in the most recent Gene Technology Amendment (2019 Measures No 1) Regulations 2019 (Cth) whereby an SDN-1 organism (one which does not contain a repair DNA guiding template and thus does not introduce new traits) does not constitute a GMO.[183] The practical implications of this amendment in the context of research and clinical uses of CRISPR technology, particularly somatic gene editing, remain ambiguous.[184] Most recently in 2022, the GTR released guidance pertaining to clinical trials involving GMOs.[185] The introduction of human genetically modified somatic cells into a person from which they are derived may require a licence from the GTR, unless subject to an exemption.[186] A licence is not required if the cells cannot secrete or produce infectious agents due to the modification and if modified using a viral vector, they are tested and do not contain other viruses and the viral vector is not present within the cells.[187] Importantly, once the genetically modified somatic cells are in the person, the GMO is no longer regulated by the *GT Act*.[188] It appears that regulation then transfers to the TGA. Despite this guidance, according to the GT Regulations, an organism which carries new traits resulting from CRISPR technology is deemed a GMO and remains within the regulatory ambit of the *GT Act*. It is uncertain how this interacts with the recent clinical trial guidance in cases where somatic gene editing is used to introduce a new trait or repair a gene in a person. Greater clarity is required with respect to these circumstances, including its operation in relation to HHGE and the regulation of this GMO under the *GT Act*.

Legislative guidance is necessary to ensure researchers are well informed of the limitations placed on specific uses of CRISPR technology and the relevant regulators. A more streamlined process, which clearly delineates the jurisdiction of each regulator, would help alleviate the uncertainty and ambiguity introduced by the operation of the *GT Act*.

C *Inconsistent Legislative Objectives*

The appropriateness of each statute governing CRISPR technology is questionable. In particular, the *GT Act*, *RIHE Act* and *PHCR Act* were not introduced to explicitly address and regulate CRISPR technology. As such, it is argued the regulation of CRISPR technology in humans is inconsistent with the legislative objectives of the triad of governing legislation. Each statute must be examined to determine whether it remains fit for purpose.

Over time, despite its incremental expansion to regulate some uses of CRISPR technology in humans, recent guidance indicates that the GTR ceases to be the regulator once the GMO is introduced into a person. As noted above, the *GT Act* was not intended to govern the use of CRISPR technology in humans. Section 3 of the *GT Act* states:

> The object of this Act is to protect the health and safety of people, and to protect the environment, by identifying risks posed by or as a result of gene technology, and by managing those risks through regulating certain dealings with GMOs.[189]

183. Explanatory Statement Gene Technology Amendment Regulations (n 60) 9.
184. Eckstein and Nicol (n 173) 276.
185. See Office of the Gene Technology Regulator, *Guidance for Conducting Human Clinical Trials Involving GMOS* (Guidance, September 2022).
186. Ibid.
187. Ibid.
188. Ibid.
189. *GT Act* (n 57) s 3.

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Section 4 of the *GT Act* reinforces this, noting this legislative objective will be met through the establishment of the regulatory framework.[190] The absence of explicit language pertaining to the regulation of a gene technology in humans is telling and the emphasis on environmental harm is evident:

> [The regulatory framework must ensure] … where there are threats of serious or irreversible *environmental damage*, a lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent *environmental degradation* …[191]

Subsequent reviews and guidance have merely reinforced the 'plant centric' nature of the GT Scheme and supported the collaboration of the TGA in cases involving gene editing in humans for clinical purposes.

Similarly, the *RIHE Act* responded to advancements in research techniques involving human embryos and was dominated by a moral debate concerning the status of an embryo. It is arguable that the *RIHE Act* is the most appropriate legislative vehicle to address HHGE, given its potential application in ART.[192] This is supported by the legislative object of the Act, which states:

> The object of this Act is to address concerns, including ethical concerns, about scientific developments in relation to human reproduction and the utilisation of human embryos by regulating activities that involve the use of certain human embryos created by assisted reproductive technology or by other means.[193]

The application of HHGE in ART may fall within the remit of 'other means', particularly in cases involving gene editing of a viable human embryo to achieve a pregnancy. The current legislative landscape requires scientists to rely on the *RIHE Act* to ascertain the boundaries of lawful research involving embryos and navigate the GT and/or TGA Schemes, where applicable.

Finally, the *PHCR Act* was intended to 'address concerns, including ethical concerns, about scientific developments in relation to human reproduction and the utilisation of human embryos by prohibiting certain practices'.[194] Despite this broad statement, Parliamentary debates and policy indicated the primary intent of this Act was to prohibit and criminalise human cloning for reproduction, in reaction to Dolly the sheep. Similarly, the advent of CRISPR technology acted as a recent catalyst prompting a strict 'law and order' response from the legislature, which led to the criminalisation of such practices under the *PHCR Act*. The appropriateness of this response and insertion into the *PHCR Act* is questionable, as it is not commensurate with its legislative and policy objective.

The evolution of gene technology, and in particular HHGE, had not been foreseen by policy and lawmakers at the time in which each statute was drafted and debated. Rather, as gene technology matured leading to the introduction of CRISPR technology, lawmakers opted to build upon the existing regulatory infrastructure to address these advancements. However, in attempting to do so, this has created a fragmented, complex regime in which the regulation of future uses of CRISPR technology, namely HHGE, may be compromised. Further, the relevant statutes were not drafted nor

190. Ibid s 4.
191. Ibid s 4(aa) (emphasis added).
192. It is acknowledged that the interaction of state-based legislation must also be considered when determining an appropriate statutory host for HHGE.
193. *RIHE Act* (n 103) s 3.
194. *PHCR Act* (n 107) s 3.

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intended to regulate CRISPR technology in humans and as such do not fulfil their legislative objectives.

Parts II and III of this article attempt to provide context to Australia's current regulatory approach. The relevant theories applied represent one justification for the law and policymaking approach adopted in the area of emerging technology. Each governing statute in Part III reflects a reactionary response to technological developments, the extent of which is contingent upon the acceptability of its use. This refers to Kranzberg's notion that a technology's moral identity will be shaped by societal perceptions of acceptable and unacceptable uses. Further, the underlying theory inherent within these statutes arguably reinforces Hume's Law, indicating that the law will remain an 'enforceable ought', as the arbiter of the ethics accompanying a technology and its moral identity. On the other hand, science will continue to factually instruct the law by offering descriptive evidence of CRISPR technology's technical capabilities and limitations. Consequently, this instruction will attempt to bridge the 'descriptive-normative' divide. An application of these theories also leads to the three regulatory gaps identified.

Given the rapid advances of HHGE and its potential use in a clinical context, such as ART or disease prevention/treatment, it is timely to re-consider the most appropriate approach to regulation and the designated regulator.

V Conclusion

Australia's current legislative approach is illustrative of Snow's thesis — the law attempts to communicate with advancements in science, but a large disconnect remains. It also reinforces Burk's notion that the law may rely on both scientific evidence and accompanying moral/ethical concerns to formulate an appropriate response. Hume's Law continues to provide an instructive lens to explain the existence of two siloed cultures, which attempt to operate in tandem. However, it is argued the relationship between the two cultures becomes more distant and complex when responding to CRISPR technology and HHGE.

The bridging of these cultures by improving communication, understanding and involvement of science experts as part of policy development and lawmaking is integral. The triad of governing legislation is indicative of technology's influence on society and its acceptable applications very much inform its moral identity. Whilst an overarching utilitarian purpose is favourable, the outstanding ethical concerns relating to HHGE require public interrogation and consultation.

An examination of each statute reveals a piecemeal and fragmented regulatory approach, reinforcing the disconnect between the two cultures. Despite the arrival of CRISPR technology, it is a repeat of history. The law has reacted in a highly precautionary and prohibitive manner, which may unduly restrict important research required to further refine CRISPR technology. A precautionary approach to avoid another ethical disaster as observed with CRISPR Babies is warranted; however, this must be balanced against a prevailing need to enhance the safety and efficacy of the technology.

An analysis of each statute revealed three gaps in Australia's legislative landscape: complexity, operational ambiguity and inconsistent legislative objectives. The statutory objectives and policy support the argument that these statutes may no longer be fit for purpose. At the very least, some shifting of the legislative landscape to provide clarity would be welcomed. The interactive relationship between the triad of governing legislation and the *TGA Act* perpetuates both the complexity of our regulatory system and ambiguity in the enforcement of relevant provisions of law.

It is not within this article's remit to offer solutions to these gaps. Rather, it serves to identify the nature of these gaps, by examining the governing statutes. Further, the application of theories explored in Part I assisted in applying a contextual lens to the broader relationship between the law

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and science, as a means to provide one explanation of how Australia arrived at the current legislative landscape.

It is perhaps timely to review each statute to ensure our laws are equipped to effectively regulate HHGE. Past experience in developing policy and law within the field of emerging technology should inform next steps to future-proof Australia's current regulatory regime.

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