Human Gene Editing: A New Legal Frontier

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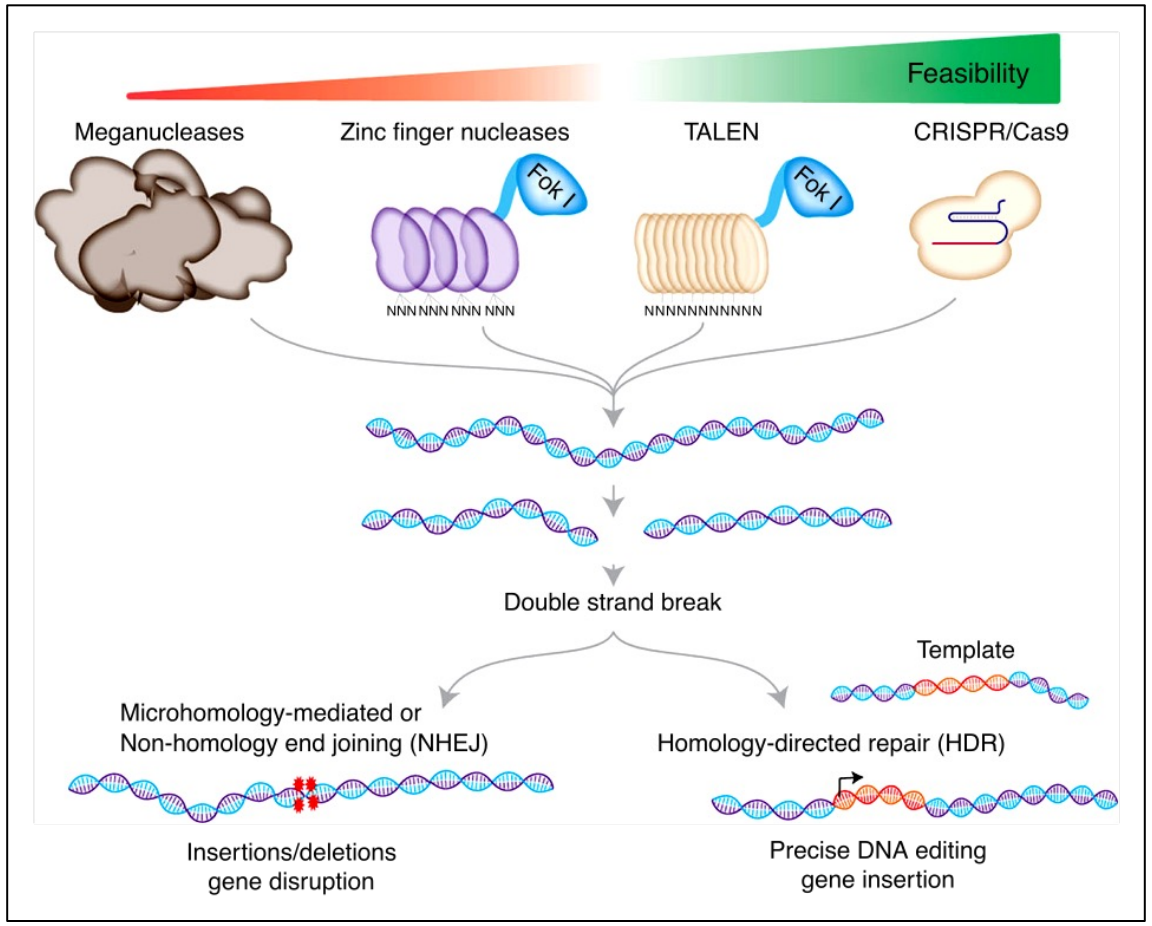
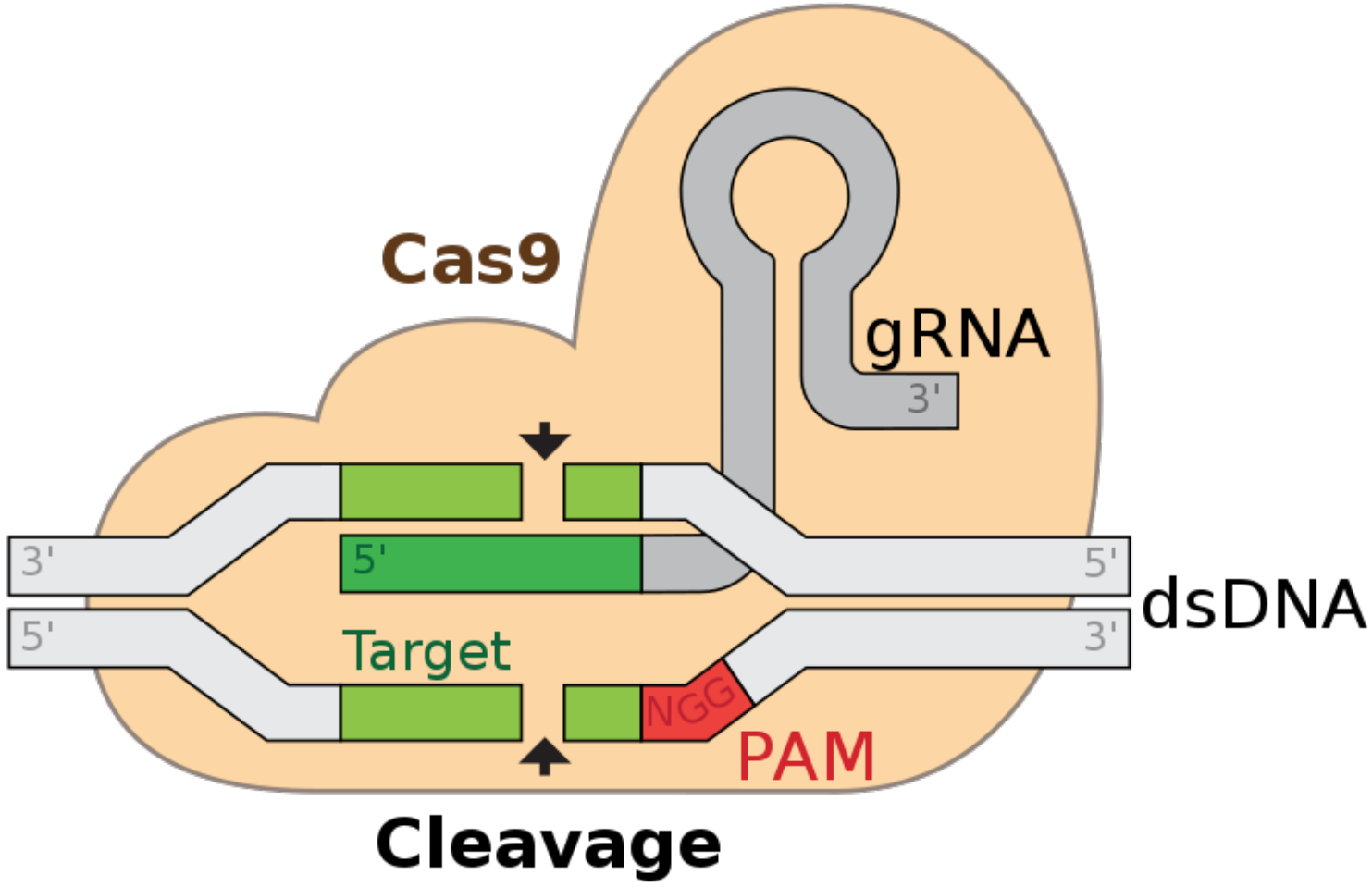
What Is Gene Editing?

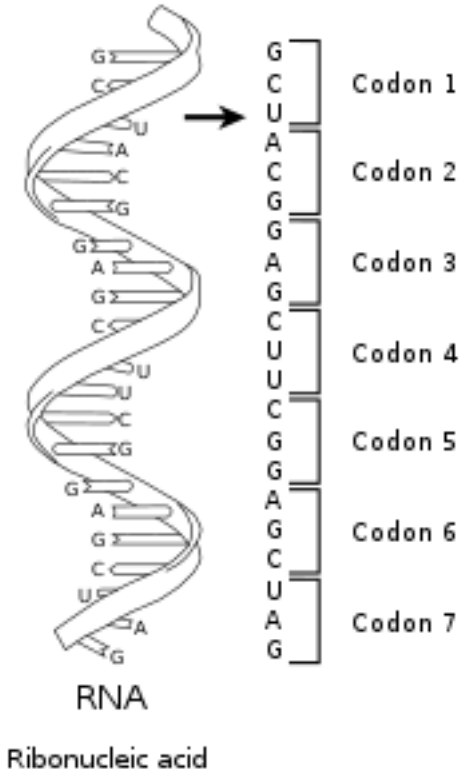


What is CRISPR-Cas9?



Gene Editing Hits the Headlines

What Can Gene Editing Do Now?



Examples of notable Mutations

ΔF508 deletion in cystic fibrosis

1st base \ 2nd base	U	C	A	G
U	UUU (Phe/F) Phenylalanine	UCU (Ser/S) Serine	UAU (Tyr/Y) Tyrosine	UGU (Cys/C) Cysteine
	UUC (Phe/F) Phenylalanine	UCC (Ser/S) Serine	UAC (Tyr/Y) Tyrosine	UGC (Cys/C) Cysteine
	UUA (Leu/L) Leucine	UCA (Ser/S) Serine	UAA Ochre (Stop)	UGA Opal (Stop)
	UUG (Leu/L) Leucine	UCG (Ser/S) Serine	UAG Amber (Stop)	UGG (Trp/W) Tryptophan
C	CUU (Leu/L) Leucine	CCU (Pro/P) Proline	CAU (His/H) Histidine	CGU (Arg/R) Arginine
	CUC (Leu/L) Leucine	CCC (Pro/P) Proline	CAC (His/H) Histidine	CGC (Arg/R) Arginine
	CUA (Leu/L) Leucine	CCA (Pro/P) Proline	CAA (Gln/Q) Glutamine	CGA (Arg/R) Arginine
	CUG (Leu/L) Leucine	CCG (Pro/P) Proline	CAG (Gln/Q) Glutamine	CGG (Arg/R) Arginine
A	AUU (Ile/I) Isoleucine	ACU (Thr/T) Threonine	AAU (Asn/N) Asparagine	AGU (Ser/S) Serine
	AUC (Ile/I) Isoleucine	ACC (Thr/T) Threonine	AAC (Asn/N) Asparagine	AGC (Ser/S) Serine
	AUA (Ile/I) Isoleucine	ACA (Thr/T) Threonine	AAA (Lys/K) Lysine	AGA (Arg/R) Arginine
	AUG (Met/M) Methionine	ACG (Thr/T) Threonine	AAG (Lys/K) Lysine	AGG (Arg/R) Arginine
G	GUU (Val/V) Valine	GCU (Ala/A) Alanine	GAU (Asp/D) Aspartic acid	GGU (Gly/G) Glycine
	GUC (Val/V) Valine	GCC (Ala/A) Alanine	GAC (Asp/D) Aspartic acid	GGC (Gly/G) Glycine
	GUA (Val/V) Valine	GCA (Ala/A) Alanine	GAA (Glu/E) Glutamic acid	GGA (Gly/G) Glycine
	GUG (Val/V) Valine	GCG (Ala/A) Alanine	GAG (Glu/E) Glutamic acid	GGG (Gly/G) Glycine

- Myotonic dystrophy
- SCA 8

β-Thalassemia

McArdle's disease

Prostate cancer

Colorectal cancer

Sickle-cell disease

Friedreich's ataxia

Fragile X Syndrome

Selection of notable mutations, ordered in a standard table of the genetic code of amino acids.

Clinically important missense mutations generally change the properties of the coded amino acid residue between being basic, acidic, polar or nonpolar, while nonsense mutations result in a stop codon.

Amino acids
- Basic
- Acidic
- Polar
- Nonpolar (hydrophobic)

Polyglutamine (PolyQ) Diseases
- Huntington's disease
- Spinocerebellar ataxia (SCA) (most types)
- Spinobulbar muscular atrophy (Kennedy disease)
- Dentatorubral-pallidoluysian atrophy

Mutation type
- = Trinucleotide repeat
- = Deletion
- = Missense
- = Nonsense

What Can Gene Editing Do Now?

What might it be able to do in the future?

Current Legal Framework

- Gene Therapy Advisory Committee (GTAC)
  - Research Ethics Committee

- Gene editing for ‘non-medical’ purposes is prohibited

Should We Proceed with Gene Editing?

Germline Genome Editing

“The moratorium is a pause. Society needs to figure out if we all want to do this, if this is good for society, and that takes time. If we do, we need to have guidelines first so that the people who do this work can proceed in a responsible way, with the right oversight and quality controls.’

Feng Zhang, Broad Institute of Harvard and MIT

Improving Health and Wellbeing

- Treat disease
- Treat disability
- Improve individual health

Eradicating Disease, Disability… and Difference

Disability as Harm

"It is hard to doubt that most people must regard disability as having negative value. However strong their all-things-considered commitment to any or all existing disabled people, however willing they are to do all they can to make life as good as possible for them, and even though they would not change their existing disabled child or spouse or colleague for any able-bodied person in the world, the fact remains that most people would think it better for themselves if their disabled friends and relations and employees were not disabled."

Janet Radcliffe Richards

Eradicating Disease, Disability… and Difference

Eradicating Disease, Disability… and Difference

Social Model of Disability

"it is not individual limitations, of whatever kind, which are the cause of the problem but society's failure to provide appropriate services and adequately ensure [that] the needs of disabled people are fully taken into account in its social organization".

Mike Oliver

Eradicating Disease, Disability… and Difference

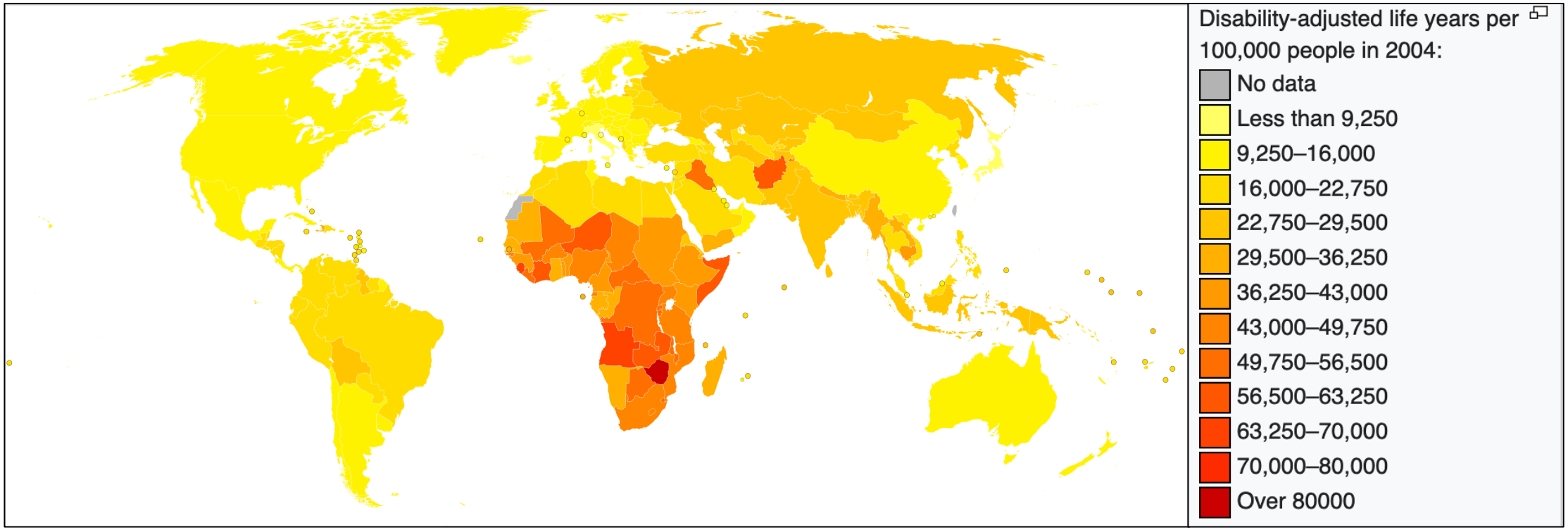
Disability as a Good

‘I can’t bring myself to say that his dyslexia is pathological. To use the old, deeply inaccurate language of brain lateralization, he’s a right brain person. He sees holistically; he’s a big picture person; he intuits; he connects wildly distant and different concepts. …

When I see a tree, it’s clothed with other peoples’ written descriptions of trees. The tree itself is more or less invisible. But not for Tom. There’s nothing vicarious about his world. He sees for himself, and seems to see far more of the real tree than I do. Not for him the neat, prescriptive relationship between word and reality that defines and suffocates me.’

Charles Foster

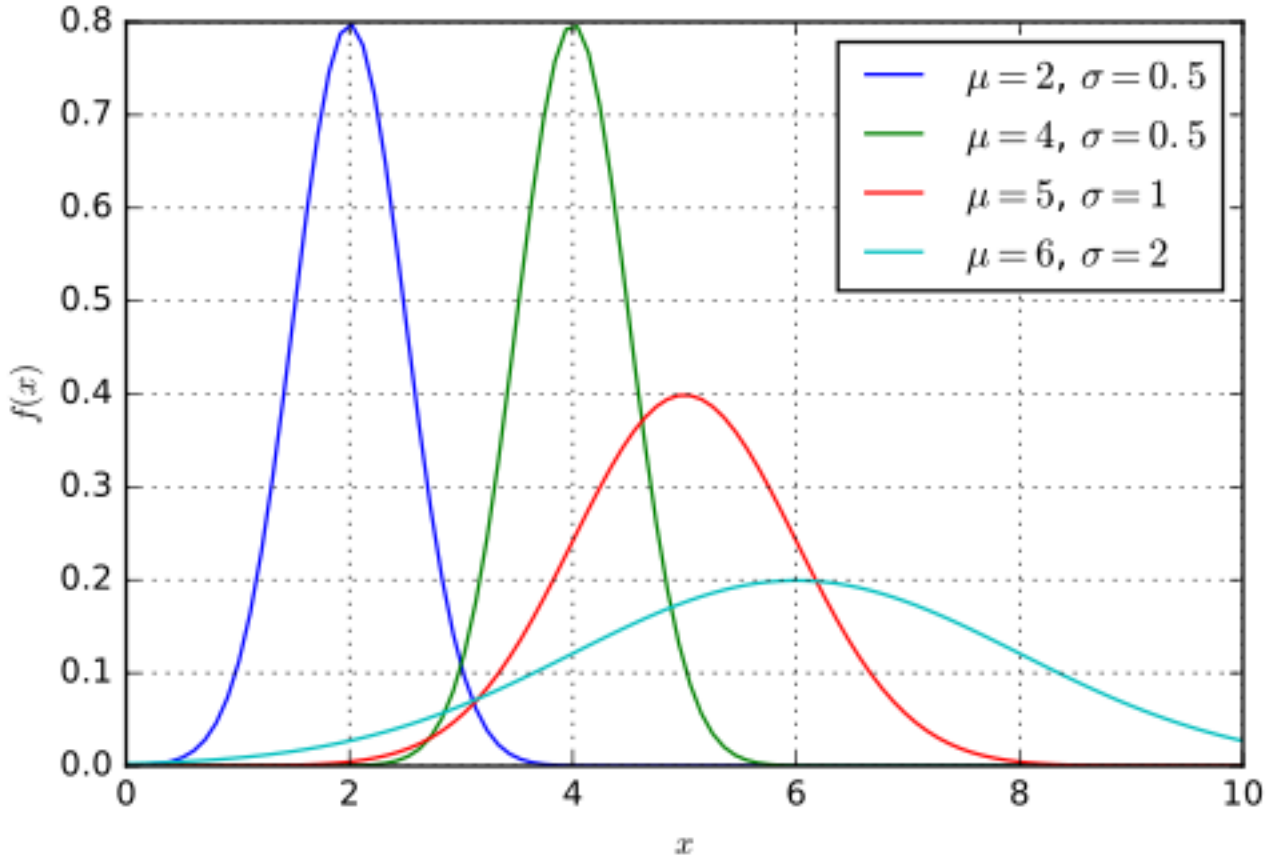
Health Inequities



Reproductive Autonomy

- Afford parents choices in their children
- Avoid termination and embryo selection problems
- Concerns about ‘designer babies’

Genetically Enhancing Ourselves



Genetically Enhancing Ourselves

Genetically Enhancing Ourselves

“The deeper danger is that they represent a kind of hyperagency—a Promethean aspiration to remake nature, including human nature, to serve our purposes and satisfy our desires. The problem is not the drift to mechanism but the drive to mastery.”

Michael Sandel

Genetically Enhancing Ourselves

“Both aspects of our lives are interwoven and, indeed, it is this interweaving and our struggles with it that make us what we are and constitutes in its interplay of light and dark, much that is of value and significance in human existence”

Mike Parker

“Some people have a lot of light and no dark; others are all dark. The issue is whether we should accept what nature delivers up or make a choice.”

Guy Kahane and Julian Savulescu

Enhancement and the Parent/Child Relationship

“In a social world that prizes mastery and control, parenthood is a school for humility. That we care deeply about our children and yet cannot choose the kind we want teaches parents to be open to the unbidden. Such openness is a disposition worth affirming, not only within families but in the wider world as well. It invites us to abide the unexpected, to live with dissonance, to rein in the impulse to control.”

Michael Sandel

An Open Future?

- Letting nature decide our future
- Pressure on children to meet expectations
- Offering opportunities

Limiting Use

- Distinguishing which uses may be permissible and which might not
  - Somatic v germline
- Welfare questions
- Diversity
- Changing norms

Conclusions

Thank you!