



Australia's National Science Agency

State of Research and Development in Cattle

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Asia Oceania Animal Biotechnology Regional Virtual Workshop

The Impact of Gene Technology in Animal Agriculture and Food Production

August 31 – September 1st

Outline of the presentation

- The “delivery” system to industry.
- Methodologies that being applied in cattle.
- Considerations for the trait selection.
- Some examples.

Combining biotechnologies

- Reproduction
- Genomics

Reproductive biotechnology

Artificial insemination
Fixed-time artificial insemination
In vitro fertilization, embryo transfer
Cloning

Well established technologies
Used to multiply desired animals

Advanced genomics

Genomic estimated breeding values
Embryo genotyping
Gene editing
Pluripotent cells transfer

Mixed developmental stages, some ready,
some need refinement

Low technology

Medium technology

High technology

Genomic EBV + bull

Genomic EBV + FTAI

Gene editing + cloning

Genomic EBV + AI

Genomic EBV + IVF

IVF + Gene editing

High penetration

Low penetration

Herd improvement

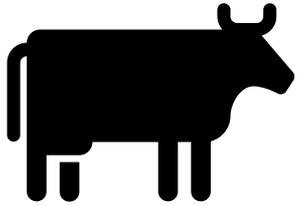
Generate great animals

Technology ready to use (or near to)

Under development

Methodologies for gene editing in livestock

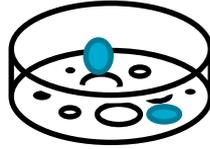
Cell editing + cloning + embryo transfer



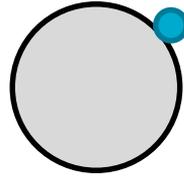
Isolate
somatic
cells



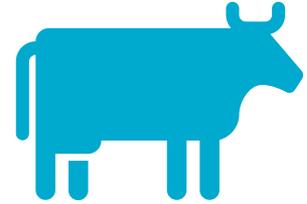
Gene
editing
cells



Screen/
selection
of cells

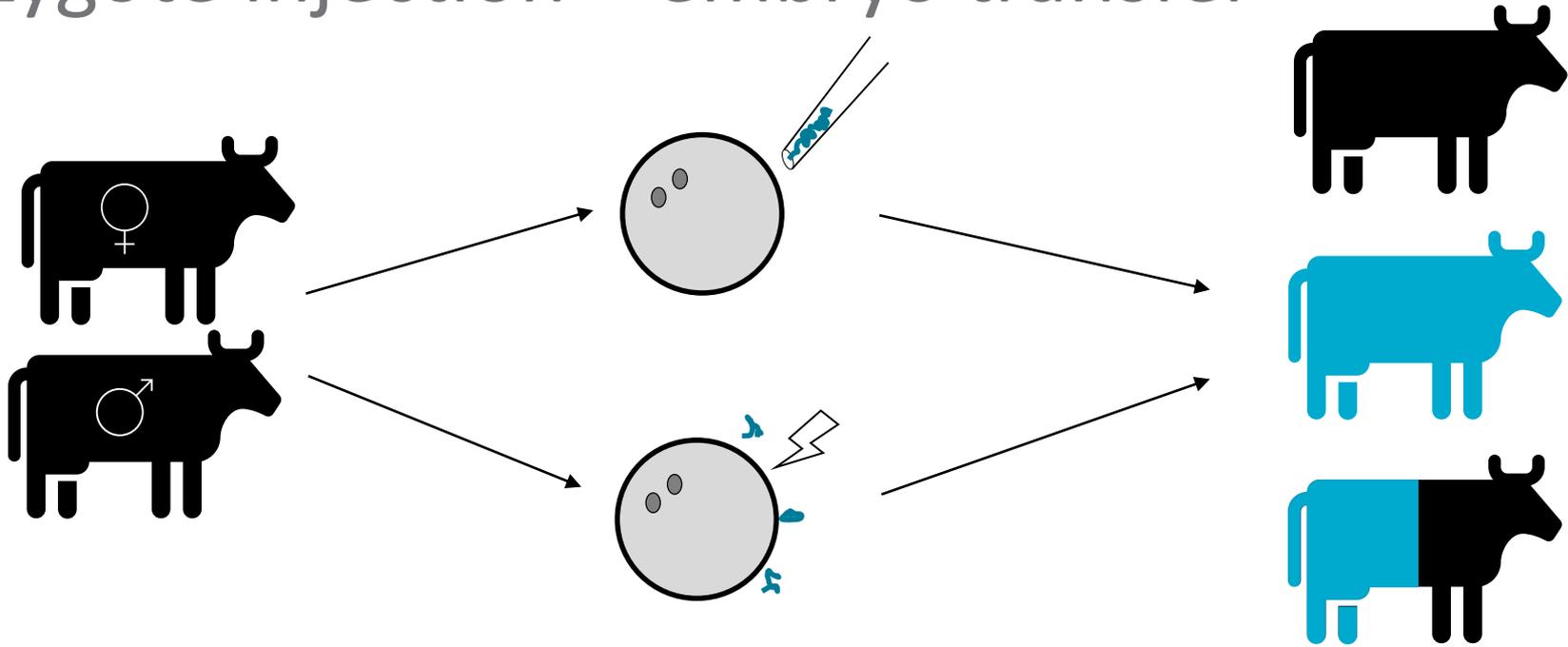


Cell cloning
+ embryo
transfer



The genetic modification is fully monitored – low efficiency in generating offsprings

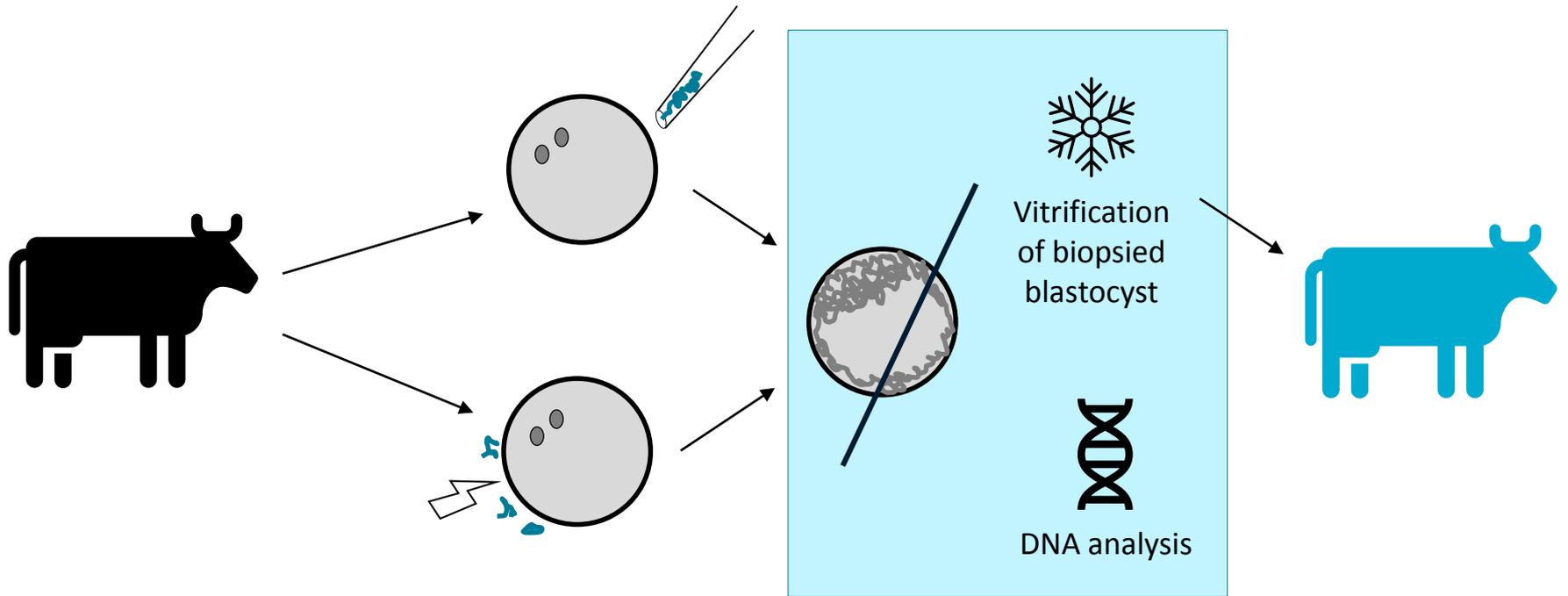
Zygote injection + embryo transfer



Zygote electroporation + embryo transfer

High efficiency in generating offsprings – not so controlled gene editing

Embryo screening before transfer



Adding “monitoring” of gene editing

Trait selection and examples

Trait selection – decision tree

What is the industry problem?

Welfare, Health, Environment, Productivity

Gene or variant already identified?

Complexity of gene editing

Is it a GM solution?

Can we scale up?

Some trait examples

Coat colour



MC1R
E/e



PMEL
WT/del

Schmutz & Dreger. 2013 Anim Genet. 44(1):9-13

Coat type



PRLR
Several
mutations

Littlejohn et al. 2014 Nat Commun. 18;5:5861
Porto-Neto et al. 2018 Front Genetics 9:57
Murillo et al. 2021 Anim Genet. 52(1):132-134

Polled (BTA1)



Recombinetics at UC Davis

Carlson et al. 2016 Nat Biotechnol 6;34(5):479-81.

Carcase yield (muscle) - *MST*



Proudfoot et al. 2015 Transgenic Res 24:147-153.

Creating sex-bias

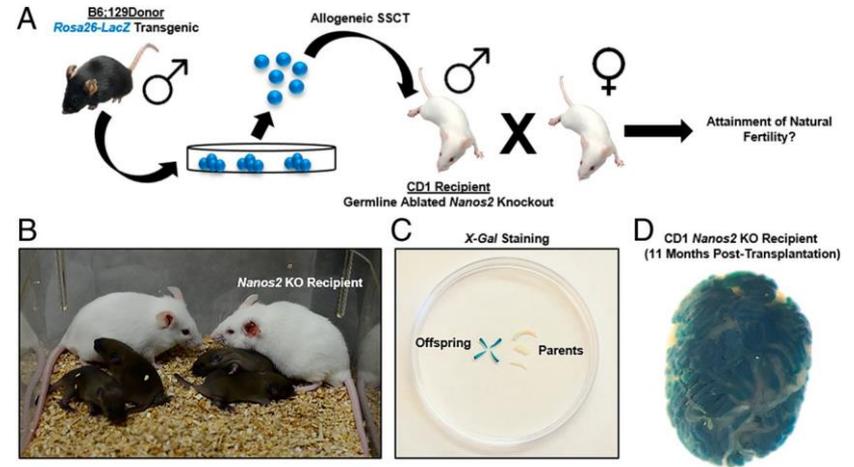


Knock-in *SRY*

Owen et al. 2021 BMC Genomics. 12;22(1):118.

Surrogate males

- Knockout *Nanos2* (stop development of germ cells)
- “Recolonise” testis with spermatogonial stem cell



Ciccarelli et al. 2020 Proc Natl Acad Sci U S A. 29;117(39):24195-24204

Thank you

Agriculture & Food

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