

The Future of Embryo Transfer (ET)

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What is Embryo Transfer

Embryo transfer is the production of more progeny by a donor ewe within a given time period than the ewe could produce by natural means.

Why use Embryo Transfer

1. Increase the number of lambs born per year per donor ewe
2. Produce lambs from more than one sire from a donor ewe in a single breeding season
3. Rapidly establish a new breed
4. International trade – import and export embryos
5. Establish a gene-bank to preserve rare breeds
6. For gene editing purposes

Current use of ET

Domestic production of pedigree sheep

- Texel, Suffolk, Beltex, Charollais, Blue Texel, Dutch Spotted, Blueface Leicester, Valais Blacknose and others
Reliant on high prices being paid for some pedigree animals

Export / Import of embryos

- New Zealand, Australia, USA, EU, Central and Southern America.
Reliant on a demand from these countries for British sheep genetics

Gene banking of rare breeds

Domestic production of high performance sheep

Reliant on a domestic demand for high performance sheep

Traditional ET versus IVF

1. Traditional In vivo ET

- Involves the donor ewe from superovulation to embryo collection
- 99.9% of ET currently carried out in the UK uses the traditional approach

2. IVF - In vitro ET

- Where oocyte maturation, fertilisation and embryo development occurs in the laboratory.
- Research basis

Traditional ET

- In vivo Superovulation Ovulation, Collection and Embryo Transfer (MOET) (99.9% of ET carried out in the UK)
- Where ova maturation, fertilisation and embryo development occurs within the donor ewe.
- A donor ewe (the genetically elite ewe) is superovulated to produce multiple ova
- Ova fertilised via AI (very rarely natural service)
- 5-6 days later these fertilised ova – called embryos, are collected usually via laparotomy (abdominal surgery) while the ewe is under a general anaesthetic.
- Embryos transferred to recipient ewes (usually crossbred commercial ewes) using a laparoscopic assisted technique. OR frozen.

Traditional ET involves surgical embryo collection

Preparing for surgery



Introducing media into the uterine horn



Embryos are flushed from the uterus

Surgical Flushing

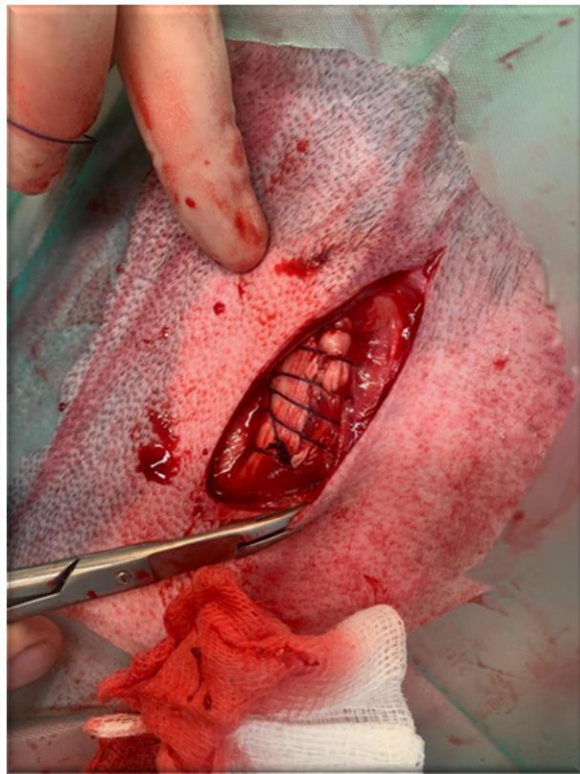


Collecting embryos in media into the petri dish

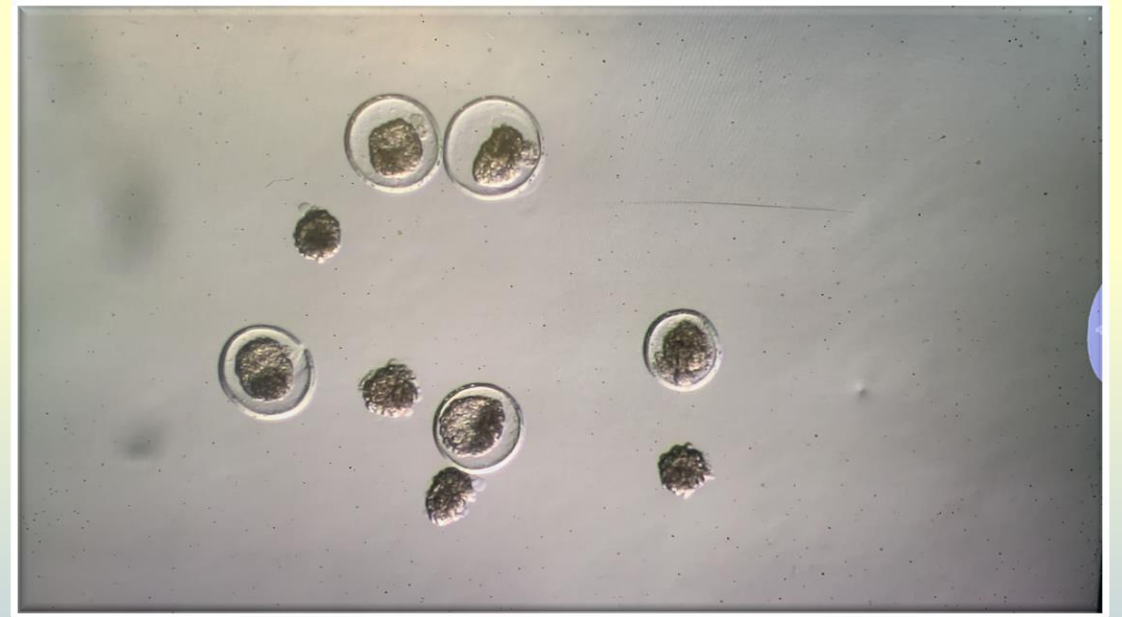


Completion of surgical embryo collection

Closing the abdomen



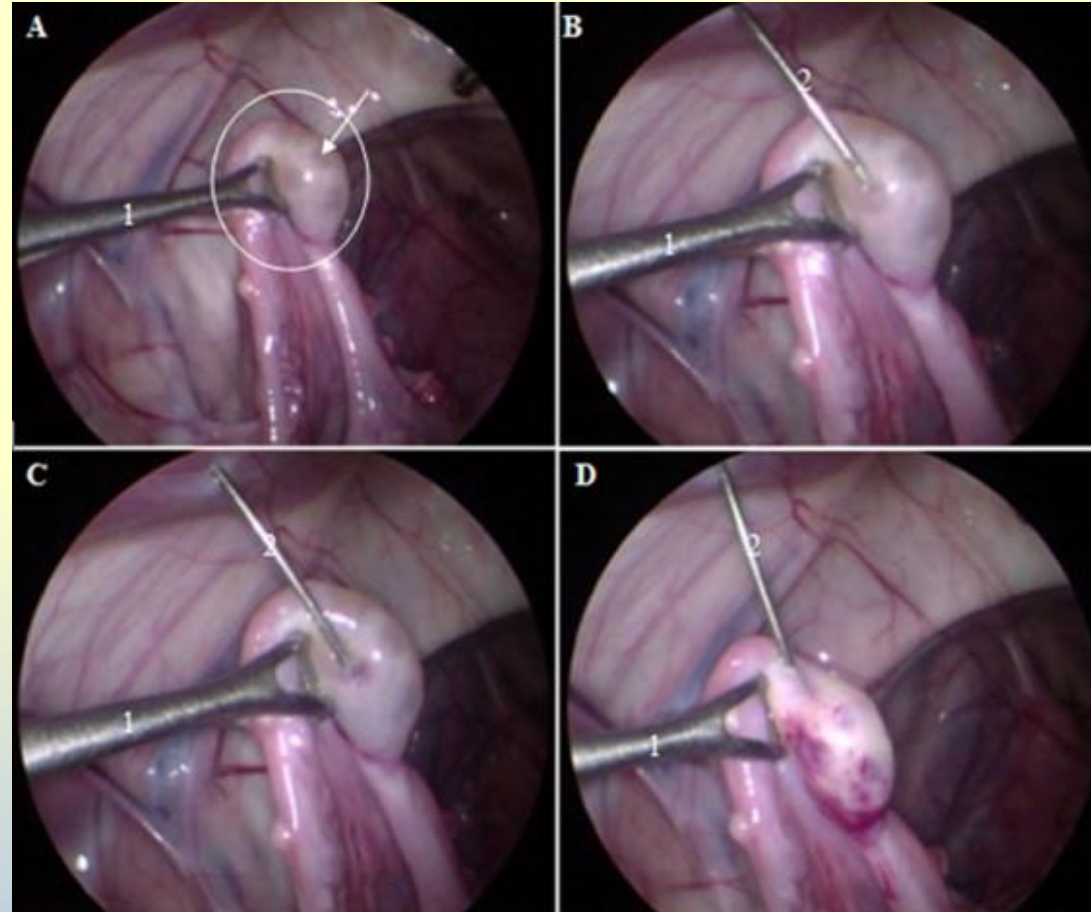
Sheep Embryos



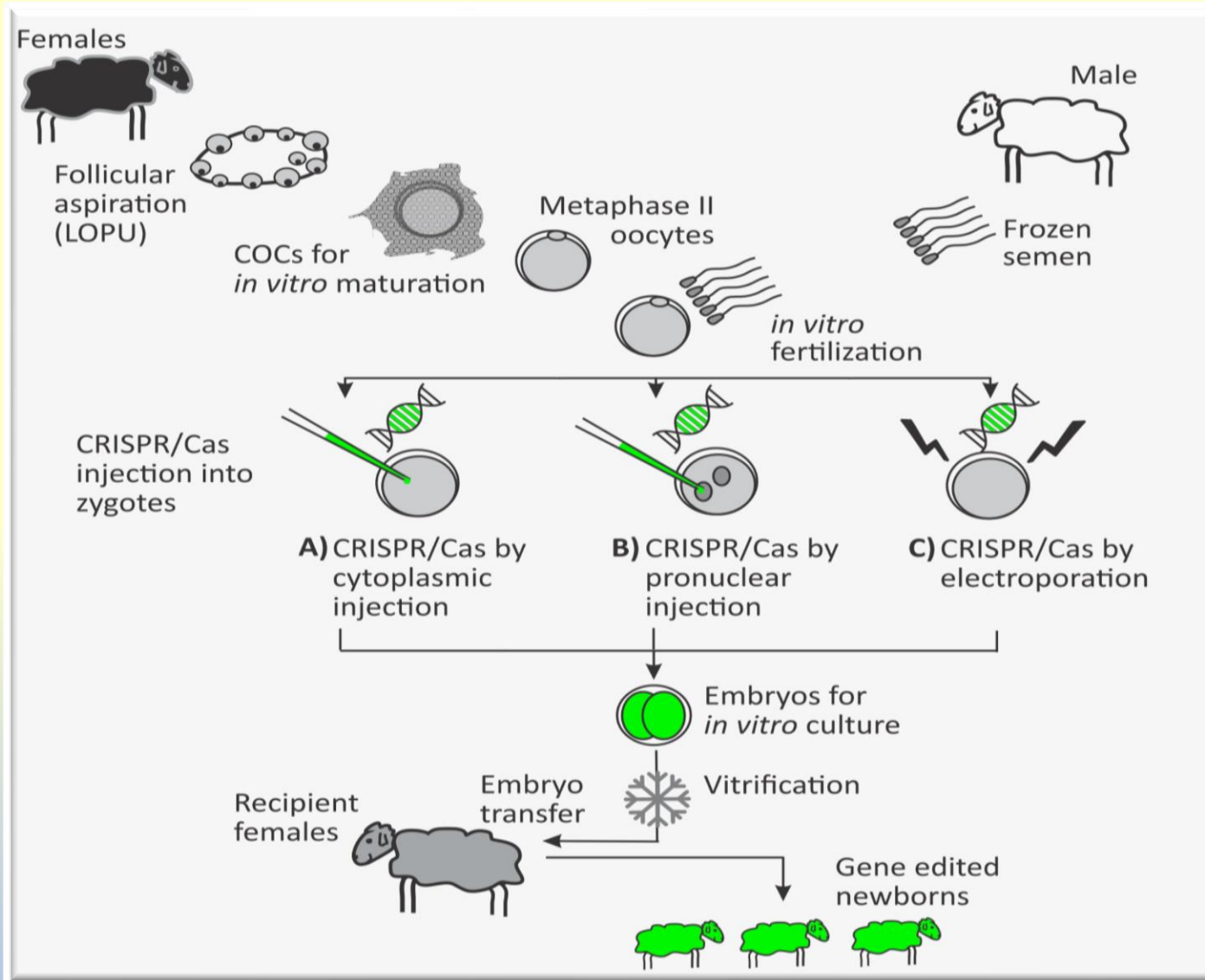
In vitro ET

- Where oocyte maturation, fertilisation and embryo development occurs in the laboratory.
- Not widely available commercially
- Oocytes are collected from un-ovulated follicles using laparoscopy - 10-14 per ewe. (less superovulation hormone used)
- Oocytes transferred to the laboratory in specialized media, matured then fertilized to become embryos while held in an incubator
- Gene editing can take place soon after fertilization
- Embryos grown to 6 day old blastocysts in specialized media in an incubator
- 40% success rate = 4-6 blastocyst embryos per IVF collection
- The blastocysts are either frozen, vitrified or transferred to a recipient ewe using a laparoscopic assisted technique.

Collection of oocytes by laparoscopy



IVF and Gene editing



The changing demand for ET

Historically:

- Not much has changed in traditional ET from 1994 to 2024
- A different superovulation hormone, the use of CIDRs and different anaesthetic protocols.
- The rise in popularity of the Texel post FMD 2001 lead to a dramatic uptake in ET
- The introduction of new breeds – Beltex, Valais Blacknose, Blue Texel and Dutch Spotted fuelled an increase in ET

Headwinds

- **Animal Welfare**
 - Possible ban on the surgical collection of embryos
 - Regulation of recipient selection
- **Ban on the use of PMSG**
 - Potential ban on the use of PMSG based on animal welfare issues relating to its production. - PMSG used to assist superovulation and to synchronise recipient ewes. The use of PMSG is banned in Switzerland.
- **Reduced domestic demand due to less available cash**
 - Reduction of BPS
 - Domestic “recession” and household inflation
 - Sheep farm inflation – fertiliser, energy, wages.
 - ET inflation – cost of superovulation hormone has doubled in 4 years
- **A reduction in demand from overseas markets**
- **Changes to breed society rules that discourage ET**
- **Completion of the “ET cycle”**

The Near Future

Improve animal welfare outcomes

- Laparoscopic embryo recovery from conventionally superovulated donors
- Cervical embryo recovery – not commercially viable
- IVF (laparoscopic collection of ova) – not currently commercially viable
- Improve recipient selection

Alternative to PMSG

- Kisspeptin analogue C6
- Amend superovulation protocols such that PMSG is not required
- Use of teaser rams to synchronise ewes
- Move ET further into the ewe's natural breeding season

Cervical Embryo Collection

Collecting embryos using cervical ET



The tortuous nature of the ewe cervix



The future of ET

Combine ET with other advanced technologies

- Using sex sorted semen in ET/IVF programmes
- IVF and gene editing
- Improve the success of ET in ewe lambs
- These are expensive technologies, the structure of the sheep industry will have to change considerably if these advanced technologies are to used.

The future demand for ET

Dam line sires with desirable genes

High tolerance of roundworms

High productivity with low inputs

Low methane emissions

Terminal sires with favourable genes

Improved meat eating quality

Easy lambing and high lamb survival (outdoor lambing)

ET in 2035?

Will the British sheep industry become more akin to the New Zealand sheep industry?

If yes;

- Pedigree breeding will shrink significantly resulting in very little ET in pedigree sheep
- More breeding companies will be established using a small amount of ET
- Exports might increase if British sheep have genes desired by other countries
- Surgical embryo collection may be replaced by Laparoscopic embryo collection
- IVF may be more successful and affordable
- Sexed semen must be available

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