Chapter
1

Embryo Transfer Technology: Selecting Donors and Recipients

INTRODUCTION

- The term 'embryo transfer' involves the retrieval of embryos from a donor and their placement into the uteri of synchronized recipients.
- Embryo transfer (ET) involves a series of procedures to remove embryos from a donor's reproductive tract and transfer them into a synchronized recipient's reproductive tract.
- Embryo transfer can, in principle, be carried out in any mammalian species.
- However, its most significant application is in dairy cattle and buffalo for the rapid multiplication of elite females.
- The process involves many procedures, schedules, techniques, and supplies.

Application of Embryo Transfer in Cattle and Buffaloes

- **Genetic improvement:** The main goal of embryo transfer (ET) is to enhance the rate of genetic improvement by boosting the reproductive rates of high-quality female animals. For instance, in the case of cattle and buffalo, which have a low reproductive rate and long generation interval, ET is particularly valuable for increasing the reproductive rate. The elite donor animal continues to produce embryos while recipient animals bear the burden of the long gestation period.
- **Clones and transgenic animals:** This technique also transfers clones or transgenic embryos produced in the laboratory, producing clones and transgenic animals.
- **Generation interval:** ET technology dramatically reduces the generation interval.
- **Disease control:** When the embryos are transferred into recipients, it is unlikely that they will spread viral and bacterial diseases.
- **Import and export:** Importing and exporting embryos is easy and more cost-effective than buying a live animal due to the development of efficient cryopreservation methods for cow, sheep, and goat embryos.
- **Circumvention of infertility:** Elite infertile animals, either due to injury, disease, or senility, can be propagated through this technique. Since many infertility conditions have a genetic predisposition and have lower success rates, it should be avoided.

- **Conservation:** ET can also boost the population of rare or endangered animals, provided there are enough recipients. Frozen embryo banks can also be established to conserve excess embryos for future use as longer-term breeding strategies.

History of Embryo Transfer Technology

1890: Walter Heape reported the first embryo transfer in the rabbit.
1940: Casida and co-workers reported multiple ovulations in cattle (superovulation) for the first time.
1949: Warwick and Berry successfully produced the first lamb using embryo transfer.
1951: Willett and co-workers reported the first calf through ETT.
1969: Rowson and his colleagues recorded the first commercially acceptable results.
1973: Wilmut and Rowson produced the first calf from a frozen-thawed embryo.
1983: Nicholas and Smith are credited with coining the term "MOET" for multiple ovulation and embryo transfer.
1983: Drost and co-workers produced the first buffalo calf through embryo transfer.
1988: Mishra and co-workers reported the first buffalo calf through embryo transfer in India.

Selection of Donor Animals

The embryo transfer process for cattle and buffaloes begins with the selection of a genetically elite, well-nourished, non-pregnant donor. It is crucial to determine an embryo transfer program's ultimate success or failure. It has been suggested that donor cows for embryo transfer programs should be selected based on the following criteria:

- They should be phenotypically and genetically superior.
- They need to be reproductively healthy in order to achieve the best results.
- They should be at least 60 days postpartum before the transfer procedure begins.
- They should have a clean, normal-sized uterus.
- They should have completed, preferably, two heats since calving.
- Their oestrous cycle length should be 18–24 days.
- A history of no more than two breeding per conception.
- The previous calf has been born at approximately 365-day intervals.
- No reports of difficulties during parturition.
- No detectable genetic defects or conformational abnormalities.
- The donor shall be in positive energy balance, having a body condition score around 3.
- Comparatively younger donors (4–8 years of age) should be preferred.

Selection of Recipients

The recipient's condition is a key factor in successfully achieving pregnancy after embryo transfer. The first step in managing recipients is selecting suitable females to receive embryos. It has been common in embryo transfer programs to overlook the recipients' quality. The process of selecting and identifying high-quality recipients is complex and multifaceted. While some individuals prefer virgin heifers, others opt for cows with a documented history of high fertility. It has been suggested that recipient cows in embryo transfer programs should be selected based on the following criteria:

- They should have good reproductive health, a history of easy calving, and strong milking and mothering abilities.
- All female recipients should have a known health status and be screened for common diseases such as brucellosis, tuberculosis, and BVD
- They should be vaccinated against the common diseases.
- They should be 3–6 years of age and have completed 60 days postpartum.
- They should exhibit regular oestrous cycles before synchronization.
- They must receive proper nutrition.
- Recipients should not be fat and should preferably gain 0.1–0.2 kg daily.

EXERCISES

A. SHORT QUESTIONS AND ANSWERS

1. Why are cows preferred over heifers as donors?

Ans: Cows have a proven record of production and reproduction, while heifers are selected based on their dam and sire records, which may not reflect their own performance. Therefore, cows are a better choice than heifers.

2. Why heifers are a safer option for purchase as recipients?

Ans: Heifers are a better option to purchase as recipients owing to low purchase cost, low maintenance cost, no additional management for milking and related issues, minimum reproductive issues, and higher pregnancy rate in virgin heifers than lactating animals.

3. Why is it advisable to keep the new arrivals (either donors or recipients) separate from the breeding herd until enough time has passed?

Ans: It is because for diagnostic screening tests and any incubating disease to become apparent during the quarantine period.

4. Why are cows, instead of heifers, a safer choice as recipients in larger breeds?

Ans: Cows should have good conformation during calving, and second or third calvers are the best choice.

5. Why is a body condition score of 2.5–3.5 considered ideal for embryo transfer in recipients?

Ans: It is because outside of this range of condition score, pregnancy rates decline significantly.

6. Who, when, and in which species was the first embryo transfer performed?

Ans: The first embryo transfer was performed by Walter Heape in 1890 in rabbit species.

7. Why is embryo transfer in cattle considered beneficial?

Ans: A cow typically produces an average of 8–10 calves throughout her lifetime under standard management system. However, it has nearly 150,000 potential ova in her ovary at birth. All these potential eggs continuously degenerate unnoticed, and barely 8–10 are effectively utilized in her lifetime. Therefore, much of a female's reproductive potential remains unutilized. The embryo transfer technique allows the utilization of some of these unutilized eggs to develop into embryos, their subsequent recovery from the donor, and then transfer into recipients.

8. How is an animal from an imported embryo more disease-resistant than an imported animal?

Ans: A calf born from an imported embryo transferred to a local recipient gains colostrum immunity to local diseases and may thrive better than an animal imported live. Therefore, importing embryos and transferring them to indigenous recipients can be a strategic and beneficial approach for cattle breeders to enhance the health and productivity of their herds while minimizing the risks associated with importing live animals.

9. Why is it better to import an embryo than an entire animal?

Ans: Importing an entire animal as compared to those of embryos involves large government restrictions in both countries, including quarantine. Import of embryos is a less costly and time-consuming process. The calf born through the transfer of an imported embryo into an indigenous animal is more disease resistant to local diseases as he acquires colostral immunity from her surrogate mother.

10. Why are embryos produced in the ETT program unlikely to spread contagious diseases from donor to recipient?

Ans: Generally, embryos are collected while still within the zona pellucida. The zona pellucida acts as a barrier, protecting embryonic cells from uterine infections. In vitro, removing microbial contamination from the zona pellucida can be achieved by washing embryos and treating them with trypsin.

B. MULTIPLE CHOICE QUESTIONS

1. In embryo transfer, the recipient female is typically selected based on:

a. Genetic compatibility with the donor
b. Sound reproductive health
c. Physical appearance
d. Blood type

Ans: b. Sound reproductive health

2. The main reason for selecting a young donor in embryo transfer is:

a. Higher superovulation response and embryo viability
b. Lower risk of genetic abnormalities
c. Greater physical strength
d. Longer reproductive lifespan

Ans: a. Higher superovulation response and embryo viability

3. When selecting a recipient for embryo transfer, which factor is typically considered the most important?

a. Age
b. Body weight
c. Blood type compatibility
d. Reproductively sound

Ans: d. Reproductively sound

4. Which of the following is not a reason for preferring cow over heifer as donor?

a. Cows have a proven record of production and reproduction
b. Heifers have a proven record of production and reproduction
c. Heifers are selected based on their dam and sire records.
d. None of the above

Ans: b. Heifers have a proven record of production and reproduction

5. Which of the following is not a suitable reason to purchase heifers as recipients in the ET program?

a. Low purchase cost
b. Good milking and mothering ability
c. Minimum reproductive issues
d. Higher pregnancy rate

Ans: b. Good milking and mothering ability

6. Which of the following is not a reason for selection of cows as recipients?

a. Known history of high fertility
b. History of calving ease

c. Have good milking and mothering ability
d. Higher conception rate than heifer

Ans: d. Higher conception rate than heifer

7. Why are embryos produced in the ETT program unlikely to spread contagious diseases from donor to recipient?

a. Donor animals are typically carefully screened and tested for diseases before their embryos are collected
b. Embryos are collected while still within zona pellucida
c. The washing of embryos and treatment with trypsin before transfer to recipients
d. All of the above

Ans: d. All of the above

8. A calf from an imported embryo is more disease resistant than an imported animal because:

a. Embryos are treated with trypsin before import.
b. ET animals are more disease-resistant.
c. Importing animals "on the hoof" (live animals) introduces foreign pathogens to the local population.
d. Calf acquires colostral immunity from her surrogate mother.

Ans: d. Calf acquires colostral immunity from her surrogate mother.

C. MARK THE FOLLOWING STATEMENTS AS TRUE OR FALSE

1. The superovulation response is not affected by lactation in beef or dairy cows, provided the cows are cycling and not losing weight.

Ans: True

2. Young cows yield slightly lower transferable embryos than heifers under the same conditions.

Ans: False. Higher

3. Upon arrival at an embryo transfer centre, all new cattle must be accompanied by a health certificate showing negative brucellosis and tuberculosis (TB) tests conducted within the previous 90 days.

Ans: False (30 days)

4. New animals must be isolated from existing cattle for at least 60 days until negative tests for TB, brucellosis, anaplasmosis, and bluetongue are confirmed.

Ans: False (30 days)

5. Embryo transfer is beneficial in cattle due to their relatively low reproductive rate and long gestation period.

Ans: True

6. The technique of embryo transfer has been extensively utilized in pigs.

Ans: False

7. Embryo transfer in horses is less common compared to cows.

Ans: True

8. Embryo transfer techniques are firmly established in sheep due to the extensive use of the ewe in research as a low-cost model for the cow.

Ans: True

9. Recipients and their maintenance are significant bottlenecks in running a commercial bovine embryo transfer program.

Ans: True

10. Culls from a breeding programme, repeat breeders, animals in poor body condition, early postpartum animals, and animals with an unknown breeding history make suitable recipients in the ET program.

Ans: False

D. MATCH THE PAIRS

1. Match the appropriate milestone (column A) with the corresponding researcher (column B)

Column A	*Column B*
1. First embryo transfer	a. Warwick and Berry
2. First superovulation in cattle	b. Willett and co-workers
3. First lamb by embryo transfer	c. Casida and co-workers
4. First calf through ETT	d. Walter Heape

Ans: 1. (d) 2. (c) 3. (a) 4. (b)

2. Make sure to match the correct milestone with the corresponding year

Column A	*Column B*
1. First embryo transfer	a. 1890
2. First superovulation in cattle	b. 1951
3. First lamb by embryo transfer	c. 1940
4. First calf through ETT	d. 1949

Ans: 1. (a) 2. (c) 3. (d) 4. (b)

3. Match the correct researchers

Column A	*Column B*
1. The first calf born from a frozen-thawed embryo	a. Nicholas and Smith
2. The term 'MOET' was given	b. Wilmut and Rowson
3. First buffalo calf produced through ET	c. Mishra and co-workers
4. First buffalo calf produced through ET in India	d. Drost and co-workers

Ans: 1. (b) 2. (a) 3. (d) 4. (c)

4. Match the milestones with the correct years

Column A	*Column B*
1. The first calf born from a frozen-thawed embryo	a. 1983
2. The term 'MOET' was given	b. 1988
3. First buffalo calf produced through ET	c. 1973
4. First buffalo calf produced through ET in India	d. 1983

Ans: 1. (c) 2. (a) 3. (d) 4. (b)