T Level Technical Qualification in Animal Care and Management

Animal Management and Science Occupational Specialism

Research Project Guide Standard Exemplification Material Distinction

Version and date	Change detail	Section
V1.0 October 2024	Approved version	

Contents

Introduction

The sample evidence within this document refer to the Animal Management and Science Occupational Specialism research project. The aim of these materials is to provide centres with examples of knowledge, skills and understanding that attest to a distinction grade. The evidence presented here has been developed to reflect a distinction grade within each task but is not necessarily intended to reflect the work of a single candidate. It is important to note that in live assessments a candidate's performance is very likely to exhibit a spikey profile and the standard of performance will vary across tasks. The Guide Standard Exemplification Material (GSEM) illustrates linear performance across all pieces of evidence at the grade. A distinction grade will be based on a synoptic mark across all tasks.

The evidence in this GSEM is separated into the sections as described below. Evidence is presented against tasks from the research project. Assessors using the GSEM may find it helpful to review this document along with the sample assessment materials (SAMs).

Task

This section details the evidence to be submitted for marking and any additional evidence required including any photo/video evidence. Also referenced in this section are the performance outcomes and the evidence will be marked against when completing the tasks within it. In addition, evidence that has been included or not been included in this GSEM has been identified within this section.

In this GSEM there is evidence from:

- Task 1
- Task 2
- Task 3

Evidence

This section includes exemplars of evidence, photo/video recordings of the evidence in production (or completed). This will be exemplar evidence that was captured as part of the assessment and then externally marked by the assessor.

Word counts

Typical word counts/page lengths, as indicated in the SAMs, are used as approximates for guidance to support the production of sufficient evidence. The marking will relate to the quality of the evidence produced and not whether the word count/page length has been met and candidates may be under or over the word count without affecting their grade.

Commentary

This section includes detailed comments to demonstrate how the evidence attests to the standard of distinction.

It is important to note that the commentary section is not part of the evidence or assessment but are evaluative statements on how and why that piece of evidence meets a particular standard.

Grade descriptors

To achieve a distinction, a candidate will typically be able to:

Demonstrate an excellent level of performance that consistently meets industry requirements, to be able to enter the animal science industry to begin work in the occupational area.

Demonstrate an excellent understanding of husbandry plans and highly effective technical skills and techniques for carrying out routine health assessments associated with breeding and rearing animals.

Demonstrate an excellent understanding of human-animal interaction, consistently applying safe and welfare orientated techniques when handling, restraining and moving animals, adapting them when necessary.

Accurately interpret technical information to be able to plan and prepare equipment and work areas, assess risk and follow safe working methods appropriately when applying practical skills to an excellent standard and within relevant legislation and regulations.

Produce comprehensive population management plans for the care and monitoring of animals in accordance with relevant legislation, conservation and evolution.

Carry out comprehensive planning and research on reproductive technologies and gene manipulation including thoroughly assessing the validity and reliability of sources.

Carry out comprehensive analysis and evaluation of research to enable effective presentation of results to targeted audiences.

Demonstrate excellent knowledge and understanding of genetics and evolution of common wild and captive animals, health and nutrition for animals and the effects of disease on the animal with reference to veterinary practice and legislation.

Demonstrate excellent knowledge and understanding of fundamental scientific principles relevant to biology and chemistry for animal scientists.

Consistently use technical terminology accurately in plans, reports and documentation.

Task 1 Planning and researching

Evidence contributes to the following:

Performance outcome(s)
PO1 Apply research methods to collect and analyse scientific information on reproductive technologies and gene manipulation.

Evidence	Candidate producing	Assessor producing	Included in this GSEM
Task 1a - Research proposal	√		√
Task 1b – Research action plan	√		√

Task 1a) Create a written research proposal for your research project

Candidate evidence – research proposal

Title of the research proposal

Examine and compare the success and effectiveness of embryo transfer (ET) and genetic testing in cattle and dogs.

Aim:

Reproductive technologies, such as embryo transfer and genetic testing, form an important aspect of breeding programs in animals. These technologies, which are adopted by a number of organisations, have an ethical and welfare impact on the animals involved which Guilds genetics are keen to investigate.

The aim of this research is:

i) to investigate the legal, ethical and welfare considerations of embryo transfer and genetic testing in cattle and dogs

ii) to compare the uses and limitations of embryo transfer and genetic testing in cattle and dogs.

Objectives:

- To examine the procedure of embryo transfer (ET) and its uses in cattle and dogs
- To examine the legal and ethical considerations of ET and genetic testing in cattle and dogs
- To research the success and limitations of ET in cattle and in dogs
- To examine genetic testing procedures performed in cattle and dogs - what conditions can be tested - why - how does it benefit the individual/breed
- To evaluate the welfare implications of genetic testing
- To provide the Guilds Genetics team with information on the legal, ethical and welfare considerations associated with embryo transfer and genetic testing in cattle and dogs.

Principles of the research design

The method used to gather information and data on embryo transfer and genetic testing in cattle and dogs needs to be logical and systematic to ensure a reliable and valid summary of results to inform Guilds Genetics of the legal, ethical and welfare implications and uses/success of these procedures.

Research methods can include primary and secondary sources which include quantitative and qualitative data.

Primary research is data generated and collected first-hand by conducting your own research using questionnaires, interviews and observations. This method will not be adopted for this assessment as all research will be completed in a supervised classroom setting.

Secondary research involves the collection of data and information that already exists and has previously been collected by other people. This will be the method of data collection used for this research project. Sources of secondary data include newspapers, articles, books, scientific journals, and scientific articles. The main advantage of using secondary research is it has already been collected, however ensuring the accuracy and credibility can be difficult. It is important to ensure that if there is more than one viewpoint on a topic, the researcher ensures that they explore both aspects and make an informed decision that is not deemed to be biased.

This research project will include a range of secondary data sources to ensure accurate and unbiased information is obtained.

Textbooks and e-books are viewed as credible sources of information having been peer reviewed and edited pre-publishing, while on-line media articles and magazines may be considered as containing less accurate, biased information and details written by individuals giving opinions and who are not necessarily well informed in the scientific field which we are examining.

However, textbooks and e-books can be outdated compared to scientific journals and scientific articles depending on the date of publication. Scientific journals that have been peer reviewed are considered as credible and reliable sources of information.

Sources of information

Source	Advantages/benefits of the source	Disadvantages/limitations of the source
e-books	Access via computer/internet from college library Published e-books will be peer reviewed ensuring accuracy of information which means they are good to use	College library may not subscribe to the e-book Date of publication - can be old/out of date information as genetic research field is constantly evolving and updating Can be challenging to find the source if key words are not inserted accurately
Textbooks (hard copy)	Published books are peer reviewed and therefore include accurate information Textbooks can be accessed if books are brought into the assessment room by the tutors	Publishing date - can be old/out of date information as genetic research field is constantly evolving and updating which means they may not be as good to use Access only by visiting the library - unable to do during the assessment unless provided in the classroom by supervisor
Scientific journals and articles	Current in the field of research and genetic technologies Immediate access (open access publications) Peer reviewed to ensure accuracy of information which means they are good to use	Scientific journals can be difficult to read/interpret Information may be more specific on one aspect than needed May not be able to access some journal articles if college does not subscribe to that journal or the journal is not open access on internet
Internet sites	Immediate access - computer and internet access Large range of internet sites for scientific information	Accuracy of information can be questionable depending on the author/internet site Some sites contain articles but with no known author or date - which would be considered inaccurate and unreliable Information may be biased depending on the author/internet site purpose which means they may be

		good to use but caution should be taken Large volume of information may easily get side tracked and end up going off topic

Methodology

1. Embryo Transfer (ET) procedure, success, advantages and limitations in breeding cattle and dogs
    - ET procedure (e-books, internet sites)
    - Literature review (scientific journals, scientific articles, e-books), explore the success, advantages and limitations of ET use in cattle and dogs
    - Compare the use/advantages of ET in cattle and dogs

2. Legal and ethical aspects of ET and genetic testing
    - Examination on gov.com website of legislation
    - Explore the ethical side of ET techniques
    - Effects of ET on animal health, welfare and wellbeing

3. Key organisations involved in ET and genetic testing
    - Internet search of organisations/required criteria to enable organisations to perform these technologies

4. Genetic testing procedures in cattle and dogs
    - Examination of genetic testing procedures - which disorders are identified by genetic testing in cattle and dogs
    - Importance of genetic testing for bovine/canine welfare and breed/ population health and welfare improvement. Data to illustrate breed health improvements?
    - Compare the use/advantages of genetic testing in cattle and dogs

5. Provide a written report for Guilds Genetics
    - Prepare a written report to summarise the research findings, with suitable evidence-based information

Techniques to analyse and interpret data

- Carry out a literature review, ensuring all information accessed is cross referenced with a variety of sources to ensure validity and reliability
- Present research information and data into a suitable format that shows the research findings clearly (use of charts, graphs, images)
- Carry out a comparison of the success of ET and genetic testing in cattle and dogs
- Data collection: explore data on the influence of genetic testing
- Produce a contingency plan in case I am unable to access/find specific information required for this research investigation or have an issue with completing the written or presentation aspect (e.g. computer failure, power cut, laptop battery failure).

Commentary

The candidate has submitted an excellent research proposal to investigate, analyse and compare the use and effects of embryo transfer and genetic testing in both cattle and dogs. They have considered a wide range of sources to be used to gather the information and the process is logical and detailed with good reasoning behind each step. For example, the methodology has main outcomes, but then also includes the smaller steps showing excellent consideration of the principles of research in this topic.

The candidate has made excellent consideration of the techniques needed to analyse the data they collect, such as literature sources, with assessment of the validity and reliability of sources. A range of techniques have been thoughtfully considered and selected that will allow an excellent level of analysis of the outcomes of the data. For example, the intention to cross-reference sources through the literature review demonstrates the candidate's understanding of the importance of ensuring the reliability and validity of sources when considering research outcomes.

The candidate has shown excellent knowledge of planning and research by including additional knowledge on the principles of research design to support their set of objectives for the project. For example, stating that their data collection should be logical and systematic which is reflected in their clear and concise objectives.

Task 1b) Produce an action plan

Candidate evidence – research action plan

Topics to research	Resources required	Suitability of the resources	Search criteria	Timeline (6 hours total)
Legal considerations of reproductive technologies ET/genetic testing	Government site RCVS website	Accuracy of information Interpretation may be difficult (language of legislation)	Legislation in animal reproductive technologies UK Canine breeding and RCVS	20mins
ET - procedure cattle	E-book Textbook Internet site (veterinary practice)	Procedure method should be reliably explained within e-books and scientific journals Look for organisations (MOET/UK based)	Bovine embryo transfer procedure	30mins
ET uses - cattle	Internet sites - veterinary practice delivering ET work/published sites Peer reviewed scientific journals/articles	E-book on veterinary reproduction or cattle reproduction should have accurate information	Advantages of ET in cattle Effect of ET on bovine reproduction/breed development/health	20mins
ET - success/limitations of cattle breeding	Internet site/scientific journals	Accurate detail in scientific journals - need to access several for comparison - need to make sure evidence is peer reviewed	Success rate of bovine ET	20mins

ET procedure dogs	E-book/textbook Internet site scientific journal or vet practice site - Kennel Club site/published sites	Procedure method should be reliably explained within e-books, scientific journals and published sites	Embryo transfer procedure in dogs	20mins
ET benefits dogs (may be similar to cattle benefits)	Internet site - Kennel Club, scientific articles	Benefits will be accurately outlined in scientific articles, but will need to be careful with information from specific dog breed internet sites as they may be biased in their information Look for organisations involved with ET (Kennel Club?)	Advantages of embryo transfer in dogs Kennel Club and canine embryo transfer	10mins
ET - success/limitations of dog breeding	Internet sites - peer reviewed scientific journals, media information, published internet sites	Scientific journals, peer assessed - several will need to be examined for accuracy Avoid dog breed sites and media-based reports as they may be inaccurate	Embryo transfer successes in dogs Live births of pups from embryo transfer technique	30mins
ET - ethical considerations	Internet sites - published sites, specific animal ethics or welfare sites E-book - animal welfare	Specific animal welfare sites (UFAW, Animal Ethics) should include accurate unbiased information	Ethics and reproductive technology Ethics of canine embryo transfer Ethics associated with bovine ET	50mins

		Media sites will be inaccurate and opinion based - so need to avoid		
Genetic testing - method	Textbook/knowledge from course: A level biology book/Internet sites Kennel club/dog breed sites	Organisations involved with genetic testing (dogs) Kennel Club/DNA testing/British veterinary society/Genus	Genetic testing in dogs Genetic testing procedures in cattle Cattle/dog genetics Hereditary diseases and genetic testing in dogs/cattle	30mins
Genetic testing procedures - cattle conditions	Internet sites - cattle breeds? /e-books on cattle reproduction or genetic technology	Genus (artificial insemination/ET) - genetics?	Genetic testing in cattle	30mins
Genetic testing/pros and cons - cattle		Uses of cattle genetic testing for preventing disorders		
Genetic testing procedures - canine conditions	Internet site - Kennel Club, dog breeding sites, e-books or textbooks on veterinary reproduction or dog reproduction	Uses of genetic testing for preventing disorders	Kennel Club genetic testing in dogs	40mins
Genetic testing procedures - canine pros and cons		Hereditary conditions in dogs and genetic testing		
Welfare implications genetic testing	Internet - university federation for animal welfare, Kennel Club	AW internet sites/journals may give a balanced viewpoint	Genetic welfare issues in dogs Genetic disorders in cattle and dogs Why identify animals carrying recessive gene disorders	50mins

	Animal welfare sites e.g. UFAW			
Contingency time				10mins
				Total 360 mins (= 6 hours)

Visual representation of action plan – Gantt chart

Minutes	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Legal considerations																		
ET procedure cattle																		
ET uses cattle																		
ET success cattle																		
ET procedure dogs																		
ET benefits dogs																		
ET success dogs																		
ET ethical																		
GT method																		
GT cattle																		
GT dogs																		
GT welfare																		
Contingency																		

Minutes	190	200	210	220	230	240	150	260	270	280	290	300	310	320	330	340	350	360
Legal considerations																		
ET procedure cattle																		
ET uses cattle																		
ET success cattle																		
ET procedure dogs																		
ET benefits dogs																		
ET success dogs																		
ET ethical																		
GT method																		
GT cattle																		
GT dogs																		
GT welfare																		
Contingency																		

Timeline and monitoring progress

Total time allowance for my research = 6 hours (360 minutes)
Each topic has been given a specific length of time to research, which will be monitored to ensure that I do not exceed it.

Contingency plan

A contingency plan is outlined in case something unexpected happens.

Possible event	**Contingency plan**
Power cut	Unable to use the chrome books/computers especially if the battery life has been depleted. No light in the computer room/classroom at college. My tutor will need to allocate alternative time on a different day for me to complete my research. I will need to identify exactly how long I have left of my time allocation. Have a pen and paper to note down what I was searching at the time so that I can continue when allowed.
Fire drill/fire alarm	Same as with the power cut. A different area of the college or day/time allocation may be given to complete the research.
Internet malfunction	If the internet became inaccessible, I would have to wait until the connection was restored or access hard copies of the materials (textbooks, scientific journals and articles). Suitable textbooks and hard copies of scientific journals may be accessed/used from the college library provided they have hard copies available on site. If online save failed to work, a notes app or pen and paper could be used as an alternative
Search criteria	If Google Scholar did not hold any useful articles or e-books, then the internet would be used, but the accuracy and credibility of the sources would need to be examined. Peer reviewed and published sites on the internet would hold more accurate information.
Damaged files	Ensuring that the research details are saved in more than one file, so if one file becomes damaged - the other would hopefully be okay.
Illness	If I was unable to attend college on the assessment date: to contact my tutor as soon as possible (may need to get a doctor's letter as proof of illness as this is a formal assessment). The tutor would then rearrange another date for me to complete the work.

Commentary

The candidate has produced an excellent action plan in line with the requirements of the research project brief and included visual representation of the critical pathway analysis, demonstrating higher knowledge and skills for the planning of research, however this could have been discussed in more detail to explain the visual aid in comparison to the action plan table.

The candidate has identified key criteria to research to follow their identified objectives, achieve the aim of the assessment and carry out research within documented time frames. For example, they have explained that they will monitor the timeframes whilst completing the research which demonstrates excellent planning.

The candidate has used an excellent structure of the action plan to align with their methodology and given suitable time frames for each step. The candidate has also considered time for contingencies as they may occur. For example, the individual sections to research have been split, considering time allowance, and multiple search criteria for each, demonstrating their understanding that this may be necessary to achieve a good amount of research.

Task 1c) Carry out your research

The research notes provided are one side of A4 exemplar notes of the expected standard to be produced by the candidate but are not marked so no commentary has been provided.

Candidate evidence – research notes

ET: mammal success first reported 1890 Walter Heape; first live calf 1951 (Betteridge, Mapletoft); 2015 first live puppies (Nagashima)
Donor / Recipient females.
Superovulation - production of numerous ova from a donor's ovary; AI to fertilise the ovum (AI can be done in vivo or in vitro) = fertilisation - embryo. Embryo at the blastocyst stage will be introduced into the recipient.
Removal of embryo from donor & introduction into recipient = either surgical or non-surgical method. Surgical method under GA- laparoscopic surgery into the uterus (method used in dogs). Non-surgical transcervical epidural and local anaesthetic (method used in cattle).
UK ET organisations cattle- Genus breeding Semex UK: government listed legal organisations allowed to perform ET / Dogs no directory of legal organisations- more experimental than commercial activity currently.
50-65% success in cattle pregnancy (Campbell 2014). 5% lose pregnancy at day 45.
36% success in dog pregnancy (Nagashima 2015). Lower = oestrus cycle different long metoestrus period difficult to synchronise the donor and recipient. Dogs breed 2x year.
Legislation AWA 2006. Veterinary Surgeons Act 1966; Animal (Scientific Procedures) Act 1986, Welfare of Farmed Animals (England) Regulations 2007= prevent unnecessary suffering. No specific legislation to regulate ET in UK (some control with cattle ET /No regulatory body monitoring canine ET)
Welfare: hormone manipulation techniques / handling the animals/ method used to harvest embryo/ method used to implant embryo / offspring traits (enhanced traits - large udders in cattle - mastitis, lameness) / brachycephalic breeds (difficulty breathing, apnoea). Viable embryos / success rate
Ethics: Jeremy Bentham ‘’The question is not can they reason? Nor can they talk? but can they suffer?’’
Genetic Testing - 2003 complete mapping human genome (NHI) 2004 canine genome (Ostrander & Wayne). Identify abnormal recessive or dominant gene/ carrier animals (phenotype normal genotype carrier gene). Canine genetic disease progressive retinal atrophy, von Willebrands disease, Bovine Leukocyte adhesion deficiency Holstein cattle.
Organisations: dogs- Kennel Club database; Animal Health trust, Cambridge laboratory - analyse samples (blood / cheek cell DNA)
Success genetic testing AHT- 8 dog breeds, 10year period of DNA tests - 90% decrease in diagnosed cases of genetic conditions (Kennel club & Woodmansey 2019). Limitations - specific test needed for each genetic disorder for each breed - not same mutation in every breed (e.g. progressive retinal atrophy). Dairy cattle - sperm test - male and female sperms. Prevent bull calves - poor financial value - shot at birth. Farmers buy ‘’sexed straws’’ for AI their cows
Legislation: AWA Veterinary surgeons act 1966

Betteridge, K.J. (2003). A history of farm animal embryo transfer and some associated techniques. *Anim Reprod Sci*, 79:203-244.

Campbell, M. (2014) Does the current regulation of assisted reproductive techniques in the UK safeguard animal welfare? *Anim Welf*. 2014 Feb 1; 23(1): 109–118. doi: 10.7120/09627286.23.1.109
Does the current regulation of assisted reproductive techniques in the UK safeguard animal welfare? - PMC (nih.gov)

Fayrer-Hosken, R (2007). Embryo transfer in the Dog and cat. *Theriogenology* 68: 382-385 https://doi.org/10.1016/j.theriogenology.2007.05.052 Accessed 10/3/24

Gov.uk. Bovine embryo collection and production teams (2024) https://www.gov.uk/government/publications/livestock-and-equine-embryo-collection-approved-premises/bovine-embryo-collection-and-production-team Accessed 10/03/2024

Kennel Club (2019) https://www.thekennelclub.org.uk/media-centre/2019/january/study-reveals-powerful-long-term-impact-of-dna-tests-on-Dog-diseases/ Accessed 16/03/2024

Mapletoft, R.J. (2013) History and perspectives on bovine embryo transfer. *Anim. Reprod* 10 (3): 168-173

Nagashima, J.B., Sylvester, S.R., *et al* (2105) Live Births from Domestic Dog (*Canis familiaris*) Embryos Produced by *In Vitro* Fertilization. *Plos One* https://doi.org/10.1371/journal.pone.0143930 accessed 10/3/2024

NHI: National human genome research Institute (2022) Human genome project https://www.genome.gov/human-genome-project/timeline accessed 11/03/2024

Ostrander, E.A. and Wayne, R.K. (2005). The Canine Genome. *Genome Res.* 2005 15: 1706-1716 doi:10.1101/gr.3736605

Woodmansey, D (2019) Study reveals 'fantastic work' of DNA testing. https://www.vettimes.co.uk/news/study-reveals-fantastic-work-of-dna-testing/ Accessed 16/03/24

Task 2 Research report

Evidence contributes to the following:

Performance outcome(s)
PO1 Apply research methods to collect and analyse scientific information on reproductive technologies and gene manipulation.

Evidence	Candidate producing	Assessor producing	Included in this GSEM
Research report	√		√

Task 2) Produce a written research report

Candidate evidence – research report

Title

Examine and compare the success and effectiveness of embryo transfer (ET) and genetic testing in cattle and dogs.

Aim

The aim of this research is:

i) to investigate the legal, ethical and welfare considerations of embryo transfer and genetic testing in cattle and dogs, and

ii) to compare the benefits and limitations of embryo transfer and genetic testing in cattle and dogs

Objectives

- To examine the procedure of embryo transfer (ET) and its uses in cattle and dogs
- To examine the legal and ethical considerations of ET and genetic testing in cattle and dogs
- To research the success and limitations of ET in cattle and in dogs
- To examine genetic testing procedures performed in cattle and dogs
- To evaluate the welfare implications of genetic testing
- To provide the Guilds Genetics team with information on the legal, ethical and welfare considerations associated with ET and genetic testing in cattle and dogs.

Introduction

Assisted reproductive technologies (ART) are used to improve and manipulate an animal's natural breeding cycle for a number of reasons namely:

- to enable the selection of specific phenotypic characteristics
- to identify an individual's parentage
- to identify genetic disorders
- to prevent species extinction

Embryo transfer (ET) and genetic testing are two examples of globally used ART.

Mammalian ET was first developed with some reported success in 1890 by Walter Heape, but it wasn't until 1951 when the first live calf (Betteridge, 2003; Mapletoft, 2013), and 2015 (Nagashima, 2015) when the first live puppies were delivered using this technology. Currently ET is used globally in farm animal reproduction but is not as widespread in canine reproduction.

Genetic testing procedures have been widely used techniques since the complete mapping of the human genome in 2003 (NHI, 2022) and canine genome in 2004 (Ostrander and Wayne, 2005). These techniques identify genetic disorders in animals selected for potential breeding.

Despite significant advances and developments in ART, animal welfare and ethics need to be considered. The cost and benefit to the animal should be examined before considering using a procedure. Just because we are able to perform a certain technique, does it follow that we should? ''The question is not can they reason? nor can they talk? But can they suffer?'' (Jeremy Bentham, 19th century philosopher). This report will research the legal and ethical implication, success and limitations of embryo transfer and genetic testing in the cow and the dog.

Embryo Transfer (ET): method

ET is a breeding technique where one individual, the donor, is stimulated to produce a number of eggs which when fertilised become embryos. These embryos are then removed from the donor animal and inserted into another female, the recipient. The recipient animal carries the embryo to term, giving birth and rearing the resultant offspring.

The donor female is selected based on her genetic traits, phenotypic characteristics and fertility. She will be required to produce several genetically superior embryos. These embryos will exhibit desirable traits and specific qualities, for example enhanced milk yields in dairy cattle.

Once selected, the donor female receives a series of hormonal treatments to stimulate the ovary to produce many follicles. Each follicle results in the production and release of an ovum (egg). Collectively a large number of follicles produce a large number of ova (eggs) - this is the process of superovulation. Superovulation enables a large number of eggs to be produced and collected from one donor at each ovulation.

The eggs are fertilised using sperm collected from a male animal of the same species/breed. The male animal will have been selected for his superior genetic and phenotypic characteristics. His sperm will fertilise the ova (either *in vivo* or *in vitro*). Eggs fertilised *in vivo* are allowed to develop *in situ* for a few days, reaching the blastocyst stage. Once at the blastocyst stage, the embryos are removed using either a surgical or non-surgical technique. The technique used depends on the experience of the operator and animal species. The surgical technique involves the donor having laparoscopic surgery into the uterus under general anaesthesia. Risks involving the general anaesthetic are limited as the animal is healthy, however there are other more serious issues and risks especially in ruminant (cattle)

animals. The non-surgical method involves an epidural and local anaesthesia as embryos are harvested transcervically. Either method can be used for harvesting cattle embryos, however only the surgical method is viable for the canine ET procedure.

Embryos retrieved from the donor are examined in the laboratory to ensure viability and identify the embryo's sex (depending on the species). A viable healthy embryo is then inserted into a recipient female; more than one recipient may be needed depending on the number of viable embryos flushed from the donor.

The recipient acts as a surrogate. She only needs to be able to carry the embryo to term and give birth. Her genetic and phenotypic characteristics are not important. She does, however, need to be at the same stage of the reproductive cycle as the donor to ensure a successful outcome, namely a live birth. To ensure the recipient is synchronised with the donor and at the correct stage of the reproductive cycle to receive the embryo, she also undergoes a series of hormonal treatments.

Organisations involved in ET

A large number of organisations in the UK are involved in bovine ET, such as Genus breeding and Semex UK. All these organisations are listed on the government website together with their approval dates (gov.co.uk, 2024). This identifies the organisations legally allowed to perform ET in cattle in the UK.

No such directory of approved organisations exists for canine ET, largely due to the limited success of this procedure in dogs. Currently, canine ET is mainly performed under experimental purposes rather than being commercially available to potential breeders.

Success, limitations and advantages of ET

Campbell (2014) reported 50-65% of recipient cows became pregnant after ET however, 5% of recipients lost their pregnancies at day 45 of gestation. The success rate varied depending on the skill of the operator and the farm conditions.

Nagashima (2015) reported a 36% success rate for positive canine pregnancies following ET, however all were performed by research facilities rather than being commercially available. The female dog (bitch) has a specific oestrus cycle completely different to that of other mammals which makes it difficult to synchronise the donor and recipient and therefore achieve a positive outcome.

ET has a number of advantages. It enables an infertile female to produce offspring, allows for the easy trade of embryos (and genetic material) between different countries, reduces the number of live animal transportation between countries, reduces risks of disease transmission and enables the storage of rare genetic material. However, the disadvantages of ET include its high cost and requirements for specialised equipment and operator skills.

Legal and ethical implications of ET

The Animal Welfare Act (AWA) 2006, Veterinary Surgeons Act (VSA) 1966, Animal (Scientific Procedures) Act (ASPA)1986 and Welfare of Farmed Animals (England) Regulations 2007 protect animal welfare and prevent unnecessary suffering. However currently there is no specific legislation to ensure animal welfare is maintained to a high standard during the application of ET.

Bovine ET is regulated by the government with organisations needing to achieve approval before being allowed to offer this procedure to cattle breeders commercially. There is no regulatory body responsible for monitoring and regulating canine ET and ART.

Welfare and ethical issues can develop from the high intensity of hormonal treatments the donor and recipient animals need to endure for synchronisation, the method used (surgical or non-surgical) for harvesting or flushing the embryos from the donor, the method used to implant embryos into the recipient and the skill / competence of the human performing the technique. Welfare and ethical concerns are more prominent in canine ET techniques. Both the donor and recipient animals require general anaesthesia to harvest the embryos and insert the viable embryos respectively.

Welfare and ethical concerns can also be seen in the offspring that have enhanced traits e.g. enhanced milk yield in dairy cattle which results in the individual having an increased risk of mastitis and lameness.

If the success of canine ET improves and is offered on a commercial basis, this may result in additional concerns. Increased brachycephalic breeds that are unable to mate naturally being produced by ET may suffer from welfare issues such as apnoea, exercise intolerance and difficulty in breathing. There will also be an increase in unregulated facilities offering this service, similar to those currently offering canine artificial insemination.

Genetic testing

Genetic testing is a technique widely used to identify an individual animals' parentage, genetic profile and/or their predisposition to a range of genetic disorders. The procedure involves taking a DNA sample, usually from the animal's cheek cells, which is analysed. The result enables the owner/breeder to make an informed decision on whether the animal is suitable for breeding.

Genetic diseases can result from either an abnormal or mutated dominant or recessive gene. Genetic testing is used to identify specific abnormal genes and whether the animal is heterozygous and therefore likely to pass the abnormality onto its offspring. This information will enable the breeder/owner of an animal to decide if the individual is considered suitable for breeding.

Examples of genetic diseases tested include progressive retinal atrophy (the condition results in blindness) in dogs, von Willebrand disease (blood clotting deficiency) in dogs and Bovine Leukocyte Adhesion Deficiency (immune system deficiency) in Holstein cattle. Genetic testing procedures are commercially available with a much higher uptake for dogs, with more widespread genetic disorders being tested compared to cattle. Individuals in a commercial herd are rarely tested for genetic disorders, unlike individuals within a pedigree herd. This is due to the cost of genetic testing and the development of specific tests.

Organisations involved in genetic testing

Organisations such as the UK Kennel Club, include a database of their members with breeding dogs that have been genetically screened negative. This allows the Kennel Club to set guidelines on responsible breeding practices, specifically to prevent genetic diseases in offspring.

There are a number of commercial laboratories e.g. Animal Health Trust (AHT), Cambridge laboratory which analyse samples sent for genetic testing.

Success, limitations and advantages of genetic testing

The AHT and Kennel Club investigated the long-term health effects of eight different dog breeds identified with a number of hereditary genetic conditions and found within 10 years of the DNA test being available, the number of animals diagnosed with the genetic condition decreased by 90% (Kennel Club, 2019 and Woodmansey, 2019).

There are limitations to genetic testing. Some hereditary conditions are multifactorial, caused by a number of genetic and non-genetic (environmental) factors making it challenging to improve the health of a breed using genetic testing alone. An example of this is hip dysplasia in German Shepherd Dogs. Different breeds may have different mutated genes that cause the same disease therefore requiring a specific genetic test for example, progressive retinal atrophy (PRA) is a condition which results in blindness and can occur in many breeds but the genetic mutation responsible is not the same in every breed.

Routine management on dairy herds, and to an extent in beef herds, use artificial insemination techniques instead of natural mating. Farmers can buy specific sexed (male or female) ''straws'' of semen, where the sperm has been tested to identify the XX (female) or XY (male) chromosome. The main purpose especially in dairy herds is to reduce the number of male calves. Male dairy calves are of little financial value and generally shot at birth, which is a significant welfare and ethical dilemma.

The cost of developing specific genetic tests and the uptake of the tests is one of the main reasons why genetic testing is not used as much to identify hereditary diseases in commercial cattle herds compared to dogs.

Legal and ethical implications of genetic testing

There is no legal restriction on who can take the sample provided it is taken from the cheek cells, however, taking a blood sample for genetic testing requires a qualified veterinary surgeon/nurse (VSA, 1966). The AWA 2006 is responsible for the welfare standard ensuring avoidance of unnecessary suffering to the animal. Genetic testing generally improves the welfare and health of future generations by preventing individuals carrying genetic disorders being selected for breeding purposes. Determining the sex of the sperm to avoid unwanted male calves prevents farmers from having to shoot the animals at birth, however there is the ethical dilemma of acting as ''God'' and predetermining the offspring's sex.

Evaluation of the research project

Using the methodology and action plan enabled a more structured approach to the research, ensuring all aspects of the research project brief were examined. It was difficult to find numerical data to support how well genetic testing has improved the health of dogs and cattle over time. This could be due to the search criteria used or needing more time allowance on this part of the research, maybe specific numerical data could have then been found.

Time management was a significant factor. Each topic in the action plan was allocated a specific time limit for research. Finding the right website or journal article was challenging without getting side tracked and ending up researching something related to the topic but not the actual topic.

Using abbreviations resulted in some errors and subjects of no relation to that research identified by the internet search engine, which did waste a little time. Specifically, when canine ET was put into the search criteria, results on endotracheal tubes, canine anaesthesia and aliens resulted, which had nothing to do with the topic in question. Changing to using the full terminology enabled me to achieve better search results and get back on track with the timings.

Conclusion

ET and genetic testing are procedures used in both bovine and canine breeding programmes with a range of success and limitations. There are ethical and welfare related dilemmas and considerations associated with both procedures. ET techniques are expensive and time consuming and currently used in high value pedigree herds in cattle, while in more of the experimental stage with dogs. Genetic testing is widely used with a number of health benefits, however the most commonly used genetic testing in cattle involves sperm sexing which has some ethical implications.

References

Betteridge, K.J. (2003). A history of farm animal embryo transfer and some associated techniques. *Anim Reprod Sci*, 79:203-244.

Campbell, M. (2014) Does the current regulation of assisted reproductive techniques in the UK safeguard animal welfare? *Anim Welf*. 2014 Feb 1; 23(1): 109–118. doi: 10.7120/09627286.23.1.109

Fayrer-Hosken, R (2007). Embryo transfer in the Dog and cat. *Theriogenology* 68: 382-385 https://doi.org/10.1016/j.theriogenology.2007.05.052 Accessed 10/3/24

Gov.uk. Bovine embryo collection and production teams (2024) https://www.gov.uk/government/publications/livestock-and-equine-embryo-collection-approved-premises/bovine-embryo-collection-and-production-team Accessed 10/03/2024

Kennel Club (2019) https://www.thekennelclub.org.uk/media-centre/2019/january/study-reveals-powerful-long-term-impact-of-dna-tests-on-Dog-diseases/ Accessed 16/03/2024

Mapletoft, R.J. (2013) History and perspectives on bovine embryo transfer. *Anim. Reprod* 10 (3): 168-173

Nagashima, J.B., Sylvester, S.R. *et al* (2105) Live Births from Domestic Dog (*Canis familiaris*) Embryos Produced by *In Vitro* Fertilization. *Plos One* https://doi.org/10.1371/journal.pone.0143930 accessed 10/3/2024

NHI: National human genome research Institute (2022) Human genome project https://www.genome.gov/human-genome-project/timeline accessed 11/03/2024

Ostrander, E.A. and Wayne, R.K. (2005). The Canine Genome. *Genome Res.* 2005 15: 1706-1716 doi:10.1101/gr.3736605

Woodmansey, D (2019) Study reveals ‘fantastic work’ of DNA testing.

https://www.vettimes.co.uk/news/study-reveals-fantastic-work-of-dna-testing/ Accessed 16/03/24

Commentary

The candidate showed excellent knowledge and understanding of the reproductive technologies and gene manipulation, with the report examining the use, limitations and advantages of embryo transfer and genetic testing in the cow and the dog. Their discussions on the ethical and welfare concerns of the techniques demonstrate an excellent knowledge of how the techniques can affect the animals' welfare with good detail. For example, the discussion of sperm sexing in dairy cattle shows understanding that this can minimise the number of male calves being shot and the ethical dilemma this poses.

The candidate has produced a well organised report, showing clear and logical headings with an excellent evaluation of the projects they have researched, enabling them to provide suitable information required by Guilds Genetics. The literature review makes comparisons between the species for each technology, showing excellent reasoning for the differences in success. For example, identifying that genetic testing is done more in pedigree dogs than pedigree cattle and this is down to cost shows a wider consideration of consequences for the company in line with the requirements of the brief.

The candidate has given a comprehensive analysis and evaluation of the research process, discussing areas in which their research went well or could have been improved. The candidate was able to recognise their own errors during the research process and gave techniques used to rectify them. For example, their use of abbreviations during the research meant incorrect results were shown, but they identified that using the full and correct terminology meant they were able to get back on track.

Task 3 Presentation

Evidence contributes to the following:

Performance outcome(s)
PO1 Apply research methods to collect and analyse scientific information on reproductive technologies and gene manipulation.

Evidence	Candidate producing	Assessor producing	Included in this GSEM
Task 3a - Scientific poster	√		√
Task 3b - Presentation	√		√
Task 3b - Video(s)		√	√

Task 3a) Create a digital, scientific poster

Candidate evidence – Scientific poster

Examine and compare the success and effectiveness of embryo transfer and genetic testing in cattle and dogs

Candidate Number CSG1234

Aims and Objectives

Reproductive technologies, such as embryo transfer and genetic testing, form an important aspect of breeding programs in animals. These technologies have an ethical and welfare impact on the animals involved which Guilds genetics are keen to investigate.

The aims of this research are:

i. To investigate the legal, ethical and welfare aspects of embryo transfer and genetic testing in cattle and dogs, and

ii. To compare the uses and limitations of embryo transfer and genetic testing in cattle and dogs

Objectives:

- To examine the procedure of embryo transfer (ET) and its uses in cattle & dogs
- To examine the legal and ethical considerations of ET and genetic testing in cattle and dogs
- To research the success and limitations of ET in cattle and in dogs
- To examine genetic testing procedures performed in cattle and dogs
- To evaluate the welfare implications of genetic testing
- To provide the Guilds Genetics team with information on the legal, ethical and welfare considerations associated with ET and genetic testing in cattle and dogs.

Introduction

Assisted reproductive technologies (ART) are used to improve and manipulate an animal's natural breeding cycle for a number of reasons namely:

- to enable the selection of specific phenotypic characteristics
- to identify an individual's parentage
- to identify genetic disorders
- to prevent species extinction

Embryo transfer (ET) and Genetic testing are two examples of globally used ART.

Despite significant advances and developments in ART's, animal welfare and ethics need to be considered.

The cost and benefit **to the animal** should be examined before considering using a procedure

Legislation

1. **Animal Welfare Act (2006)**
   - ✣ Duty of Care / Responsibility
   - ✣ Five Welfare Needs
   - ✣ - "protect from pain, suffering injury and disease"
2. **Veterinary Surgeons Act 1966**
3. **Animal(Scientific Procedures) Act (ASPA)1986**
4. **Welfare of Farmed Animals (England) Regulations 2007**

Embryo Transfer (ET)

Embryo transfer is the process of flushing embryos from a donor animal and inserting them into a recipient animal.

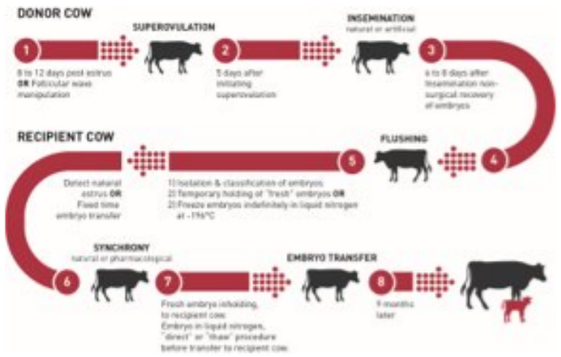

Figure 1: Flowchart illustrating the process of ET in cattle

	Bovine (*Bos taurus*) ET	Canine (*Canis familiaris*) *ET*
Harvesting and implantation Method	Usually Non-surgical - Local anaesthetic - Conscious animal	Surgical - General anaesthetic
UK Organisations involved	Examples: Genus Breeding UK Sexing UK Directory of approved organisations - Government website	No directory of approved organisations Not commercial Research facilities
Advantages	- Allows infertile females to produce offspring - Trade of embryos / genetic material globally - Stops live animal transportation - Store rare genetic material	
Limitations	- Cost - Specialist equipment - Operator skills - Welfare - Ethics	- Cost - Equipment - Skills - Difficulty in synchronisation - Welfare - Ethics
Success	50 – 65% pregnancy in recipient cows (5% loss pregnancies at day 45 Commercially (Campbell, 2014)	36% success Research facilities only (Nagashima, 2015)

Genetic Testing

Genetic testing involves the analysis of DNA samples (blood or cheek cells) taken from an animal to identify parentage and if they are homozygous or heterozygous for a specific genetic disorder. Genetic testing can also be used to identify the sex of a sperm or embryo.

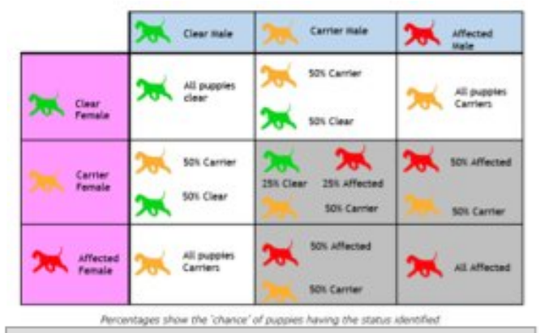

Figure 2: Identification of carrier animals for genetic disorders

	Bovine (*Bos taurus*) ET	Canine (*Canis familiaris*) *ET*
Method	Blood sample to identify genetic disorder Sperm sex identification Embryo sex determination (XX= female; XY = male)	Blood sample / cheek cell sample To identify genetic disorder
Organisations / laboratories involved	Cattle Societies Numerous laboratories e.g. Cambridge Laboratory	Kennel Club AHT (Animal Health Trust) Cambridge Laboratories
Advantages	Identification of male sperm/embryos in cattle Preventing transmission of genetic disorders to offspring Improved breed / population welfare and health	
Limitations	Cost Uptake Development of specific tests	Multifactorial disorders (genetics and environmental) Cost Specific breed test needed
Success	Reduced percentage of male offspring in dairy cattle	Reduction 90% of genetic disorders in 8 dog breeds (Kennel Club, 2019; Woodmansey, 2019)

Ethical and Welfare Considerations

Cattle (*Bos Taurus*)

ET:

- Enhancing specific phenotypes (e.g. high milk yield in dairy cattle. Increased risk of lameness, mastitis
- Donor and recipient cows – to control their breeding cycles – numerous handling and restraint, hormonal treatment, long term effects

Genetic Testing

- Identifying male and female sperm / embryos / Acting as "God"
- Cost and uptake in commercial breeds

Dog (*Canis familiaris*)

ET:

- Methods used in Harvesting embryos from donor / implantation embryos into recipient
- Poor success rate: dog's breeding cycle and synchronization of donor and recipient

Genetic Testing

- Genetic disease incidence / numbers in offspring

Conclusions

ET is an expensive and time consuming technique and currently used in high value pedigree herds in cattle, while in more of the experimental stage with dogs. The costs are too great for ET to be used routinely in commercial cattle herds.

Genetic testing is widely used with a number of health benefits, however the most commonly used genetic testing in cattle involves sperm sexing which has some ethical implications

References

- Campbell, M. (2014) Does the current regulation of assisted reproductive techniques in the UK safeguard animal welfare? *Anim Welf.* 2014 Feb 1; 23(1): 109–118. doi: 10.7120/09627286.23.1.109
- Kennel Club (2019) https://www.thekennelclub.org.uk/media-centre/2019/january/study-reveals-powerful-long-term-impact-of-dna-tests-on-dog-diseases/ Accessed 16/03/2024
- Nagashima, J.B., Sylvester, S.R., ***et al*** (2105) Live Births from Domestic Dog (***Canis familiaris***) Embryos Produced by *In Vitro* Fertilization. ***Plos One*** https://doi.org/10.1371/journal.pone.0143930 accessed 10/3/2024
- Woodmansey, D (2019) Study reveals 'fantastic work' of DNA testing. https://www.vettimes.co.uk/news/study-reveals-fantastic-work-of-dna-testing/ Accessed 16/03/24

Figure 1: Source: https://repro360.com.au/reproductivetechnologies/et

Figure 2: Source: http://www.giantschnauzerhealth.org.uk/breeding-dna-tested-dog/

Commentary

The candidate has produced a comprehensive poster explaining the process, limitations, successes and ethical considerations of embryo transfer and genetic testing in both cattle and dogs. They have taken the relevant information from the report and presented it in a manner suitable for the targeted audience, in line with the requirements of the brief. For example, the candidate has outlined the main points in tabular format for both ART and included a specific section highlighting the ethical considerations that should be considered by Guilds Genetics using technical terminology relevant to the team leader of the company.

The poster provides all relevant information in a format and structure that is clear and easy to follow. The sections are clear and align with the research report in previous tasks to aid in ease of reading. For example, the candidate has placed information and discussed the two artificial breeding technologies in clear demarcated sections, demonstrating the need for information to be easy to find and follow.

Task 3b) Present the scientific poster

Candidate evidence – video(s)

AMS_GSEM_Research_Project_Task_3_Presentation_Distinction.

Commentary

The candidate demonstrated excellent presentation skills to targeted audiences, introducing the poster to the specified audience in line with the brief.

The candidate was clear throughout, consistently using technical terminology accurately and appropriate to the target audience. For example, explaining the techniques with correct wording such as recipient, donor and laparotomy, demonstrating excellent knowledge and effective consideration of the target audience and an effective presentation.

The candidate discussed each element of the poster clearly and with excellent detail, spending a considered amount of time on each section, demonstrating excellent time keeping and presentation skills. For example, each section was clearly explained before progressing to the next section and there were no incidences of needing to go back and clarify a point showing excellent planning.