An undergraduate curriculum in veterinary reproduction at James Cook University

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Abstract

The curriculum developed to teach a new, five-year undergraduate veterinary science degree at James Cook University is outlined and discussed. The curriculum in veterinary reproduction involves delivering 87 h of lectures and 133 h of laboratory and practical classes which comprises 6% of the total number of hours involved in delivering the veterinary degree course. An integrated model of delivering curriculum is utilized where theriogenology is integrated within all five years of the course rather than being delivered as a separate subject. Tracking is not possible and all students are exposed to the entire reproductive curriculum although the opportunity is given for final year students interested in theriogenology to utilize electives and externships to further improve their knowledge and skills. A strong emphasis on the development of clinical skills is fostered with horizontal and vertical integration of theriogenology throughout the curriculum and the creation of an extensive set of laboratory classes. Stand alone theriogenology rotations are not provided in the final year of the course but clinical aspects of theriogenology are included within other clinical rotations and electives. The curriculum will be continually developed with feedback from staff, students, employers, peer review, and development of further learning aids.

Keywords: Veterinary education, curriculum, theriogenology curriculum

Introduction

The Bachelor of Veterinary Science (BVSc) degree course commenced at James Cook University (JCU) in 2006. It is a five-year, undergraduate degree program based on an integrated curriculum. Knowledge and skills related to veterinary reproduction are progressively delivered throughout the course. Structure and function are emphasized in Year 2; pregnancy diagnosis, an introduction to dystocia and infectious agents in Year 3; clinical management of reproduction and disorders of the reproductive system in Year 4; and clinical application of reproduction in Year 5. In Year 5 structured learning activities are conducted in the areas of canine, equine and bovine reproduction. Additional opportunities are provided through in-practice rotations, electives and extramural experiences. This report provides a brief overview of the BVSc course at JCU and details and discusses the veterinary reproduction curriculum.

Overview of the veterinary science curriculum

The academic year at JCU during Years 1 to 4 of the course is divided into two, 13 to 14 week study periods. In Year 5 students participate in a 33-week program over the course of the year. In the first year of the course students undertake four, three-unit subjects in study period (SP) 1 and again in SP 2. These introductory subjects cover areas such as animal, plant and cell biology; chemistry; biochemistry; anatomy; an introduction to the animal industries; careers in veterinary science; animal behavior, welfare, and handling; ethics; case studies; and personal professional development. In the second to fourth years of the degree program students are enrolled in each SP in a single 12-unit subject (Table 1). These subjects are organized around several interdisciplinary themes which are outlined in Table 2. Themes within the integrated curriculum provide an organizational framework for developing learning activities that enhance integration between disciplines.[1,2] For example, anatomy and physiology are both taught within the theme entitled ''Structure and Function'' as both anatomical structure and physiological function are intimately connected. The curriculum in Year 5 is aimed at providing students with in-practice experience through a series of structured, "lockstep" rotations, and eight weeks of electives. Rotations are conducted through facilities located at James Cook University and contracted practices and facilities. On campus these include the School of Veterinary and Biomedical Sciences and the JCU Veterinary Emergency Centre and Hospital. Off campus rotations are conducted at the JCU Townsville Veterinary Clinic Equine Clinical Teaching Centre, Aachilpa Veterinary Hospital, JCU Veterinary Teaching Resource Centre in cooperation with the Tableland Veterinary Service and an export

abattoir located on the outskirts of Townsville. A list of rotations that students complete during the 5-year degree program is shown in Table 3.

Extramural practice requirements

The extramural practice requirements which students must complete during scheduled University vacation periods are outlined in Table 4. Placements are structured to provide students with a broad range of experiences across a number of animal industries and clinical veterinary sciences.

Veterinary reproduction curriculum

Aspects related to veterinary reproduction are embedded throughout Years 1 to 3 of the curriculum in keeping with the integrated model of curriculum delivery. An overview of the animal industries and an introduction to the husbandry associated with a range of species are provided in Year 1. Reproductive anatomy and physiology are emphasized in Year 2, and pregnancy diagnosis, semen evaluation, and infectious agents affecting the reproductive system are covered in Year 3. In Year 4 the emphasis is placed on clinical reproduction as it relates to individual animal species. Where appropriate comparative aspects are emphasized but the focus remains on the individual species as this is the context in which reproductive problems normally present in veterinary practice. Clinical issues relevant to reproduction in rabbits, guinea pigs, ferrets, rats, mice, and reptiles are dealt with in a week-long intensive that students undertake examining clinical conditions associated with these species in Year 4 while relevant husbandry associated with these species is introduced within Years 1 and 2. Avian and aquatic animal reproduction is dealt with in lectures which address the biology, physiology and clinical management of these species. Lecture topics and practicals relevant to veterinary reproduction in Years 2 to 5 are listed in Tables 5 to 11.

The total number of hours of training, excluding extramural studies and elective rotations encompasses 3755 hours of lectures, practicals, supervised work, clinical work and other learning activities.[4] Time devoted to training in reproduction comprises a minimum of 6% (220/3755) of the time devoted to intramural studies between Years 1 and 5. This includes 87 h devoted to didactic lectures and 133 h devoted to practical and laboratory exercises. The number of boarded or board eligible theriogenology staff involved in the teaching of this discipline is one, although teaching is supported by other staff from the disciplines of anatomy, physiology, and clinical sciences. Private practitioners are also used to support teaching.

Assessment

A range of assessment methods and instruments are used to evaluate student learning which have been recently outlined.[4] The predominant methods used to summatively assess students are listed in Table 12. In addition, presentations, case studies, clinical skill report writing and for some students research proposals and literature reviews may be completed which relate to topics in veterinary reproduction. During the course Year 3 and 5 students are summatively assessed in relation to their pregnancy diagnosis skills in cattle and the method for performing rectal and vaginal examination of horses. During Year 5 students are formally assessed in regards to their pregnancy diagnostic skills and are expected to accurately perform manual pregnancy diagnosis in cattle over nine weeks of gestation with at least 80% accuracy or remedial instruction is provided.

Peer review

A recent review of the reproduction curriculum by Professor Bruce Eilts, of Louisiana State University suggested that the major areas of reproduction were covered during the course.

> "The reproduction course is well conceived, presented, and adequately covers most aspects of a student's need for knowledge in reproduction."

A small number of practitioners who were interviewed indicated that they thought that students were well prepared for their clinical experience. Interviews with students indicated their understanding of the importance of reproduction in veterinary medicine and felt that they were getting good training in reproduction. Suggestions raised in the review included reducing some of the information provided to students and separating information into essential from non-essential information. Reducing practicals which involve a single topic, such as pregnancy diagnosis from three hours to one hour,

while simultaneously reducing the number of students from, for example 30 to 12, may facilitate more active student engagement and provide students with more contact time with animals. Increasing staffing levels, reduction in teaching loads in favor of more time for research and/or clinical activities and exposure to clinical cases in some species were highlighted as areas that may assist with staff development, satisfaction and retention in the future.

Discussion

The newly developed curriculum in reproduction at JCU provides an extensive overview of reproductive issues that confront practicing veterinarians. Knowledge, skills and attitudes in relation to veterinary reproduction are addressed through didactic lectures, practical classes, case studies, assignments and in-practice training. Unlike curricula in many North American or European veterinary schools, the curriculum at JCU is aimed at providing every student with reproductive training in all of the major domestic animals species. Opportunities to undertake electives which encompass additional and perhaps more advanced reproductive techniques allow students with a particular interest in reproduction to further develop their knowledge and skills.

The number of hours devoted to lectures and laboratory sessions within the curriculum at JCU is greater than what has been reported in one survey of veterinary colleges in North American and the Caribbean.[5] A maximum of 60 h of lectures and 42 h of laboratory sessions in theriogenology were reported in the survey. A total of 67 h of didactic lectures are included at Louisiana State University (Eilts B, personal communication) and also at Iowa State University (Christensen BW, personal communication). The greater number of hours devoted to training in reproduction at JCU could reflect differences in content and emphasis compared to some other veterinary colleges and that training in all of the major domestic species is required for all students. Time involved in the teaching of anatomy, physiology, and surgery related to reproductive structure, function and clinical applications was included in the data derived from JCU. It is unclear if this data were included by all survey participants when documenting theriogenology training in North America.[5] The undergraduate curriculum at JCU may also require more time to be devoted to the teaching of the basic sciences compared with places where veterinary science is studied as a postgraduate degree.

The greater number of hours devoted to the teaching of reproduction at JCU compared to some North American colleges suggests that there is some scope to reduce the amount of time devoted to the teaching of reproduction at JCU. This however, must be balanced with staffing levels, the need to achieve day 1 competencies, a reported concern that there is a need to increase practical exposure to theriogenology in veterinary education and that many reproductive procedures are still regarded as being valuable by practicing veterinarians.[6] Revisions to the curriculum, in particular shortening many practicals while at the same time reducing student numbers attending individual practicals will in part reduce the total number of student contact hours while at same time should improve teaching quality. Further attempts to reduce contact hours will involve investigating the use of blending guided-independent and on-line study with didactic lectures, removing non-essential content and transferring some content to electives.

There are at present no stand alone rotations in theriogenology in the final year of the program at JCU. In North America 72.7% (16/22) of schools responding to a survey required some clinical experience in theriogenology.[5] The provision of up to eight-week of electives in the final year of the program and the integration of some aspects of clinical reproduction into core and elective rotations does provide students with some exposure to reproduction training in the final year and also enables those interested in reproduction to pursue further training during externships. It is envisaged that clinical training in theriogenology will continue to be integrated into core and elective rotations in the final year of the program. The number of boarded or board eligible faculty at JCU (n=1) is currently less than the mean (± SD) number of 3.3 ± 2.2 reported in North America.[5] The current case load, staffing levels, timing of core rotations and the occurrence of peak reproductive activities for some species occurring outside of the academic year will contribute to the ongoing difficulty of offering stand alone theriogenology rotations or electives for final year students at JCU.

Classes in pregnancy diagnosis commence in the third year of the course, although students are first introduced to rectal palpation in Year 2 as part of physical examination exercises in cattle. The philosophy behind introducing rectal palpation in Year 3 is that it coincides with when students have completed the relevant anatomy and physiology and it is prior to when students will commence

extramural practice with veterinarians. Introducing them to the technique in horses and cattle provides students with an opportunity to continue to practice these techniques when they commence their extramural practice. Students are first exposed to abattoir specimens, then non-pregnant animals and then in the case of cows they are exposed to pregnancies under five months and then subsequently to pregnancies over five months. Access to pregnant mares is limited so the emphasis in horses remains on preparation of the mare for examination, safe examination of the non-pregnant uterus, assessment of vulval conformation and vaginal examination. By the end of Year 5 all students should have participated in at least 14 and 32 hours of formal classes involving rectal palpation in mares and cows, respectively. Feedback from graduates and employers in the future will be helpful to determine if graduates meet employers' expectations in regards to pregnancy diagnostic skills and whether any further emphasis on developing pregnancy diagnostic skills are needed within the curriculum.

An introduction to obstetrics is taught in Year 3 with students being introduced to equipment, normal delivery of the fetus in cranial and caudal presentation, and diagnostic traction. The aim again here is to provide students with basic skills for delivery of a fetus by traction so that they may benefit more from their extramural veterinary practice. In Year 4 diagnosis and correction of malpresentations, percutaneous and subcutaneous fetotomy are taught in separate classes.

Practical classes focusing on male animals include the conduct of breeding soundness examinations (BSE) in the dog, bull and stallion. Semen evaluation is addressed beginning in Year 2, and covered again in Year 4 and 5. In Year 5 semen processing is introduced. The guidelines issued by the Society for Theriogenology are used for the evaluation of dogs and stallions while the guidelines issued by the Australian Cattle Veterinarians are used for the evaluation of bulls.[7]

At JCU the curriculum has been structured to foster integration between different disciplines and to present information and problems in ways veterinarians are likely to encounter them in the workplace.[3] Veterinary reproductive anatomy and physiology are taught in close association during Year 2 of the course while students are also introduced to techniques that are used to prevent reproduction, BSE of the bull and semen evaluation. The emphasis here is an attempt to place their knowledge of anatomy and physiology into an applied context. Clinical techniques are related back to the relevant anatomy and physiology. For example, the structure and function of the testes are reinforced when students are shown the surgical technique for castration of a colt and a dog, with the relevant anatomy being outlined as the surgeon progresses through the castrations. Anatomy of the reproductive tract is highlighted as students practice ultrasound examination of pregnant and non-pregnant tracts in water and the Willis spay technique.[8] The physiology of the estrous cycle and spermatogenesis are revisited as students use literature and their knowledge of the cycle to determine ways of preventing reproduction. Aspects of reproduction can also be introduced in case studies in the early years of the course and ethical problems can be introduced, for example, the ethics associated with sterilization techniques or artificial breeding of dogs. In Year 4 the teaching of reproduction is centered mainly within individual species and as such the reproductive course may be less comparative than in some teaching institutions. Since reproductive problems usually present within the context of a given species we have elected to teach the majority of the clinical reproduction in the context of individual species.

The use of a range of assessment modes provides an opportunity to provide reliable and valid assessment of students as well as provide a degree of diversity which may assist some students who may be disadvantaged by a particular form of assessment.[9] Time will tell if the standard requirement set for all students in regards to pregnancy diagnosis is too high for the majority of students to attain before completing the final year of the course. Feedback from practitioners would however, suggest that achieving such a standard amongst our graduates would be desirable. Vertical and horizontal integration of the reproduction components of the course provide an opportunity to scaffold and reinforce the development of knowledge and skills in reproduction throughout the course. Vertical integration of clinical skills into the early years of professional degree programs appears to have a positive benefit on student motivation.[3] Further improvements in the quality of education could perhaps be obtained by the development of interactive cases, exposure to additional clinical cases and expansion of staff numbers with advanced training in reproduction. Reviewing of the content of the curriculum will be required as more feedback is obtained from practitioners and external auditors such as the Veterinary Schools Accreditation Advisory Committee.

Conclusion

A detailed curriculum in veterinary reproduction has been developed for the new undergraduate degree program at JCU. Highlights include a detailed overview of most topics relevant to practicing veterinarians, an extensive series of practical exercises and where possible vertical and horizontal integration of the educational material throughout the course. Positive feedback on the content and effectiveness of the training from an independent reviewer and favorable feedback from students and practitioners have been obtained. Further improvement will continue as teaching materials are continually redesigned, and feedback is obtained from students, staff and external reviewers. The quality of training will also likely be improved with development of additional learning aids, recruitment of new staff and the development of more time for research and clinical duties.

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Table 1. Names of subjects and units of study allocated to individual subjects which are undertaken by students during the Bachelor of Veterinary Science course at James Cook University.

Year	Study period	Subjects	Units
1	1	Veterinary Professional Life 1	3
		Chemistry: An enabling science	3
		Cell Biology and Biochemistry for Agricultural and Veterinary Science	3
		Biological Principles for Agricultural and Veterinary Science.	3
1	2	Veterinary Professional Life 2	3
		Plant Biology for Agricultural and Veterinary Science	3
		Animal Biology for Agricultural and Veterinary Science	3
		Physiology and Pharmacology for Veterinary Science	3
2	1	Integrated Animal Structure and Function 1	12
2	2	Integrated Animal Structure and Function 2	12
3	1	Transitions from Health to Disease: Identification and Management 1	12
3	2	Transitions from Health to Disease: Identification and Management 2	12
4	1	Veterinary Clinical Sciences 1	12
4	2	Veterinary Clinical Sciences 2	12
5	1-3, 6	Veterinary Clinical and Professional Practices	24

Table 2. Thematic structure of subjects undertaken by students in years 2 and 3 of the veterinary science degree program at James Cook University.[3,4]

Theme	Focus
Structure and function	Diversity of living organisms
	Structure and function of plants and animals
	Techniques that are available to study plants and animals
Disease, defence and chemical agents	Molecular and cellular basis of disease processes, organisms and bodily defence
	Diversity of organisms that cause disease
	Pharmacology
Animal production, management and behavior	Animal production, welfare and behavior
Veterinary services	Epidemiology and public health
Veterinary practice	Knowledge, skills and attitudes required for veterinary practice
Professional life	Self understanding, management and personal development
	Team skills
	Communication skills
	Conflict resolution
	Information literacy and lifelong learning skills
	Practice management/business skills

Table 3. Year 5 rotations.[4]

First half of the year	Duration (Weeks)	Second half of the year	Duration (Weeks)
Small animal emergency practice	2.0	Equine practice or small animal practice (first accession) — whichever not completed in the lockstep phase	2.0
Small animal practice (first accession)	2.0	Small animal emergency practice	2.0
Small animal medicine and Imaging	2.0	Dairy cattle and mixed practice (Malanda 2)	2.0
Surgery and anesthesia	2.0	Abattoir	0.8
Equine practice	2.0	Electives	8.0
Dairy cattle practice (Malanda 1)	2.0		
Beef cattle and small ruminants	2.0		
Composite 1 (epidemiology, veterinary public health, intensive animal production and aquaculture)	2.0		
Composite 2 (behavior, canine theriogenology, clinical microbiology, toxicology, parasitology, immunology, virology and wildlife, avian, reptiles and exotics)	2.0		

Table 4. Extramural practice requirements.[4]

Nature of work	Minimum period (weeks)	Year
'Seeing Practice' – Five consecutive days of extramural work experience in an approved veterinary practice prior to entering Year 2	1	1
Farm/Animal Industry – 12 weeks of farm/animal industry extramural work experience following completion of the Year 1 and prior to the completion of Year 3	12	2 to 3
Clinical Placements – 12 weeks of extramural work experience in approved veterinary premises, working alongside registered veterinarians following completion of Year 3 and prior to the commencement of Year 5	12	4

Table 5. Reproduction curriculum – Year 2.

Lecture topic	Hours	Practical title	Hours
Sex determination; Hormones	2	Reproductive anatomy and histology	3
Female reproductive tract and function	1	Reproductive biology – hyperactivation of sperm and examination of embryos	3
Folliculogenesis	1	Prevention of reproduction	4
Estrous cycles; ovulation; corpus luteum	1	Semen evaluation	4
Male reproductive system	1	Calf castration, dehorning, branding and bull BSE	2
Spermatogenesis	1		
Regulation of gonadal function	1		
Maturation of the hypothalamic-pituitary-gonadal axis and puberty	1		
Action of steroids on adults	1		
Sperm transport and fertilization	1		
Embryo development and placentation	1		
Maternal recognition of pregnancy of pregnancy	2		
Parturition	1		
Olfaction and reproduction	1		
Reproduction in birds	1		
Development of the reproductive system	1		

Table 6. Reproduction curriculum – Year 3.

Lecture topic	Hours	Practical title	Hours
Pregnancy diagnosis in the cow	2	Pregnancy diagnosis – Examination of abattoir specimens	3
Pregnancy diagnosis in the mare	1	Examination of the reproductive tract of the mare	11
Introduction to obstetrics	2	Pregnancy diagnosis in cattle – Examination of non-pregnant cows	6
Pregnancy diagnosis in the bitch, queen, sow, ewe and doe	1	Pregnancy diagnosis in cattle - Examination of pregnant cows 6 to 16 weeks	5
		Introduction to obstetrics	3
		Pregnancy diagnosis in cattle – Examination of pregnant cows >20 weeks	3
		Sheep week – Industry visitation including pregnancy diagnosis, husbandry, flock reproductive performance and genetic selection of rams	6

Table 7. Equine reproduction curriculum – Year 4.

Lecture topic	Hours	Practical title	Hours
Castration	1	BSE mare (includes synchronization of estrus, culture, cytology & biopsy)	3
Equine estrous cycle, anatomy, and estrous behavior	1	Diagnosis and treatment of endometritis (includes Caslick's), interpret lab results from mare BSE practical, uterine treatment and lavage	3
Manipulation of the estrous cycle of mares	1	BSE stallion	3
Artificial insemination and embryo transfer in mares	1		
Non-infectious causes of infertility	1		
Infectious causes of infertility – endometritis	1		
Problems during pregnancy 1– early embryonic loss, non-infectious causes of pregnancy loss	1		
Problems during pregnancy 2– infectious causes of pregnancy loss	1		
Periparturient and postpartum complications in the mare	1		
Equine urogenital surgery	2		
Stallion reproductive physiology and BSE	1		
Reproductive problems of stallions	2		
Assessment of reproductive performance of stallions	1		
Surgery of the male reproductive tract – stallion	1		

Table 8. Canine and feline reproduction curriculum – Year 4.

Lecture topic	Hours	Practical title	Hours
Estrous cycle review, estrous behavior, vaginal cytology	1	Vaginal cytology	2
Breeding management	1	Breeding management case studies	2
Estrous cycle control, induction of estrus, prevention and termination of pregnancy	1	BSE in the male	2
Disorders of pregnancy and abortion	1		
Disorders of the reproductive system	2		
Problems during pregnancy, periparturient and postpartum disorders	1		
BSE and reproductive disorders of the male	1		
Male and female reproductive surgery	2		
Surgical management of pyometra and cesarean section	1		

Table 9. Porcine reproduction curriculum – Year 4.

Lecture topic	Hours	Practical title	Hours
The breeding herd	1	Pig husbandry procedures	3
The farrowing herd	1		
Reproductive failure	1		

Table 10. Livestock reproduction curriculum – Year 4.

Lecture topic	Hours	Practical title	Hours
Overview of bovine estrous cycle and pregnancy	1	Obstetrics – Correction of malpresentations	3
Detection of estrus in cattle	1	Obstetrics – Percutaneous fetotomy	3
Synchronization of estrus	2	Obstetrics – Subcutaneous fetotomy	3
Artificial insemination in cattle	1	Artificial insemination (all species)	3
Non-infectious causes of reduced reproductive performance in cattle	4	Synchronization of estrus and detection of estrus	3
Problems during pregnancy in cattle. Infectious and toxic causes of reproductive loss	2	BSE and semen morphology	2
Problems during pregnancy in the cow – physical and metabolic problems	1	Evaluation of reproductive records (dairy and beef)	3
Induction of parturition and abortion in cattle, sheep, goats and pigs	1	Pregnancy diagnosis revision	3
Periparturient and postpartum disorders	1		
Cesarean section in ruminants	1		
Surgery of female reproductive disorders	1		
Obstetrics	3		
Evaluation of reproductive records-cattle (dairy, beef)	1		
Cryopreservation of semen (multiple species)	1		
Embryo transfer in cattle	1		
Assisted reproductive technologies	1		
Bull reproductive anatomy, physiology and BSE	1		
Disorders of the reproductive system of bulls	2		
Surgical correction of abnormalities of the male reproductive system and preparation of teaser animals	1		
Veterinary services to the sheep industry	1		
General principles of flock and herd investigation			
Investigating low lambing percentage	3		
Lamb mortality	1		
Camelid reproduction	1		

Table 11. Reproduction curriculum – Year 5.

Topic	Hours
Canine vaginal cytology and breeding management – case studies	3
Canine BSE and semen processing	3
Stallion BSE and semen processing	3
Mare breeding management, palpation and case studies	3
Bovine pregnancy diagnosis	12
Bull BSE	6
Beef cattle case studies	3
Reproductive records analysis	3
Elective cesarean section	3

Table 12. Examples of the major methods used for summative assessment.

Assessment	Description
Multiple choice/extended match questions	Brief knowledge or problem focused questions with multiple options and a single correct answer. Designed to test objective knowledge
Item recognition	Questions are associated with images, sounds, videos are posed with 90 seconds allowed to answer questions that are posed
Scenario-based, short answer	Questions are presented in relation to case scenarios or problems. Questions test objective knowledge, quantitative skills, problem solving and analytical skills
Multiple station assessment tasks	Clinical, analytical, professional and practical skills are assessed as students rotate through a series of 10-minute assessment stations
Viva voce interviews	Ten minute interviews are conducted with an external expert with the aim of exploring the depth of student knowledge and understanding
Procedures log	List of clinical procedures linked to various species are signed upon satisfactory completion in Year 5