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TRIENNIAL REPRODUCTION SYMPOSIUM: Looking back and moving forward—how reproductive physiology has evolved

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INTRODUCTION

In honor of the 50th anniversary of the Society for the Study of Reproduction (**SSR**), a Triennial Reproduction Symposium was cosponsored by SSR and the American Society of Animal Science (**ASAS**). The Society for the Study of Reproduction was formed in 1967 when a group of reproductive biologists that were members of ASAS met with physician scientists and decided to organize a new scientific society. The goal of SSR was to promote the study of reproduction by fostering interdisciplinary communication among scientists, holding conferences, and publishing meritorious studies. Today after its 50th anniversary, the mission for SSR is to harness the science of reproduction, fertility, and development for a healthy world. The American Society of Animal Science began as the American Society of Animal Nutrition in 1908 and was broadened to include additional disciplines in 1912. The society changed its name to the American Society of Animal Production in 1915 and in 1961 the name of the society was changed to ASAS. Today, ASAS is a membership society that supports the careers of scientists and animal producers in the United States and internationally. The Society fosters the discovery, sharing, and application of scientific knowledge concerning the responsible use of animals to enhance human life and well-being.

Since 1967, the 2 societies have organized and conducted separate, annual meetings. In recent years, escalating travel costs and shrinking research budgets have forced reproductive biologists to choose to attend either the ASAS annual meeting or the SSR annual meeting. Few scientists can afford to attend both meetings in the same year.

In 2017, the ASAS-CSAS (Canadian Society of Animal Science) Annual Meeting and Trade Show ("Animal Science and Technology: Ensuring Food Security") was held on July 8 through 12 in Baltimore, MD while the 50th Annual SSR Meeting ("50 Years of Research—Looking Back and Moving Forward) was held on July 13 through 16 in Washington, DC. The proximity of the ASAS annual meeting and the SSR annual meeting as well as the back-to-back sequence of the meetings provided an excellent opportunity to conduct a one-day symposium that was of interest to many members of both ASAS and SSR. The Triennial Reproduction Symposium provided a unique opportunity for reproductive biologists to highlight recent advances in research on livestock reproduction.

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SYMPOSIUM TOPICS

Dr. Michael F. Smith from the University of Missouri and recipient of the 2015 L.E. Casida Award provided an overview of the advances in reproductive biology in domestic ruminants (with a focus on cattle) from discovery to application during the past 50 yr (Smith et al., 2018). Artificial insemination and embryo transfer are probably the 2 most important techniques that reproductive biologists have delivered to the livestock industry. Widespread use of these techniques required an in-depth understanding of basic biological mechanisms associated with semen preservation, ovulation, estrous synchronization, embryonic development, and maintenance of pregnancy. Translation of this information into optimal insemination and embryo transfer protocols led to maximal conception rates. Subsequent studies with sex-sorted semen provided the livestock industry with additional options to control the gender of offspring to enhance production efficiencies. Despite these advances, precision reproductive management of cattle will require on-farm methods for early detection of pregnancy and interventions to minimize early embryonic losses to address these economically important problems in cattle. In addition, new technologies such as cloning, genetic engineering by transgenesis, and gene editing provide reproductive biologists new opportunities to control reproductive efficiency and enhance profitability for the cattle industry.

An overview of ovarian follicular development and oocyte biology in dairy cattle was provided by Dr. Marc-Andre Sirard from the University of Laval (Sirard et al., 2018). An in-depth understanding of the basic biological mechanisms associated with oocyte development in cattle has led to development of technologies to super-stimulate the ovary, collect oocytes, and perform in vitro fertilization with sex-sorted semen to produce several female embryos twice a month from female calves at 6 to 12 mo of age. No epigenetic differences were identified between embryos developed from these young females compared with adult cows. In addition, genotyping blastocysts developed with these technqiues allows for the selection of the next generation prior to puberty or at least within 1 yr of birth. This is a significant reduction in generation interval and offers considerable opportunities to accelerate the rate of genetic improvement compared with conventional reproductive management practices for dairy cattle.

Dr. Jennifer Hernandez Gifford from New Mexico State University described the molecular mechanisms that regulate signal transduction and ovarian follicular maturation in cattle (Gomez et al., 2018). The wingless-type mouse mammary tumor virus integration site (**WNT**) family of signaling molecules was shown to be important intraovarian regulators of ovarian function in cattle. β-Catenin (CTNNB1) is a cofactor of the WNT signaling pathway and is required for maximal FSH-induced aromatase activity and estrogen production from rodent and bovine granulosa cells and luteal cells. β-Catenin is also increased in response to treatment with IGF-1 in vitro. Phosphorylation of Ser552 of CTNNB1 was enhanced by FSH but not by IGF-1 in bovine granulosa cells in vitro and this event was dependent on protein kinase A, but not on protein kinase B (AKT). Thus, the WNT signaling pathway functions in coordination with pituitary gonadotropins and local ovarian molecules (such as IGF-1) in granulosa cells to ensure that maturation of ovarian follicles and estrogen production occurs in a timely manner to enhance fertility of female cattle.

An overview of reproductive behavior in rams was provided by Dr. Brenda Alexander from the University of Wyoming (Alexander, 2018). Most sheep are bred by natural service and rams are rarely evaluated for reproductive behavior or their expression of sexual interest; however, up to 30% of breeding rams may have limited sexual interest and limited sexual behavior. There is no difference in circulating concentrations of testosterone between sexually active and sexually inactive rams. Using *c-fos* as an indicator of neural activity, sexually inactive rams had lower *c-fos* activity in the central amygdala (an area of the brain important for alertness and vigilance) and in other regions of the hypothalamus following exposure to sexual evocative olfactory stimuli compared with sexually active rams. Rams with limited sexual interest also had lower amounts of dopamine D2 receptors and lower dopamine synthesis following exposure to sexual stimuli compared with sexually active rams. Thus, sexually inactive rams are able to detect olfactory cues, but they have a lower response to these signals at the region of the brain than controls alertness and vigilance to sensory stimuli. In addition, lowered chemical activity in the amygdala may prevent chemical signals from moving forward to the preoptic area of the brain which is essential for expression of male reproductive behavior in response to sexually evocative signals.

Dr. Dustin Yates from the University of Nebraska-Lincoln described the effects of heat stress in pregnant ewes on impaired muscle growth

and metabolic dysfunction in their offspring (Yates et al., 2018). Intrauterine growth restriction (**IUGR**) is a global health issue, the second leading cause of perinatal mortality, and leads to metabolic deficiencies, shortened lifespan, and decreased quality of life for humans. In livestock, IUGR causes low birth weights, slower growth rates, decreased carcass value, and increased perinatal mortality due to reduced energy reserves and lack of vigor at birth. Sheep are an excellent model to study the biological and molecular mechanisms associated with IUGR because sheep share several developmental processes for muscle growth and metabolic responsiveness with humans. In addition, maternal heat stress is an extremely effective method to induce IUGR in sheep. Using hyperthermic sheep, initial studies defined changes in gene expression and developmental adaptations in the adrenergic and inflammatory systems of the IUGR fetus. Although reappropriation of limited supplies of nutrients and oxygen help the fetus survive, these changes suppress muscle growth and glucose metabolism after birth. Additional studies are needed to translate this known knowledge into targeted interventions to improve the outcomes of IUGR-born humans and livestock.

An overview of how the conceptus implants into the maternal endometrium was provided by Dr. Kaz Imakawa from the University of Tokyo (Imakawa et al., 2018). Successful initiation of pregnancy requires appropriate development of the conceptus and coordinated modification of the uterine endometrium for implantation of the conceptus. Numerous biological molecules (hormones, cytokines, growth factors, etc.) have been identified and shown to play specific roles in this process. Dr. Imakawa and colleagues were the first to identify interferon tau (**IFNT**) from the mononuclear trophectoderm of the conceptus and describe its function as a key regulator of the maternal regulation of pregnancy. As expression of IFNT declines, coordinated expression of genes in the conceptus and endometrium leads to further development of the conceptus and construction of the placenta.

POSTERS AND TRAINEE FLASH-TALK COMPETITION

In addition to the symposium presentations, of the 167 abstracts submitted to the symposium, 100 scientists were invited to present posters and 13 trainees were selected to give a 3-min presentation on the relevance of their research and the significance of their findings in a flash talk competition. Abstracts were reviewed by at least 3 peer reviewers and selected based on scientific merit. Topics presented in posters and flash talks covered the breadth of reproductive biology across species. The outstanding quality of science and oral presentations in the flash talk competition provided assurance that reproductive biologists will pave the way for many new developments in fertility that will benefit humans and agricultural animals in the future.

PRESENTATION OF THE L.E. CASIDA AWARD

At the conclusion of the symposium, the 2017 L.E. Casida Award was presented to Dr. Janice Bahr, Professor Emeritus at the University of Illinois. The purpose of the L.E. Casida award is to recognize excellence in the education of graduate and(or) postdoctoral students that conduct research in the area of reproductive physiology and endocrinology. The award is based on the quality of the individual's graduate education and research program and on the awardee's relationship to the philosophy of Dr. L.E. Casida (Casida, 1966). The L.E. Casida award has been presented every 2 or 3 yr since 1985 and is sponsored by the Dr. James W. Lauderdale Appreciation Club at the ASAS Foundation.

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