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The domesticated buffalo - An emerging model for experimental and therapeutic use of extraembryonic tissues

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ABSTRACT

Large animals play important roles as model animals for biomedical sciences and translational research. The water buffalo (*Bubalus bubalis*) is an economically important, multipurpose livestock species. Important assisted reproduction techniques, such as *in vitro* fertilization, cryo-conservation of sperm and embryos, embryo transfer, somatic cell nuclear transfer, genetic engineering, and genome editing have been successfully applied to buffaloes. Recently, detailed whole genome data and transcriptome maps have been generated. In addition, rapid progress has been made in stem cell biology of the buffalo. Apart from embryonic stem cells, bubaline extra-embryonic stem cells have gained particular interest. The multipotency of non-embryonic stem cells has been revealed, and their utility in basic and applied research is currently investigated. In particular, success achieved in bubaline extra-embryonic stem cells may have important roles in experimental biology and therapeutic regenerative medicine. Progress in other farm animals in assisted reproduction techniques, stem cell biology and genetic engineering, which could be of importance for buffalo, will also be briefly summarized.

1. Introduction

Domesticated animals have made a huge contribution to the development of humankind, as well as to the current knowledge of biology of ageing, physiology, endocrine function, fertilization, reproduction, and ontogenesis [1]. Surgical procedures, pain-relieving drugs, treatment of shock trauma and blood diseases, cancer cure, gene therapy, nutrition supplements, tissue and organ transplantation, stem cell therapies, have been originally tested and validated in model animals, such as rodents, livestock and non-human primates. However, rodents have limitations. For example, rodents have short pre-implantation development and gestation periods [2]. Since metabolism in rodents is much faster than in humans, differences in inflammatory and pharmacological reactions are distinctive, and the mouse model poorly reflects the genetic and proteomic response to inflammatory stress [3]. Non-human primates are relatively closer to the physiology and patho-physiology of humans. Major impediments associated with the use of non-human primates include high costs, limited availability of the animals, requirement of sophisticated equipment, and ethical issues [4].

Therefore domesticated farm animals play a pivotal role in basic and advanced biomedical research of reproduction and stem cell biology [5–8]. The diversity of farm animals provides the opportunities to assess these fields of research in different species, and to identify conserved and species-specific mechanisms. The buffalo represents an unconventional, emerging animal model in the field of stem cell biology.

The domesticated buffalo (*Bubalus bubalis,* Linnaeus 1758) is a traditionally important agricultural animal in Asia [9,10], however in recent years this species gained interest for basic and applied research, particularly in the area of stem cells and potential translational approaches [10–12].

Nowadays, buffalos are bred worldwide, with a focus on Asia, Africa, South America, Australia and Southern Europe [9]. The

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