THE DEVELOPMENT OF THE BOVINE PLACENTOME AND ASSOCIATED STRUCTURES DURING GESTATION

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Dedication

This work is dedicated to my ***Lord Jesus Christ****,*

"Who is the beginning and the end"

In loving memories

My late dad, 'Samuel Oyin Oyedepo'

My late Kiwi dad 'William Bruce Teulon'

Thank you for the inspirations you have given to me.

Abstract

Placental development is a key influencer of fetal growth and development. However, limited information exists on many basic aspects of bovine placental development and the factors which affect it. To resolve this dearth of knowledge, studies of the bovine placenta were conducted to elucidate the relationship between its development and that of the fetus throughout gestation.

The first study investigated the effects by maternal nutrient restriction of two different groups of well fed heifers just prior to mating in two consecutive years to give an overall moderate weight gain during the first trimester averaging approximately 500g/day for controls compared to around 50g/day in the restricted groups Data obtainedby Day 90 of gestation, were subjected to principal component and factor analyses to evaluate the effect of nutrient restriction on placental growth. Placental growth was not directly affected by maternal nutrient restriction over the first 90 days of gestation, suggesting that significant underfeeding with weight loss is needed before placental development is affected. The study also showed that caruncle number is a major determinant of placental mass and, probably consequently, fetal mass.

The second study investigated changes in the relative contributions of fetal and maternal tissue to placentomes throughout pregnancy, using abattoir-collected material from Days 100 to 225 of gestation. Weights were measured and volumes were estimated using an air and water displacement method. Placentome number increased between Days 100 and 170 of gestation, but decreased thereafter. Mean placentome density did not show any biologically-significant variation over pregnancy. However, the contribution of maternal tissue (as determined through both weight and volume estimations) increased more rapidly with advancing gestation than did that of fetal tissue; with the consequence that maternal tissue weights were significantly greater than fetal weights by 200 days of pregnancy. The third study built upon these results by measuring placentome size *in-vivo* by trans-rectal ultrasound of dairy cows between Days 60 and 180 of pregnancy. To try to maximise the repeatability of measurements of placentome size, only those closest to the cervix were selected. The results of this study showed that there was a significant increase in placentome size between Days 60 and 180 of gestation, but that, a limits-of-agreement

analysis showed that placentome size was insufficiently closely associated with gestation age to be used as an accurate predictor of gestation age.

The final two studies examined the central zone of the feto-maternal interface of the placentome in greater detail; again using abattoir-collected material over similar period as in Study 2. In the first of these, (Study 4) stereology was used to estimate the relative volume densities, surface densities and total surface areas of the fetal and maternal components of bovine placentomes. The final study used lectin (*Dolichos buflorus* (DBA), *Glycine max* (SBA) and *Phaseolus vulgaris* leukoagglutinin (PHA-L)) histochemistry to attempt to characterize and quantify the distribution and origins of glycoproteins within the feto-maternal interface, with particular reference to the role of the binucleate cell. This was the first time that the lectin-binding properties of the bovine placetome had been objectively quantified throughout the second and third trimesters of pregnancy. Whilst the relative volume densities and surface densities of the tissues of the feto-maternal interface of the placentomes (i.e. binucleate cells, fetal trophoblast, fetal connective tissue, maternal connective tissue and maternal epithelium) did not change with gestational age, the total surface area of the feto-maternal interface increased throughout pregnancy. The presence of glycoprotein, as inferred from the patterns of lectin staining, was confined to fetal trophoblast and maternal epithelium and, in the case of DBA and, particularly, SBA, was especially prominent in binucleate cells. The latter staining probably reflects changes in the patterns of production of a key fetal regulator of maternal metabolism, placental lactogen, a glycoprotein whose origin from binucleate cells has previously been established.

Whilst it has long been established that placental size increases as pregnancy advances, this research has shown that the relationship between advancing gestational stage and placental mass is not a simple linear relationship, and even the combination of placentome size and number is not simply related to fetal size. This is, as the results of this thesis have shown, because of differential growth of the fetal and maternal components of the placentome, accompanied by progressive development of the critical interface between the mother and fetus at the central zone of apposition. It is believed that these studies have shown that in future a combination of ultrasonography, stereology and lectin histochemistry techniques could be used to quantify structural and cellular changes in the bovine placenta during gestation. This will be of value to underpin future investigations of situations in which

placental activity may be impeded to the detriment, not only of fetal growth, but also of the metabolic environment of the ensuing adult animal.

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