A STUDY OF THE ALBINO RAT'S PLACENTA

THESIS
SUBMITTED FOR
THE PARTIAL FULFILMENT
OF THE
M. D. DEGREE
IN ANATOMY
By

AZZA KAMAL ABOU HUSSIEN
MB. B Ch, M Sc (ANATOMY)

SUPERVISED BY

PROFESSOR FAKHRY AMIN ISKANDAR
Professor of Anatomy - Ain Shams University

PROFESSOR YEHIA YOUSSEF AHMED
Professor of Anatomy - Ain Shams University

PROFESSOR ALI KHALIFA ALI
Professor of Biochemistry - Ain Shams University

PROFESSOR KARIMAN EL GOHARY
Professor of Anatomy - Ain Shams University

PROFESSOR SALWA LASHIN
Assistant Professor of Anatomy - Ain Shams University

Faculty of Medicine
AIN SHAMS UNIVERSITY
1994

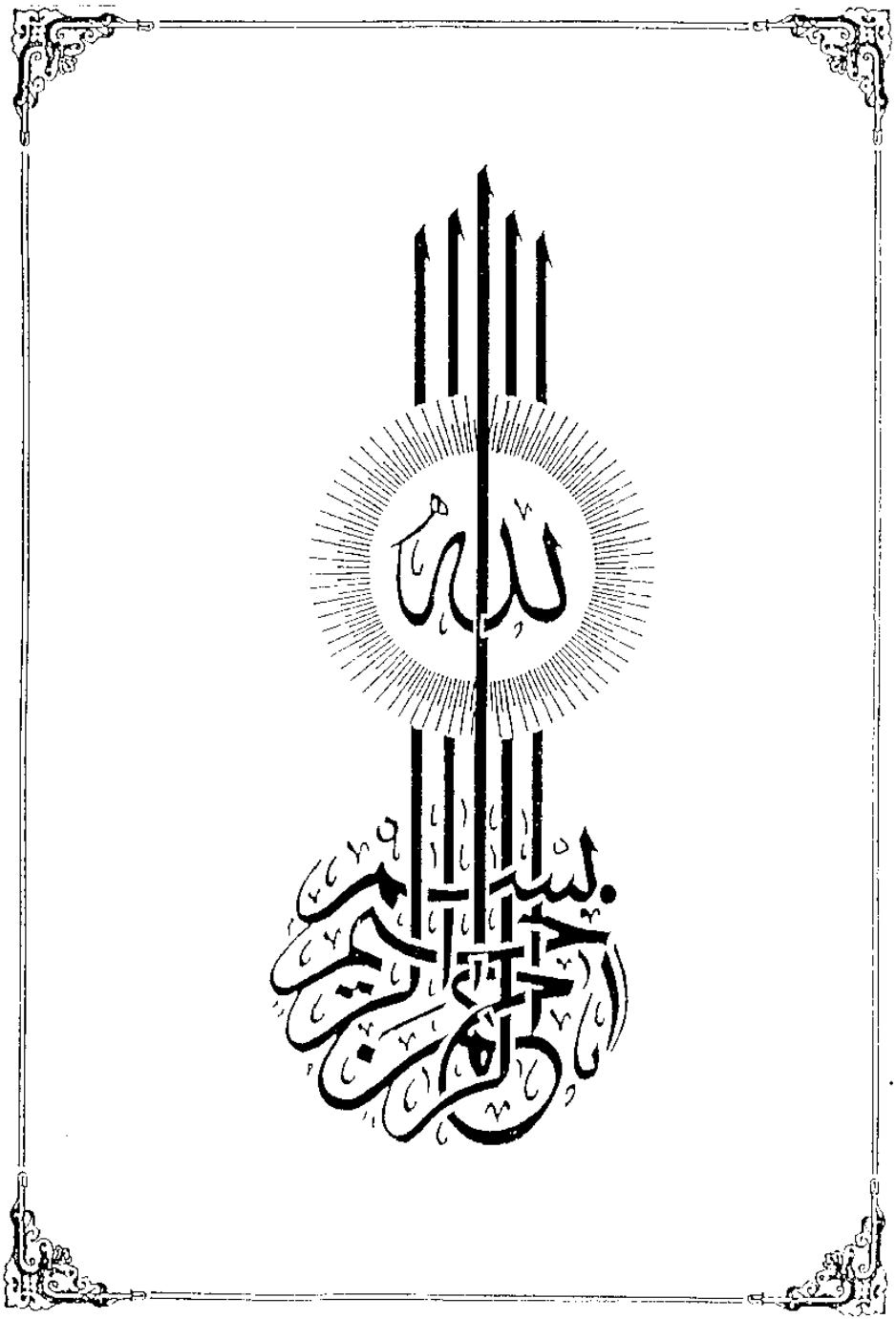
619.93
A.K

Central Library - Ain Shams University

TO AMIRA AND RANIA

who have been
two perfectly behaved
and lovable daughters
throughout
this study.

Central Library - Ain Shams University



Central Library - Ain Shams University

ACKNOWLEDGMENT

I would like to express my deepest gratitude to Professor Fakhry Amin Iskandar, professor of Anatomy, Ain Shams University, for his constant assistance, his excellent and constructive criticism and his continuous and sincere encouragement through this study.

I would like to express my sincere appreciation and gratitude to Professor Robert Mac Mahon, associate professor of paediatric surgery, Monash University, Melbourne, Australia, for his sincere criticism, constant encouragement and valuable advice throughout this work.

I am grateful to Professor Yehia Youssef, professor of Anatomy, Ain Shams University for his valuable suggestions and help.

I am grateful to Professor Ali Khalifa, professor of Biochemistry, Ain Shams University for his continuous encouragement and help.

I am indebted to Professor Kariman El Gohary, professor of Anatomy, Ain Shams University, for always being there to help, share, advice and solve problems met throughout this study. Her valuable criticism and excellent experience has added a lot on reviewing the present data.

My thanks are extended to Dr. Salwa Lashin, assistant professor of Anatomy, Ain Shams University, for her patience, kindness and help.

This study would have been impossible without the endless help, advice, patience and experience of Dr. Leo Cussen, Senior Lecturer of paediatric pathology, Monash University, Melbourne, Australia. To him I am fully indebted for the fulfilment of this work.

I would like to thank Mr Chris Mayberry to whom I am greatly indebted for his patience, encouragement and confidence in teaching me to operate the electron microscope.

Central Library - Ain Shams University

I would like to thank Mrs Jane Ng, the electron microscopy technician at Monash Medical Centre whose technical assistance was of great help throughout this study.

Finally, I would like to express my gratitude to my husband, Dr. Ahmed Zaki, who was always there for me, caring, helping and advising whenever possible. He was of great help in printing this work.

Central Library - Ain Shams University

CONTENTS

Central Library - Ain Shams University

CONTENTS

"cont."

Central Library - Ain Shams University

INTRODUCTION AND AIM OF THE WORK

Central Library - Ain Shams University

The placenta has always been one of the most fascinating organs attracting the attention of many investigators. Its unique structure allows it to carry out simultaneously the functions of the lung, liver, kidney and endocrine glands. In addition, it acts as a barrier to many pathogenic organisms. Being a tissue mainly of fetal origin, existing in an environment influenced primarily by maternal physiology, studying the placenta will not only yield information about maternal function, but will also provide an understanding of the factors affecting fetal growth and development.

The placenta of the rat is a haemochorial placenta and is therefore chosen in this study as it provides a suitable comparison model for the human placenta. The development of the placenta in the mouse and rat had long been investigated [Jenkinson (1902), Sobotta (1903), Mellisinos (1907), Sobotta (1911), Asai (1914), and Branca (1923)], but the effects of various diseases on its structure have rarely been evaluated.

Pregnancy in a diabetic is often associated with elevated incidence of fetal malformations, perinatal mortality, perinatal disease and maternal mortality and morbidity. Modern technological development has vastly improved the quality of care and management of the diabetic mothers during pregnancy and neonatal surveillance, but fetal anomalies still occur.

Central Library - Ain Shams University

The placenta of the diabetic has attracted much interest largely because it is thought that the placental damage or dysfunction may be partially responsible for this unduly high incidence of fetal complications that occur in the diabetic pregnancies. The placental abnormalities associated with maternal diabetes are so extensive and varied, that the reported observations sometimes appear contradictory. The discrepancies in the various reports on this subject arise from the inclusion of mothers with mild, moderate and severe forms of diabetes, those with and without requirements for insulin, with or without vascular disease, with or without toxaemia of pregnancy and without regard for possible genetic variation. Experimental studies involving the use of congenitally diabetic laboratory animals or animals in which diabetes is chemically induced are of great value in elucidating the specific factors in the underlying teratogenic mechanisms.

Normal fetal development is dependent upon an appropriate supply of nutrients from the mother through the placenta. Amino acids are essential elements required by the fetus for the formation of new tissue protein, and they also constitute the major source of metabolic fuel for the developing fetus. Diabetes is known to alter both the carbohydrate and the protein metabolism. Disturbances in the transfer of protein from the mother to the fetus, reflecting altered placental function may be of importance in explaining the altered somatic growth rate in infants of diabetic mothers. Previous investigators reported contradictory results regarding the amino acid levels in maternal and fetal sera with diabetes.

Central Library - Ain Shams University

The present study is therefore meant to outline the major histological and ultrastructural changes that occur in the placenta of the rat exposed to a chemically induced, metabolically altered maternal environment, namely diabetes. Furthermore, an attempt will be made to compare the amino acid levels in the blood of pregnant mothers and their fetuses and in placentas of normal and diabetic rats.

Central Library - Ain Shams University

REVIEW OF LITERATURE

Central Library - Ain Shams University

I. The Morphology Of The Rat's Chorioallantoic Placenta

Duval (1891), was the first to study the rodent placenta. He considered the trophoblastic epithelium to be syncytial in both the labyrinth (zone of combined fetal and maternal vascularisation) and the basal zone (zone of exclusive maternal vascularisation), with the exception of transitory remnants of the ectoplacental cone and certain cellular elements such as the chorionic giant cells and the glycogen cells of the basal zone.

Grosser (1908), divided the chorioallantoic placentas of eutherian mammals into 4 types, basing his classification on the number of layers separating the maternal and fetal blood streams. According to his scheme, the lagormorpha (rabbits), myomorpha (rats and mice) and histricomorpha (guinea pigs) possessed haemochorial placentas in which the chorion initially composed of cytotrophoblast, became transformed into syncytial trophoblast.

Mossman (1926, 1937), submitted evidence that in rabbits, rats, mice and guinea pigs late in gestation the syncytial trophoblast itself disappeared, so that the placental barrier became reduced for the most part merely to endothelium lining the fetal capillaries. On this basis, he proposed adding a hemoendothelial placenta to the types proposed by Grosser.

Central Library - Ain Shams University

Bridgman (1948 a & b), performed a morphological study on the development of the placenta of the rat. She stated that the cytoplasm of the labyrinthine trophoblast persisted until term and the trophoblast of the labyrinth became definitely syncytial on day 13 of gestation. She also believed that the glycogen cells of the junctional zone were of fetal origin.

Wislocki and Dempsey (1955), studied the placenta and fetal membranes of the rat by electron microscopy. They stated briefly that electron microscopy revealed that the rat's placenta was haemochorial and not hemoendothelial in character, its labyrinth possessing throughout gestation a complete layer of trophoblast. Moreover, they reported that this layer of labyrinthine trophoblast was not a simple syncytium, but consisted of overlapping sheets of cellular trophoblast having, however, many of the cytoplasmic characteristics of syncytial trophoblast.

Jollie (1964), studied the fine structural changes in the placental labyrinth of the rat with increasing gestational age. He stated that at all stages, the placental barrier consisted of four cytoplasmic layers, which he called (in order from maternal blood sinus to fetal capillary lumen):

(a) Trophoblast I.
(b) Trophoblast II.
(c) Element III.
and (d) Fetal capillary endothelium.

Central Library - Ain Shams University

He also reported that the endothelium became fenestrated at 16 days post coitum and it exhibited both fenestrations and evidence of micropinocytotic activity until term. He also stated that although the four cytoplasmic layers persisted into late pregnancy, as a result of pore formation, the effective cytoplasmic barrier to placental transport through the labyrinth was reduced to trophoblast II and element III.

Enders (1965), reported that the laboratory rat had a hemotrichorial placenta, where three layers of trophoblast existed between the maternal blood and the fetal vessels. He also stated that the outer layer of trophoblast next to the maternal blood was cellular, but the other two layers were apparently syncytial and were closely opposed to one another. He also found that the surface layer of trophoblast was rich in granular endoplasmic reticulum, whereas in subsequent layers, this element was less abundant .

Davies and Glasser (1968), studied the fine structure of the rat's placenta from day 12 to day 20 of gestation by light and electron microscopy. They reported that in the labyrinth of the mature rat's placenta, the septa of fetal mesenchyme were invested by a trilaminar trophoblastic epithelium. Layer I was adjacent to the maternal blood sinus; it was cytotrophoblastic and discontinuous. Layers II and III were observed to be syncytial with few nuclei. However, they stated that it was possible that these two layers were in reality attenuated cytoplasmic sheets. Layer I

Central Library - Ain Shams University