THE AMNIOTIC FLUID - ITS VALUES IN DETERMINING FETAL MATURITY & IN DIAGNOSIS OF INTRA-UTERINE FETAL DISORDERS

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SHABAN ABDELL RAOOF ALI

M. B., B. Ch.

UNDER SUPERVISION OF

PROF. DR. SALAH AWWAAD

PROF. OF PAEDIATRICS

FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY

FACULTY OF MEDICINE

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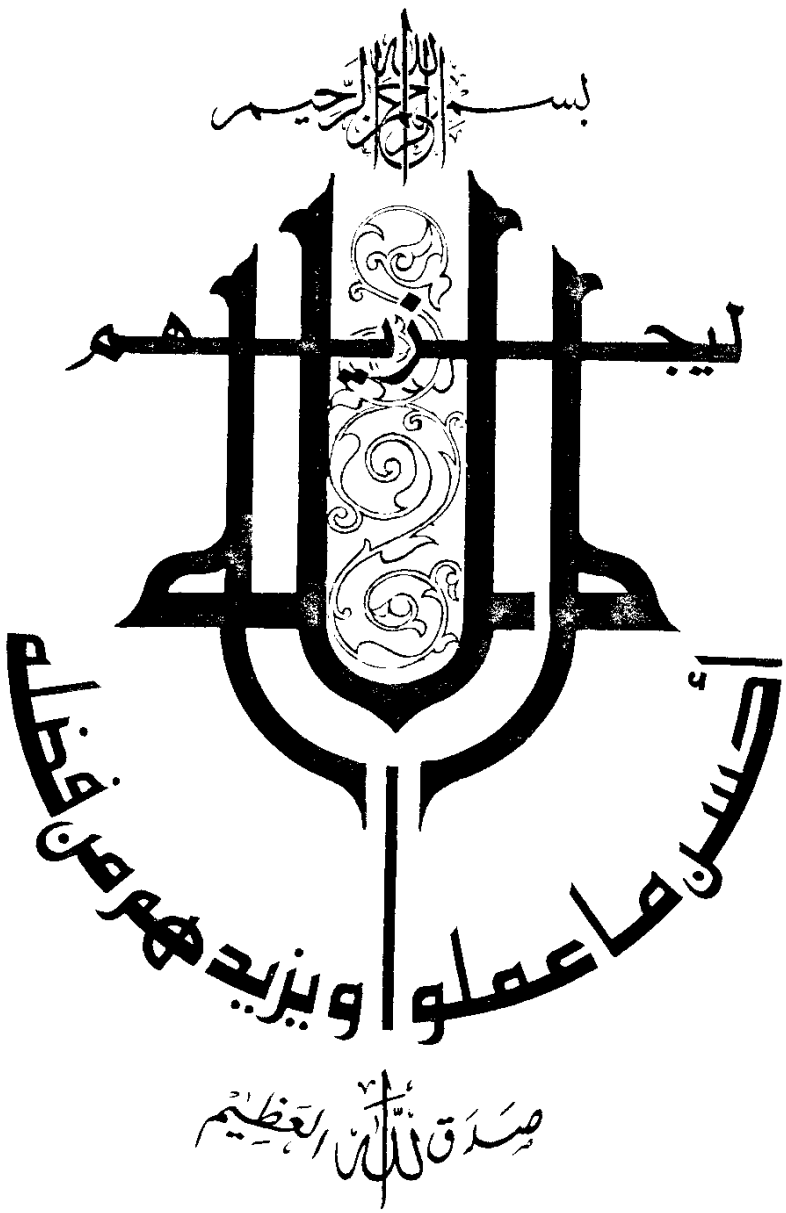

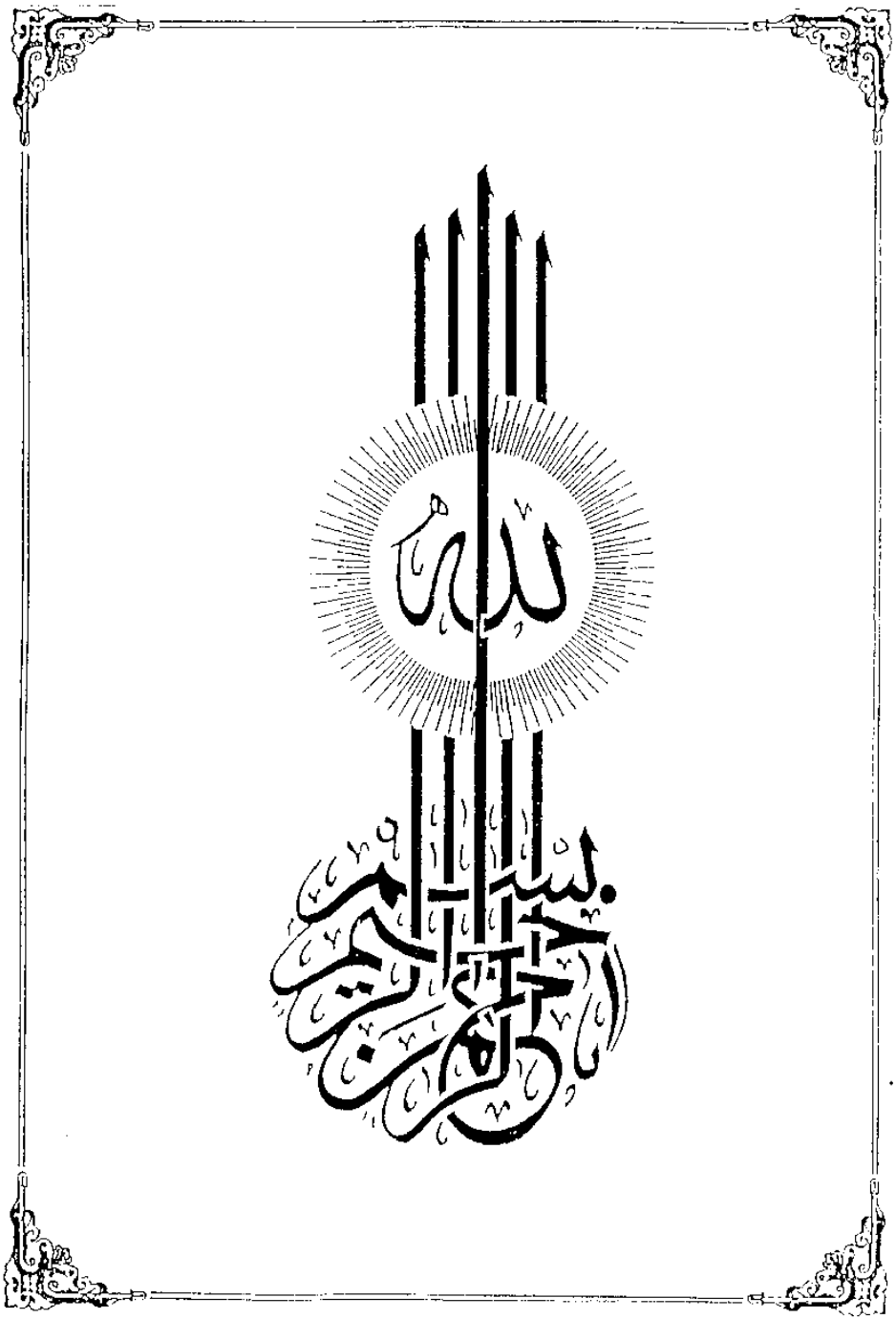

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INTRODUCTION

I

INTRODUCTION AND AIM OF WORK

The fetus in utero lies in the amniotic sac, surrounded by the amniotic fluid. The amniotic sac consists of two layers : an inner one, called the amnion and an outer one, called the chorion.

The amniotic fluid is derived from multiple maternal and fetal sources. Besides, special amnion cells with secretory properties may be an important source. During the early months of pregnancy, the amniotic fluid is clear but near term, it becomes cloudy with an admixture of vernix caseosa, a fatty material coating the skin, principally over the vertex, back and extremities *[Danforth and Scott, 1986]*.

The amniotic fluid may be regarded as the largest part of the fetal extracellular space, and it provides a more accessible means than fetal blood for investigation of the fetus.

The amniotic fluid cushions the fetus against trauma and provides a medium in which it can move easily while maintaining an even environmental temperature. Since the specific gravity of the amniotic fluid and the fetus are similar, it can exist in a state of relative weightlessness. Beside the above mentioned functions, the amniotic fluid is

a repository for a number of secretions and excretions from the fetal urinary, respiratory, and alimentary tracts *[Mandelbaum and Evans, 1969]*.

The present study is a critical review on the amniotic fluid (AF) in relation to the following topics:

1. The fetal membranes: Anatomical and Histological considerations.
2. The Amniotic fluid: Its origin, Circulation and Volume.
3. Amniocentesis: procedure and Possible complications.
4. The Biochemistry and Cytology of the Amniotic Fluid (AF).
5. The Value of AF in Assessment of Fetal Maturity.
6. The Use of AF studies in Prenatal Diagnosis of Fetal Disease.
7. Amniography and Fetography and Amnioscopy in the diagnosis of Fetal Disorders.

II

THE FETAL MEMBRANES

ANATOMICAL AND HISTOLOGICAL CONSIDERATIONS

In the ordinary course of events, the fetal membranes line the uterine cavity and completely surround the fetus. The amnion is the innermost of the two fetal membranes while the outer is the chorion.

The amnion is derived from the cytotrophoblast, immediately adjacent to the dorsal aspect of the germ disc. During the 7^{th} and 8^{th} postovulatory days, the trophoblastic cells in this area differentiate to form amniogenic cells from which the amniotic cavity develops *[Hertig et al., 1956]*.

The chorion, the outer membrane, forms a good deal of the connective tissue thickness of the placenta on its fetal side and is the structure through which the major branching umbilical vessels travel to the surface of the placenta. The chorion is juxtaposed to the outer layer of the amnion and the two membranes slide upon each other readily. Indeed, there is little connective tissue attachment between the two. The looseness of attachment between the amnion and the chorion, not only provides some safety features for the fetus in the course of its growth, but also permits differential sliding if the chorion ruptures while the amnion remains intact in the course of labour and delivery.

The strength of the membranes is imparted by the layer of dense connective tissue to which the amnion epithelial cells are attached *[Danforth et al., 1986]*.

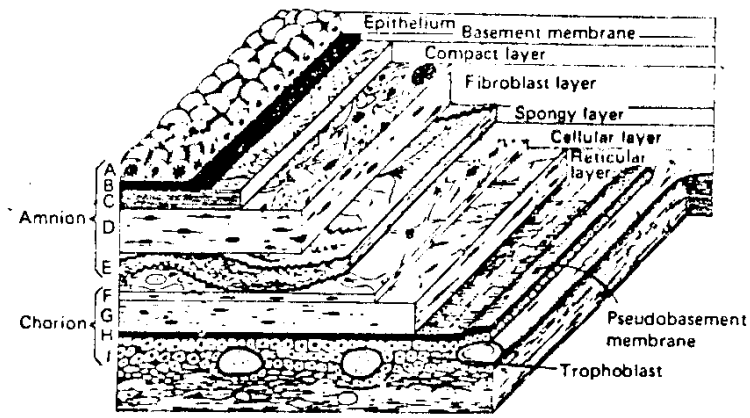
THE AMNION

In early pregnancy the amnion consists of epithelium and somatopleure only, and as pregnancy proceeds it differentiates into 5 distinct layers. As to the functional activity, in early pregnancy it is supposed to be capable of secretory activity, but to have mainly absorptive functions in the later part of gestation *[Bourne, 1962]*.

The 5 layers of the amnion, from within outwards are [Fig. 1]:

1. The epithelium; this is composed of a single layer of simple non-ciliated cuboidal cells, but flattened in the reflected amnion.
2. The basement membrane; this is a narrow band of reticulous tissue lying along the base of the epithelial cells to which it is securely adherent by means of fine fibrils.

The recent study performed by *Azzarelli and Lafuze, (1987)* indicated that, after the polymorphonuclear leukocytes cross the epithelium, they are noted to pass



Composite diagram showing relation of layers of amnion and chorion (Bourne GL: The microscopic anatomy of the human amnion and chorion. Am J Obstet Gynecol 79:1070, 1960)

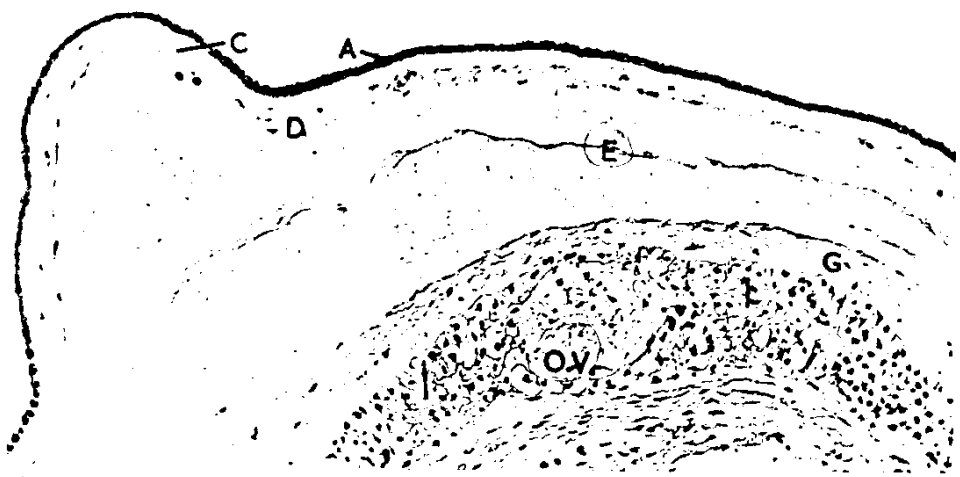


Fig. 1: Human amnion and chorion. *A*, epithelium; *C*, compact layer composed of dense connective tissue; *D*, fibroblast layer; *E*, spongy layer; *G*, reticular area; *I*, trophoblast; *OV*, obliterated villus. (×90, reduced) (Reproduced by permission from Bourne G: The Human Amnion and Chorion London, Lloyd-Luke Medical Books, 1962)

through focal basal lamina defects not due to proteolytic enzyme.

3. The compact layer: This is a relatively dense layer subjacent to the basement membrane. This layer shows a marked resistance to leucocytic infiltration, so that its boundaries can be easily observed in membranes suffering from severe inflammatory response. It is composed of a complicated reticular network responsible for most of the strength of the amnion.
4. The fibroblast layer: This layer forms the main thickness of the amnion. It consists of fibroblasts burried in a reticulin mesh. This layer would appear to play a considerable part in the transmission of fluid between the fetal and maternal compartments, although how this transfer takes place is inadequately understood.
5. The spongy layer: This layer is composed of a reticulum and is capable of considerable distension and it contains large quantities of mucus. The greatest importance of this layer is that it allows movement of the amnion upon the underlying chorion.

Blood vessels have not been demonstrated within the layers of the amnion at any stage of pregnancy. There are several reports of lymphatic vessels being present in the amnion ***[Hanon et al., 1955]***.

THE CHORION

This is formed of 4 layers, namely:

1. The cellular layer: It consists of a thin layer of interlacing fibroblasts. It is the innermost layer of the chorion.
2. The reticular layer: It consists of a reticulin network containing fibroblasts. The blood vessels in the early embryo lie within this layer.
3. The pseudo-basement membrane: This overlies the trophoblast layer.
4. The trophoblast layer: This consists of a layer of trophoblast cells varying in thickness from two to ten cells. It lies immediately adjacent to the maternal decidua with which it is in intimate contact.

The reticular layer of the chorion at term contains the vessels as they pass from the umbilical cord to the chorionic villi of the placenta. The remainder of the reticular layer of the chorion also contains blood vessels in very early pregnancy, but after the end of the first trimester a capillary blood supply can not be demonstrated in the chorion *[Bourne, 1962]*.

Recent Russian literature has-suggested that the chorion has a nerve supply, but this has not been confirmed. No actual lymphatic vessels have been observed within the layers of the chorion *[Bourne, 1960]*.

III

ORIGIN, VOLUME AND CIRCULATION OF THE AMNIOTIC FLUID

A. ORIGIN OF THE AMNIOTIC FLUID

It seems clear that the amniotic fluid is derived from multiple maternal and fetal sources. It arises as a secretion or as an ultrafiltrate either from the mother across the membranes, from the placenta and cord or from the fetus through the skin, gastrointestinal tract, tracheobronchial tree and the kidneys. Special amnion cells with secretory properties may be an important source *[Danforth et al., 1958]*.

Some experimental evidence suggests that part of the amniotic fluid is a dialysate from maternal blood serum across the fetal membranes *[Abbas et al., 1960]*.

The fluid component seems to vary in its site of origin at different periods of gestation. An active secretion may occur through the amnion in the earliest embryonic period. Later, ultrafiltration through the fetal skin is a major source, while in the last half of pregnancy this route is no longer available and there is increasing fetal urinary and possible pulmonary secretions.