FETAL MEMBRANES

Fetal Membranes:

The amniotic membrane is derived from the inner layer of the placenta & is composed of conjoined amnion & chorion membranes ***(Koob et al., 2014)***.

Inspection of the fetal membranes following delivery reveals amnion that is mildly adherent to the fetal side of the chorion. Small amounts of maternal decidual tissue can be observed attached to the outer, maternal side of the chorion ***(Cunningham et al, 2010)***.

Anatomy of the amnion & chorion:

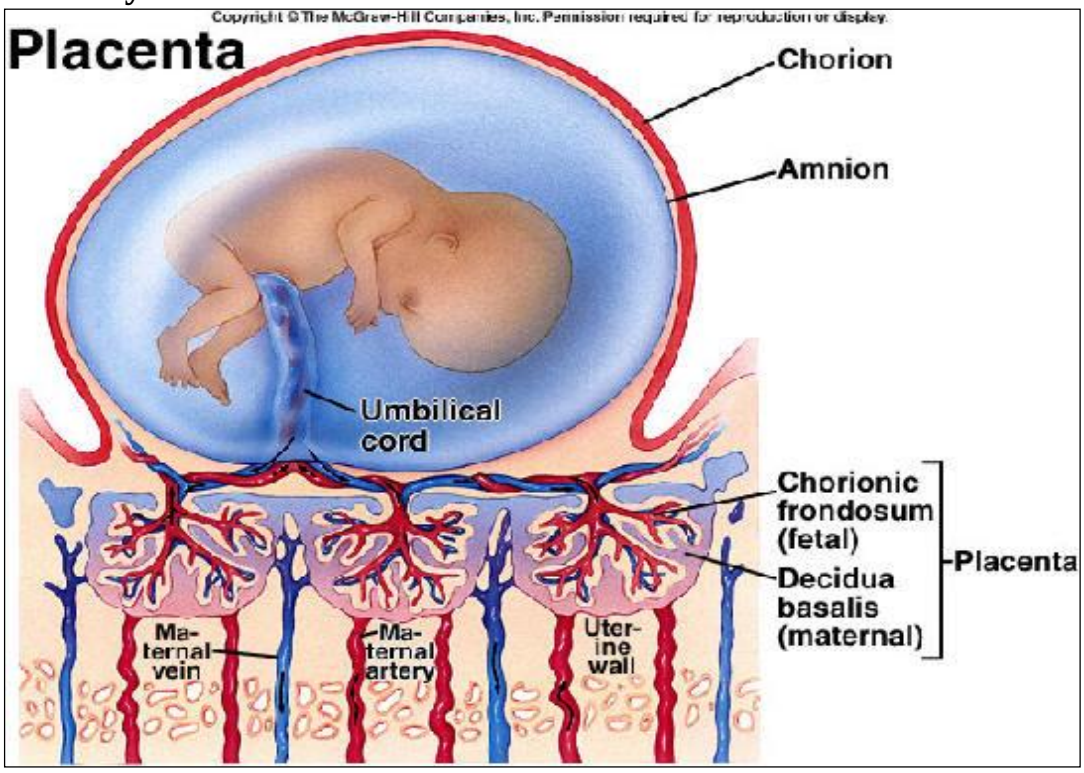


Fig (1): Anatomy of amnion and chorion.

Anatomy of the amnion:

Amnion is a thin translucent membrane. The fetal surface of which is smooth and glistening. It is reflected from the root of the cord to the fetal surface of the placenta, and then at the margin of the placenta it is continuous to line the surface of the chorion leave. Through the amnion three umbilical vessels can be seen imbedded in Wharton jelly, these are two umbilical arteries and one umbilical vein. The amnion is loosely attached to Wharton jelly except at the site of insertion of the umbilical cord in the placenta where they are firmly attached ***(Mcparland and Bell, 2004)***.

It is divided into 3 parts ***(Sagol et al., 2001):***

A- Placental amnion: covers the inner aspect of the placenta.

B- Dependent amnion: 1-2 cm overlying the internal os of the cervix.

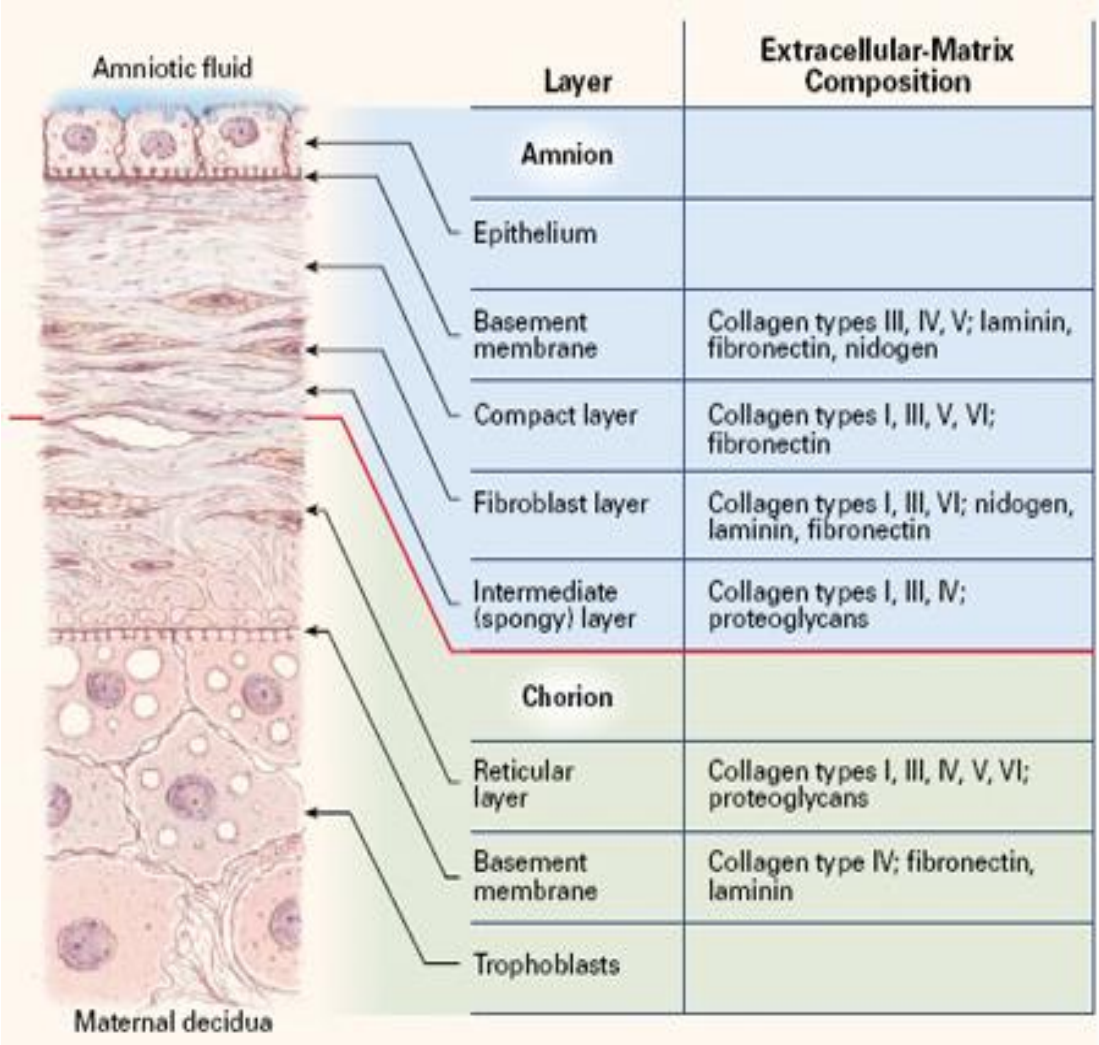
c- Reflected amnion: the reminder part of the amnion

Embryology of the amnion:

The amnion is derived from embryonic ectoderm as a single layer of epithelial cells between the ectodermal disc of the inner cell mass and the trophoblast (chorion) at 7^{th} post conception day. It consists of an avascular layer of cuboidal or columnar cells that become more columnar over the placental surface. Proliferation of the mesoderm of the extra-embryonic coelom progressively separates the amnion and chorion ***(Sobande and Albar, 2003)***.

The amniotic cavity (formed by 7-8 days) lies between the amnion and the ectodermal disc, it increases in size progressively. By the 3rd month, the amnion comes in contact with the chorion by closing the extra-embryonic coelom. It extends from the fetal surface of the placenta above, to the internal os below and wraps the umbilical cord ***(Ayad, 2002)***.

Histology of the amnion:



Layer	Extracellular-Matrix Composition
Amnion	
Epithelium	
Basement membrane	Collagen types III, IV, V; laminin, fibronectin, nidogen
Compact layer	Collagen types I, III, V, VI; fibronectin
Fibroblast layer	Collagen types I, III, VI; nidogen, laminin, fibronectin
Intermediate (spongy) layer	Collagen types I, III, IV; proteoglycans
Chorion	
Reticular layer	Collagen types I, III, IV, V, VI; proteoglycans
Basement membrane	Collagen type IV; fibronectin, laminin
Trophoblasts	

Fig. (2): Schematic representation of the structure of the fetal membranes at term. The extracellular-matrix composition of each layer and the production sites of matrix metallopteinases (MMP) and tissue inhibitors of metalloproteinases (TIMP) are shown.

According to ***Mcparland and Bell, (2004)***, the amnion consists of five layers which are from within outward:

a- The epithelium: This is normally composed of a single layer of apparently simple non ciliated cuboidal cells.

b- The basement membrane: This is a narrow band of thin layer of reticular tissue lying along the base of epithelial cells to which it is adherent securely.

c- The compact layer: This is a relatively dense acellular layer of collagen fibers lying immediately deep to basement membrane to which it is densely adherent and from which it cannot be separated.

d- The fibroblast layer: This is the most complex of the five amniotic layers. It is composed of fibroblast network set in a mesh of reticulin. The only cells normally present are fibroblasts and Hofbauer cells (Macrophages). Normally, this layer forms a considerable part of the thickness of the amnion.

e- The spongy layer: This is composed of extraembryonic celomic reticulum, contains a nonfibrillar meshwork of mostly type III collagen.

Anatomy of the chorion:

The chorion is a specialized outer fetal envelop, which is adjacent to the outer aspect of the amnion. It forms a good deal of connective tissue thickness of the placenta on its fetal aspect and in its structure, and through which major branching umbilical vessels travel on the placenta ***(Novak, 1991)***.

The remnants of the yolk sac are found resting on top of the chorion; ordinary near the insertion of the umbilical cord but, small fluid containing cysts are formed by duplication of the chorion on the placental surface ***(Fox, 1986)***.

Embryology of the chorion:

The chorion is the outer of the two fetal membranes and it is in direct contact with the maternal decidua. It's predominantly derived from the trophoblast, which arises as a single layer of cells surrounding the blastocyst ***(Maymon et al., 2000.)***

Soon after implantation, the trophoblast proliferates rapidly and invades the surrounding decidua. The trophoblast is made up of an internal layer of cubical cells, the cytotrophoblast or layer of Langhans, and an external layer of richly nucleated protoplasm devoid of cell boundaries, the syncytiotrophoblast. It undergoes rapid proliferation and forms numerous processes, the chorionic villi, which invade and destroy the uterine decidua and at the same time absorb from it nutritive materials for the growth of the embryo ***(Germain et al., 1992)***.

At 13th post conception day, primary villous stems are formed of a lining of syncytiotrophoblast and a core of cytrphoblast and mesoderm ***(Tim Chard, 2002)***.

The greater part of the chorion is in contact with the decidua capsularis, and over this portion the villi, with their contained vessels, undergo atrophy, so that by the fourth month scarcely a trace of them is left, and hence this part of the chorion becomes smooth. As it takes no share in the formation of the placenta, it is named the non-placental part of the chorion. On the hand, the villi on the part of the chorion which is in contact with the decidua placentalis increase greatly in size and complexity, and hence this part is named the chorion frondosum ***(Cunningham et al, 2010).***

Histology of the chorion:

1- The trophoblast.

2- The pseudo-basement membrane.

3- The reticular layer.

4- The cellular layer.

1- The trophoblast:

Adherent to the uterine decidua. In the extra placental chorion, it's 210 cells deep then it becomes thinned out in late pregnancy ***(Parry and Strauss, 1998)***.

2- The pseudo-basement membrane:

A narrow band of reticulin that lies between the trophoblast and the reticular layer ***(Parry and Strauss, 1998)***.

3- The reticular layer.

Forms the main part of the chorionic membrane and comprises a reticulin network containing fibroblasts and Hofbaurer cells. In the early

embryos, the reticular layer contains blood vessels and is continuous with connective tissue surrounding the vessels and umbilical cord. It also forms the core of placental villi, but in the extra placental chorion only a vascular ghost villi can be detected after the early weeks of pregnancy ***(Parry and Strauss, 1998).***

4- The cellular layer.

The deepest layer of the chorion and is adjacent to the amnion and loosely adherent to it. It consists of an interlacing fibroblastic network which may be absent in late pregnancy ***(Sagol et al., 2001)***.

Physical Properties of the Fetal Membranes:

Chorioamnion, the membrane surrounding the fetus during gestation, is a structural soft tissue critical for maintaining a successful pregnancy and delivery, however, the mechanical behavior of this tissue membrane is poorly understood. The structural component of chorioamnion is the amnion sublayer, which provides the membrane's mechanical integrity via a dense collagen network ***(Michelle et al., 2005)***.

The extra cellular membrane of the chorioamnion is largely made up of collagen, primarily types I and III in the compact layer of the amnion and throughout the chorion. Collagen type IV is found in the amnion basement membrane, and lesser amounts of collagen types, V, VI and VII are present in the ECM. The chorion is more cellular and less organized than the amnion but containing similar collagen types ***(Calvin and Oyen, 2007)***.

Solute transport across the amnion depends on solute size and appears to be limited only by the amnion's passive diffusional properties. In vivo intramembranous transport similarly depends on solute size but is not exclusively a passive diffusional process because it is primarily unidirectional outward from the amniotic fluid. Although it is a major barrier, the amnion is not the only barrier and doesn't appear to be responsible for the unidirectional

nature of intramembranous absorption. Thus, unidirectional appears to be imparted by nonpassive mechanisms in non-amnion tissues, which most likely include vesicular transport within the endothelial cells of the intramembranous micro vessels ***(Adams et al, 2005)***.

Because membrane rupture begins at a small discrete location and then propagates, it is difficult to identify the initial site of failure. Light microscopy analysis of term membranes that ruptured in labor demonstrated a restricted zone of extreme altered morphology that was characterized by swelling and disruption of the connective tissue as well as thinning of the trophoblast and decidual layers. This restricted zone of altered morphology is hypothesized to be the site of weakness where rupture occurs either at term or prematurely. Findings at the site of rupture showed reduced thickness, dilatation of intercellular canals, degenerative thinning of the trophoblastic layer, and decreased numbers and disorganization of the collagen fibers in the fibroblasts and spongy layer ***(Calvin and Oyen, 2007)***.

References

1-(Koob et al., 2014).

2- **Cunningham FG, Kenneth JL, Steven LB, John C, Hauth, Larry C, Gistrap III, and Katharine D W (2010):** Williams Obstetrics; 22 edition; 39-1326, 50-880, Disease and Injuries of the Fetus and Newborn: 649-692, Implantation, Embryogenesis, and Placental Development; 39-90, Infection; 1275-1300, Obstetrical hemorrhage 809-853, Parturition; 151-185, Preterm Birth; 855-880, Sexually Transmitted Diseases: 1301-1320

3- **McParland PC and Bell SC. (2004):** The fetal membranes and mechanisms underlying their labor associated and pregnancy. Fetal Mater Med Rev; 15: 73.

4- **Sagol S, Sagol O, Ozkal S and Asena U (2001):** Increased apoptosis in premature rupture of the fetal membranes.

5- **Sobande AA and Albar HM (2003)**: Induced labor with prostaglandin E_2 in different parity groups after premature rupture of membranes. Eastern Mediterranean Health Journal; 9 (3): 309-15.

6- **Ayad IA (2002):** Vaginal misoprostol in managing premature rupture of membranes. Eastern Mediterranean Health Journal; 8 (4-5): 515-20.

8-***(Novak, 1991)***.

9- **Fox H (1986):** Development and structure of the placenta and fetal membranes. In: Scientific foundation of obstetrics and gynecology, 3rd edition. New York, William Heikemess.

10- **Maymon E, Romero R, Pacora P, Gomes R, Athay N, Edwin S (2000):** Human neutrophil collagenase (Matrix Metalloproteinase-8) in parturition, premature rupture of the membranes, and intrauterine infection. Am J Obstet & J Gynecol; 183: 94-9.

***11*- Germain AM, Attaroglu H, Mc Donald PC and Casey ML (1992):** Parathyroid hormone- related protein mRNA in avascular human amnion. J Clin Endocrinal Metab 1992; 75: 1173.

12-(Tim Chard, 2002).

13- **Parry S and Strauss JF (1998):** Premature rupture of the fetal membranes. New Engl J Obstet Gynecol; 338: 663-70

14- **Michelle L, Oyen and Robert F (2005):** Outstanding Meeting Paper: Uniaxial and biaxial mechanical behavior of human amnion volume: 20 pages: 2902 Dol: 10. 15571 JMR. 0382.

15- **Calvin SE and Oyen ML (2007):** Microstructure and mechanics of the chorioamnion membrane with an emphasis on fracture properties. AnnNy Acad Sci; 1101: 166-185.

16- **Adams E. AChoi H M, Cheung C Y, Brace R A (2005)**: Comparisons of amniotic and intramembranous unidirectional permeabililies in the late gestation sheep. AmJ Obstet Gynecol-Jul; 193 (l): 247-55.