Eextraembryonic organs

Amnion, yolk sac and chorion belong to the fetal accessory extraembryonic organs and provide for the embryo nutritive, protective, excretory, endocrine and immune functions. Later will appear allantois, umbilical cord and placenta - the extraembryonic organs too.

Amnion

The amnion is cavity filled with an amniotic fluid which creates the environment for embryo. The amnion is developed from the amniotic sac, which appears in period of early gastrulation from the epiblast. The outer extraembryonic mesoderm of amniotic sac gives rise to the loose connective tissue of amnion. The inner layer of amniotic sac - extraembryonic ectoderm gives rise to the amniotic epithelium.

The main function of the amnion's epithelial cells is secretion of amniotic fluid and it is absorbtion by microvilli of epithelial cells. Therefore embryo floats freely in the amniotic fluid, which cushion the embryo against some trauma and helps to control embryonic body temperature.

The amnion grows till 37 week of embryo development, when it contains almost 1 liter of liquid.

Yolk sac

The yolk sac is also cavity with two layers in wall. It is appears in period of early gastrulation as primitive sac from the hypoblast. The outer layer of yolk sac is loose connective tissue forming from the extraembryonic mesoderm and inner one is yolk sac epithelium forming from the extraembryonic entoderm.

The yolk sac is nonfunctional as yolk storage in human. There are 2 main functions of the yolk sac:

1) Blood development occurs in its walls beginning in week 3 and continues to form there until the hematopoietic activity begins in the liver at about week 5;

2) Primordial germ cells appear in the yolk sac wall in week 3 and after migrate to the developing gonads where they become germ cells (oogonia and spermatogonia).

After formation of the primitive gut on forth week from the embryonic entoderm

the connection between it and yolk sac is called a yolk stalk or vitelline duct.

Unlike amnion, the yolk sac begins to constrict after week 5 of the embryo development.

Allantois

The allantois appears on day 16, as a small, fingerlike outpouching called diverticulum from the caudal wall of the yolk sac. It remains small in human embryo, is involved with early blood formation and is related to the development of the urinary bladder.

On week 4 the allontois with umbilical vessels progress in the connecting stalk.

The remnants of yolk sac and allontois are embedded onto connecting stalk.

Connecting stalk is extraembryonic mesoderm connecting the embryo with the trophoblast. After development of blood vessels, the connecting stalk becomes the umbilical cord. At this the extraembryonic mesoderm of the connecting stalk gives rise to the special mucous tissue of the umbilical cord called Wharton's jelly.

In early pregnancy, the umbilical cord contains the remnants of yolk sac and allantois, two muscular umbilical arteries and one muscular umbilical vein.

As the amniotic cavity enlarges, the amniotic epithelium forms an outer covering for the umbilical cord.

Chorion

In early gastrylation, when the cells of the extraembryonic mesoderm migrate to the throphoblast to produce a chorion. The main function of the chorion is the protection and the nutrition of the forming embryo and subsequent placenta formation.

Implantation

At the fourth or fifth day after ovulation the embryo looking like blastocyst reaches the uterus. The blastocyst remains in the lumen of the uterus for 2 or 3 days and after comes into contact with the surface of the endometrium, due to the secretion of the endometrial glands. It is beginning of the process known as implantation.

This process starts about on 6 to 7 day of gestation and and the embryo is totally submerged into the endometrium to the 9 day after ovulation

During implantation, the trophoblast differentiates into 2 layers. They are

syncytiotrophoblast and the cytotrophoblast. A multinucleated syncytial external layer or syncytiotrophoblast, arises by the fusion of mononucleated internal cytotrophoblasts cells. The cytotrophoblast consists of an irregular layer of mononucleated ovoid cells called Langhans cells lying immediately under the syncytiotrophoblast.

The surface of the syncytiotrophoblast has irregular microvilli, containing vesicles delimited by membrane. They are pinocytic vesicles which related to the transfer of material from the maternal circulation to the fetus. More deeply, the cytoplasm of the syncytiotrophoblast shows an abundance of both rough and smooth endoplasmic reticulum, a well developed Golgi complex, and numerous mitochondria. The syncyliotrophoblast contains lipid droplets also. These organelles provide the secretion of placental hormones by syncytiotrophoblast.

The syncytiotrophoblasts delineate extracytoplasmic cavities. These cavities increase in size and communicate with one another, forming a spongy structure. These cavities called lacunae are lined with syncytiotrophoblast. The lytic enzymes activity of the syncyliotrophoblast causes the rupture of both arterial and venous maternal blood vessels, with overflow of blood into these lacunar spaces.

Implantation takes place when the endometrium is in the secretory phase, when the uterine glands contain glycoproteins and glycogen and the vessels are dilated.

After implantation of the embryo, the endometrium changes and transform into tissue called decidua. At this the cells of the endometrium stroma become enlarged and polygonal and are called decidual cells. Decidual cells are more numerous during the first half of pregnancy. These cells secrete prolactin, which is similar but not identical to pituitary prolactin.

The decidua can be divided into decidua basalis, decidua capsularis, decidua parietalis. Decidua basalis situates between the embryo and the myometrium. The decidua basalis underlies the implantation site. Decidua capsularis situates, between the embryo and the lumen of the uterus. Decidua parietalis includes the remaining endometrium of the uterus and cervix. By the end of the 3 rd mounth of pregnancy the decidua capsularis fuses with the decidua parietalis and the lumen of the uterus is obliterates.

In early gastrulation the cells of the cytotrophoblast begin to extend into a syncytiotrophoblast. Together this short branching outhgrowthes of the cytotrophoblast and the branching syncytiotrophoblast form the primary chorionic villi. When the extraembryonic mesenchyme penetrates the primary chorionic villi converting them to secondary chorionic villi. In further the secondary chorionic villi provide the development of the placental fetal membrane.

The extraembryonic mesenchyme of secondary chorionic villi forms a central core of loose connective tissue with the embryonic blood vessels gradually growing here. After the villi become tertiary. Blood begins to circulate through the primitive cardiovascular system and the vessels of villi at about 21 days.

Through the first 8 weeks, villi cover the entire chorionic surface, but as the growth continues, villi on the decidua capsularis begin to degenerate, forming a smooth, avascular surface called the smooth chorion. The villi toward the decidua basalis rapidly increase in size and number and become highly branched. This region of the chorion, which is the fetal component of the placenta, is called the chorion frondosum or villous chorion.

Two types of cells are recognized in the stroma of the villi. They are fibroblasts and the Hofbauer cells. The role of the Hofbauer cells, which are more common in early placenta, is not known, but morphologically they have characteristics of macrophages.

Placenta

The placenta is a temporary organ found only in the mammals and is the site where physiologic exchanges between the mother and the fetus occur. It consists of a fetal part producing from chorion and a maternal part producing from decidua basalis.

Fetal Part

The fetal part of the placenta consists of a chorionic plate and tertiary chorionic villi. The tertiary chorionic villi consist of a loose connective tissue core derived from the extraembryonic mesenchyme and surrounding by the outer syncytiotrophoblast and the inner cytotrophoblast. The syncytiotrophoblast remains until the end of pregnancy,

but the cytotrophoblast disappears gradually during the second half of pregnancy. The cytotrophoblast undergoes extensive proliferation and cellar fusion during early placentation. However, in the second half of pregnancy, proliferation slows but the cellular fusion continues, which results in a loss of the cytotrophoblast cells and since they become incorporated into the growing syncytium.

The chorionic villi may be free or anchored to the decidua basalis. Both have the same structure, but the free ones do not reach the decidua, whereas the anchored chorionic villi become embedded within the decidua basalis. The surface of the villi is bathed with blood from the lacunae of the decidua basalis and is the site where the exchange of substances between fetal and maternal blood occurs.

The one strongly branching tertiary chorionic villus is called cotyledon. The fetal part of the plasenta is divided into 10 to 38 cotyledons at the $4^{th} – 5^{th}$ mounth of the pregnancy.

Maternal Part

For implantation, chorionic villi destroy the components of decidua basalis except it's the deepest part laying near the myometrium. This a compact part of myometrium known as the basal plate and it the maternal component of the placenta.

The placental septa penetrate from the basal plate to delimit the cotyledons from each other. At implantation, when the secondary chorionic villi penetrate into the decidua basalis, the blood vessels of the decidua basalis are destroy by enzymes of the throphoblast. As a result of myometrium blood vessels distraction for implantation the maternal cavities called are formed. The lacunae are filled by the maternal blood.

The human placenta belongs to the hemochorial type because the fetal part or chorionic villi there is in directly contact with the maternal blood.

Placental barrier

In normal condition, the fetal blood and the maternal blood do not mix because between them there is a placental barrier. Placental barrier includes:

1) The endothelium of the capillaries
2) The basal lamina of this capillaries

3) The mesenchime of the villas

4) The basal lamina of the throphoblast

5) The cytothrophoblast and syncytothrophoblast during the first half of pregnancy and only syncytothrophoblast in the second half of pregnancy

The umbilical cord usually arises at the center of the placenta and forms a connection between the fetal and placental circulations.

The final shape of the placenta is determined by the arrangement of the villi that persist in the decidua basalis. The placenta is usually circular in shape and covers about 25 to 30 percent of the luminal surface of the uterus.

Functions of placenta

The functions of placenta:

1) Nutrition of the embryo;

2) Exchange of gases and metabolic products between the fetal and the maternal blood;

3) Protection of the embryo from immunologic attack by the maternal organism;

4) Placenta is the endocrine organ, producing hormones such as chorionic gonadotropin, human plasental lactogen, chorionic thyrotropin, chorionic corticotrophin, estrogens and progesterone.