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EMBRYOLOGY

200LEVEL MBBS

Question: Discuss the second week of development.

During the second week of development, with the embryo implanted in the uterus, cells within the blastocyst start to organize into layers. Some grow to form the extra embryonic membranes needed to support and protect the growing embryo: the amnion, the yolk sac, the allantois, and the chorion.

The following events take place during the 2nd week of development:

- I. Completion of implantation of the blastocyst
- II. Formation of bilaminar embryonic disc(epiblast and hypoblast)
- III. Formation of extraembryonic structures(amniotic cavity, amnion, umbilical vesicle [yolk sac], connecting stalk, and chorionic sac)

DAY 8

At the eighth day of development, the blastocyst is partially (slowly) embedded in the endometrium. The syncytiotrophoblast continues its invasion of the endometrium, thereby eroding endometrial blood vessels and endometrial glands. More cells in the cytotrophoblast divide and migrate into the syncytiotrophoblast, where they fuse and lose their individual cell membranes. Cells of the inner cell mass or embryoblast also differentiate into 2 layers:

- I. the hypoblast layer, which is made up of small cuboidal cells, and it is adjacent(nearer) to the blastocyst cavity
- II. the epiblast layer which is made up of high columnar cells, and it adjacent to the amniotic cavity

The hypoblast and epiblast layers together form a flat ovoid shaped disc called the bilaminar embryonic disc. At the same time, a small cavity appears within the epiblast which enlarges to form the amniotic cavity. Epiblast cells adjacent to the cytotrophoblast are called amnioblasts. *Amnioblasts* together with the rest of the epiblast, line the amniotic cavity. The endometrium adjacent to the implantation site is edematous and highly vascular

DAY 9

The blastocyst is more deeply embedded in the endometrium, and the penetration defect in the surface epithelium is closed by a coagulum called fibrin. Vacuoles appear at the region of the trophoblast and they fuse to form larger lacunae. This phase of trophoblast development is known as the *lacunar stage*. The cells of the hypoblast adjacent to the cytotrophoblast form a thin membrane called the exocoelomic (Heuser's) membrane. This membrane lines the inner surface of the cytotrophoblast. The exocoelomic (Heuser's) membrane together with the hypoblast forms the lining of the exocoelomic cavity, or primitive yolk sac or primary umbilical vesicle.

DAY 10

The cells develop into an inner layer of membranes (amnion), which form the amniotic sac. When the sac is formed (by about day 10 to 12), the blastocyst is considered an embryo. The amniotic sac fills with a clear liquid (amniotic fluid) and expands to envelop the developing embryo, which floats within it.

DAY 11 and 12

The blastocyst is completely embedded in the endometrium, and the surface epithelium almost entirely covers the original defect in the uterine wall. The blastocyst now produces a slight protrusion into the lumen of the uterus. Cells of the syncytiotrophoblast penetrate deeper into the stroma (tissue) and erode the endothelial lining of the endometrial capillaries. These ruptured endometrial capillaries are called sinusoids. The lacunae then begin to communicate with the sinusoids, and maternal blood enters the lacunar system. The communication of the eroded endometrial capillaries with the lacunae establishes the primordial uteroplacental circulation. When maternal blood flows into the lacunae, oxygen and nutritive substances are available to the embryoblast and the outer surface of the exocoelomic cavity. These cells which are derived from yolk sac cells form a fine, loose connective tissue called the extraembryonic mesoderm. Soon, large cavities develop in the extraembryonic mesoderm, and when these become confluent, they form a new space known as the extraembryonic cavity, or chorionic cavity or extraembryonic coelom. This space surrounds the primitive yolk sac and amniotic cavity, except where the germ disc is connected to the trophoblast by the connecting stalk (which develops into the umbilical cord). The extraembryonic mesoderm a new population of cells appears between the inner surface of the cytotrophoblast lining the cytotrophoblast and amnion is called the extraembryonic somatic mesoderm. Extraembryonic somatic mesoderm also forms the connecting stalk the lining covering the yolk sac is known as the *extraembryonic splanchnic mesoderm*. As the conceptus implants, the endometrial connective tissue cells undergo a transformation, called decidual reaction. During this transformation, the cells of the endometrium swell because of the accumulation of glycogen and lipid in their cytoplasm, and they are known as decidual cell. The primary function of the

decidual reaction is to provide nutrition for the early embryo and an immunologically privileged site for the conceptus.

Conclusion

When the human embryo is around six days old, it starts making a nest in the wall of the mother's uterus. Cells in the outer layer of the blastocyst stick to the uterine wall and grow long projections into it — the first step in developing a placenta with blood vessels linking mother and embryo. From now on, the embryo will depend on oxygen and nutrients from the mother's bloodstream to survive. As the placenta grows and embeds itself within the uterine wall, the inner cell mass divides to form the amniotic cavity and a flat disc with two layers of cells that is the embryo. Once the embryo is embedded in the wall of the uterus, it starts preparing for a transformation called gastrulation that takes place during the third week of development. During this process, every cell in the flat disc will migrate to a new location and morph into one of three new cell types to form the inner, middle and outer layers of the 21-day-old embryo. This intricate cellular choreography is regulated by growth factors turned on and off at specific times and locations in response to signals from the embryo's genes. "The embryo uses the same seven growth factor signaling pathways over and over," O'Shea says. "But by varying signal strength, turning cell receptors on or off, or turning growth factors on or off at specific locations in the embryo, the process allows for a great deal of precision and complexity."

- **Trophoblast**

As the blastocyst embeds itself in the endometrium it differentiates into two layers: the cytotrophoblast (inner) and syncytiotrophoblast (outer). The syncytiotrophoblast invades into the maternal endometrium, and in this sense it is more invasive than any tumor tissue. As it comes into contact with blood vessels it creates lacunae, or spaces which fill with maternal blood. These lacunae fuse to form lacunar networks. The maternal blood that flows in and out of these networks exchanges nutrients and waste products with the fetus, forming the basis of a primitive uteroplacental circulation.

- **Syncytiotrophoblast**

The syncytiotrophoblast is acellular and does not expand mitotically. The syncytiotrophoblast produces human chorionic gonadotrophin (hCG), a glycoprotein hormone that stimulates the production of progesterone by the corpus luteum.

- **Cytotrophoblast**

The cytotrophoblast is cellular and expands mitotically into the syncytiotrophoblast to form primary chorionic villi. Cells from these villi can be removed for early genetic testing at some risk to the fetus (chorionic villus sampling).

- **Embryoblast**

After implantation, the inner cell mass subdivides into a bilaminar disc consisting of the hypoblast and epiblast.

- **Hypoblast**

Hypoblast cells migrate along the inner surface of the cytotrophoblast and will form the primary yolk sac. The primary yolk sac becomes reduced in size and is known as the secondary yolk sac. In humans the yolk sac contains no yolk but is important for the transfer of nutrients between the fetus and mother.

- **Epiblast**

Epiblast cells cavitate to form the amnion, an extra-embryonic epithelial membrane covering the embryo and amniotic cavity. Cells from the epiblast will also eventually form the body of the embryo.

- **Extra-embryonic mesoderm**

Extra-embryonic mesoderm cells migrate between the cytotrophoblast and yolk sac and amnion. Extraembryonic somatic mesoderm lines the cytotrophoblast and covers the amnion is. Extraembryonic somatic mesoderm also forms the connecting stalk that is the primordium of the umbilical cord. Extraembryonic visceral mesoderm covers the yolk sac.

At the end of the second week it is possible to distinguish the dorsal (amniotic cavity) from the ventral (yolk sac) side of the embryo.

The second week of human development is concerned with the process of implantation and the differentiation of the blastocyst into early embryonic and placental forming structures.

- implantation commences about day 6 to 7
- **Adplantation** - begins with initial adhesion to the uterine epithelium blastocyst then slows in motility, "rolls" on surface, aligns with the inner cell mass closest to the epithelium and stops
- **Implantation** - migration of the blastocyst into the uterine epithelium, process complete by about day 9
- interaction between trophoblast cells and endometrial epithelium (apoptosis and decidualization)
- coagulation plug - left where the blastocyst has entered the uterine wall day 12

Normal Implantation Sites - in uterine wall superior, posterior, lateral

Endometrial Receptivity

In humans, receptivity occurs 6 days after the post-ovulatory progesterone surge and lasts about 2 to 4 days. Similar "receptivity window" in other species (rat day 5 and mouse day 4.5). Many studies have looked into identifying markers for this receptivity period both to optimise and to block this process. The hatched blastocyst moves along the endometrium towards a favourable point of implantation. The endometrium is converted into an immunologically privileged site with optimum blood supply. Weak attachments are strengthened. Differentiation of the trophoblast and endometrial stroma facilitate invasion of the endometrium.

- Several cavities and membranes are formed.
- β -hCG production is stimulated.
- Complete implantation with endometrial scarring is achieved by day 10.
- Complete regeneration around the scar results around day 12.
- At the end of week 2, the chorionic cavity is formed.

Clinical Correlations

Early pregnancy testing:- hCG produced by the syncytiotrophoblast can be detected in maternal blood or urine as early as day 10 of pregnancy and is the basis for pregnancy tests.

Hydatidiform mole:-A blighted blastocyst leads to death of the embryo, which is followed by hyperplastic proliferation of the trophoblast within the uterine wall.

Choriocarcinoma:- A malignant tumor arising from trophoblastic cells that may occur following a normal pregnancy, abortion, or a hydatidiform mole.