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Embryology assignment

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

• Completion of implantation of the blastocyst

• Formation of bilaminar embryonic disc

• Formation of extraembryonic structures

Implantation is a complex biochemical and mechanical process that begins in the first week of gestation and extends into the second week. There are many influencing factors that affect the process. These can be grouped into maternal and embryonal factors. However, both entities work synchronously in order to effectively achieve implantation. The process of implantation can be subdivided into three phases:

• There is a period of apposition where the blastocyst establishes weak interactions with the uterine wall.

• The attachment phase occurs when definitive binding of the blastocyst to the uterine epithelium is more established, such that the blastocyst cannot be flushed from the uterine cavity.

• Finally invasion occurs when the blastocyst begins to burrow into the endometrium.

This period usually occurs between the 19th and 24th day of the menstrual cycle. This coincides roughly with the 6th to 10th day following ovulation.

Cells of the inner cell mass or embryoblast also differentiate into 2 layers:

• the hypoblast layer, which is made up of small cuboidal cells, and it is adjacent(nearer) to the blastocyst cavity

• 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. 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 lager 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 membrane together with the hypoblast forms the lining of the exocoelomic cavity, or primitive yolk sac or primary umbilical vesicle.

While implantation ensues, the embryoblast also undergoes differentiation to form a bilaminar disc. The flat, circular disc is comprised of a thicker epiblast with high columnar cells and a thinner hypoblast with small cuboidal cells. A small space develops relative to the epiblast; it is the precursor of the amniotic cavity.

Epiblastic cells forming the floor of the cavity subsequently separate to form amnioblasts that will form the amnion (surrounding the amniotic cavity). The sac and cavity will eventually become filled with amniotic fluid later on in the pregnancy. They provide shock absorption and facilitate movement of the foetus during development.

Peripherally, the hypoblast is continuous with another structure known as the exocoelomic (Heuser’s) membrane. It also forms the roof of the enclosed exocoelomic cavity. Combined, the membrane and the hypoblast form the visceral lining of the yolk sac. However, since the human embryo does not possess a yolk, it is more appropriate to refer to it as the primary umbilical vesicle.

Endodermal cells arising from the exocoelomic membrane extends circumferentially to enclose the embryonic disc and both cavities. It is subsequently referred to as the extraembryonic mesoderm. Both cavities facilitate embryonic folding as growth and morphological changes occur. The umbilical vesicle may play a role in nutrient transfer to the embryo. Furthermore, it is an important source of primordial germ cells.

• Early fetomaternal circulation

• While the aforementioned cavities and bilaminar disc develop, the syncytiotrophoblast began to lacunate (I.e. form lacunae). The lacunae are filled with an amalgam of cellular debris and maternal blood, known as the embryotroph. This fluid gains access to the embryonic disc via diffusion and delivers nutrients as well as oxygen to the embryo. The lacunae subsequently become confluent, forming lacunar networks, which serves as the primordial uteroplacental circulation. As the networks continue to fuse, the syncytiotrophoblast has a sieve-like appearance, particularly around the embryonic pole of the conceptus. This will subsequently give rise to the intervillous spaces of the placenta.

The capillaries around the implanted embryo become engorged, dilated and their walls become thin. From here onwards, they are known as sinusoids. The syncytiotrophoblast continues to erode the walls of the sinusoids, resulting in more maternal blood flowing freely into the lacunar networks. Much of the derived nutrients is conveyed to the embryo by the trophoblast. However, the trophoblast grows a lot faster than the embryo in the early phases. As such, it is likely to have a higher nutritional requirement than the embryo.

As time progresses, the extraembryonic mesoderm increases in size. Numerous cavities known as the extraembryonic coelomic spaces begin to appear deep to the cytotrophoblast and superficial to the exocoelomic membrane. These spaces coalesce to form the extraembryonic coelom. This coincides with a decrease in the volume of the primary umbilical vesicle; which is then referred to as the secondary umbilical vesicle. The cells of the secondary umbilical vesicle arise from migratory extraembryonic endodermal cells of the hypoblast. There is a remnant of the primary umbilical vesicle within the extraembryonic coelom that is referred to as an exocoelomic cyst.

Cellular columns, lined with syncytial coverings, extending into the syncytiotrophoblast indicate the ending of the second gestational week. This phenomenon marks the formation of the primary chorionic villi. Splanchnic and somatic derivatives of the extraembryonic mesoderm line the umbilical vesicles, and the trophoblast and amnion, respectively. The somatic extraembryonic mesoderm, along with both trophoblastic layers, gives rise to the chorion. The space enclosed by the chorion is the chorionic sac; it contains the embryo, as well as the amniotic sac and umbilical vesicle. The latter three structures are attached to the chorion by the connecting stalk. The former extraembryonic coelom is now referred to as the chorionic cavity.

By the 10th day following fertilization, the embryo is completely embedded in the endometrium. There is a small defect in the epithelium that is sealed by a fibrin-based blood clot known as the closing plug. By day 12, the area is future site of mouth and organizer of the head region.