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DEPARTMENT:

MEDICINE AND SURGERY (MBBS)

COURSE :

Embryology

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QUESTIONS

Discuss the second week of development

The period of time required for full development of a fetus in utero is referred to as gestation. It can be subdivided into distinct gestational periods. The first 2 weeks of prenatal development are referred to as the pre-embryonic stage. A developing human is referred to as an **embryo during week 3-8** and a **fetus from the ninth week of gestation until birth.**

2nd week of development

The second week of devilment is from (Days 8-14). The second week involves implantation process and blastocyst differentiation.

As implantation of the blastocyst occurs, morphologic changes in the embryoblast produce a Bilaminar embryonic disc composed of epiblast and hypoblast. The embryonic disc gives rise to the germ layers that form all the tissues and organs of the embryo. Extra-embryonic structures forming during the second week are the amniotic cavity, amnion, umbilical vesicle connecting stalk, and chorionic sac.

Completion of implantation of blastocyst-

Implantation of the blastocyst is completed by the end of the second week. It occurs during a restricted time period 6 to 10 days after ovulation. As the blastocyst implants more trophoblast contacts the endometrium and differentiates into

- The cytotrophoblast, a layer of cells that is mitotically active and forms new cells that migrate into the increasing mass of syncytiotrophoblast, where they fuse and lose their cell membranes
- The syncytiotrophoblast, a rapidly expanding, multinucleated mass in which no cell boundaries are discernible

The erosive **syncytiotrophoblast** invades the endometrial connective tissue, and the blastocyst slowly embeds itself in the endometrium. Syncytiotrophoblast cells displace endometrial cells at the implantation site. The endometrial cells undergo **apoptosis** (programmed cell death), which facilitates the invasion. The molecular mechanisms of implantation involve synchronization between the invading blastocyst and a receptive endometrium. The microvilli of endometrial cells (pinopodes), cell adhesion molecules, cytokines, prostaglandins, homeobox genes, growth factors, and matrix metalloproteins play a role in making the endometrium receptive. The connective tissue cells around the implantation site accumulate glycogen and lipids and assume a polyhedral appearance. Some of these cells-**decidual cells-**

degenerate adjacent to the penetrating syncytiotrophoblast. The syncytiotrophoblast engulfs these degenerating cells, providing a rich source of embryonic nutrition.

The syncytiotrophoblast produces a hormone-humanchorionicgonadotrophin (hCG), which enters the maternal blood via lacunae (hollow cavity). hCG maintains the hormonal activity of the corpus luteum in the ovary during pregnancy. Thecorpus luteum is an endocrine glandular structure that secretes estrogen and progesterone to maintain the pregnancy. Highly sensitiveradioimmunoassays are available for detecting hCG and pregnancy and forms the basis for pregnancy tests. Enough hCG is produced by thesyncytiotrophoblast at the end of the second week to give a positive pregnancy test, even though the woman is probably unaware that she is pregnant.

Formation Of The Amniotic Cavity, Embryonic Disc, And Umbilical Vesicle

As implantation of the blastocyst progresses, a small space appears in the embryoblast. This space is the primordium of the amniotic cavity. Soon amniogenic (amnion-forming) cells-amnioblasts-separate from the epiblast and form the amnion, which encloses the amniotic cavity. Concurrently, morphologic changes occur in the embryoblast that result in the formation of a flat, almost circular bilaminar plate of cells, the embryonic disc, consisting of two layers-

- Epiblast, the thicker layer, consisting of high columnar cells related to the amniotic cavity
- Hypoblast, consisting of small cuboidal cells adjacent to the exocoelomic cavity

The epiblast forms the floor of the amniotic cavity and is continuous peripherally with the amnion. The hypoblast forms the roof of the exocoelomic cavity and is continuous with the thin exocoelomic membrane. This membrane, together with the hypoblast, lines the primary umbilical vesicle. The embryonic disc now lies between the amniotic cavity and the umbilical vesicle. Cells from the vesicle endoderm form a layer of connective tissue, the extraembryonic mesoderm, which surrounds the amnion and umbilical vesicle. This mesoderm continues to form from cells that arise from the primitive streak. The umbilical vesicle and amniotic cavities make morphogenetic movements of the cells of the embryonic disc possible.

As the amnion, embryonic disc, and primary umbilical vesicle form, isolated cavities- lacunae-appear in the syncytiotrophoblast. The lacunae soon become

filled with a mixture of maternal blood from ruptured endometrial capillaries and cellular debris from eroded uterine glands. The fluid in the lacunar spaces-embryotroph-passes to the embryonic disc by diffusion and provides nutritive material to the embryo. 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 embryo. Oxygenated blood passes into the lacunae from the spiral endometrial arteries, and poorly oxygenated blood is removed from them through the endometrial veins.

The 10-day human conceptus (embryo and extraembryonic membranes) is completely embedded in the endometrium. For approximately 2 days, there is a defect in the endometrial epithelium that is filled by a **closing plug**, a fibrinous coagulum of blood. By day 12, an almost completely regenerated uterine epithelium covers the closing plug. As the conceptus implants, the endometrial connective tissue cells undergo a transformation, the **decidual reaction**. After the cells swell because of the accumulation of glycogen and lipid in their cytoplasm, they are known as **decidualcells**. The primary function of the decidual reaction is to provide nutrition immunologically privileged site for the conceptus.

In a **12-day embryo**, adjacent syncytiotrophoblastic lacunae have fused to form **lacunar networks**, giving the syncytiotrophoblast a sponge like appearance. The lacunar networks, particularly obvious around the embryonic pole, are the primordia of the intervillous spaces of the placenta. The endometrial capillaries around the implanted embryo become congested and dilated to form sinusoids, thin-walled terminal vessels that are larger than ordinary capillaries. The syncytiotrophoblast erodes the sinusoids, and maternal blood flows freely into the lacunar networks. The trophoblast absorbs nutritive fluid from the lacunar networks, which is transferred to the embryo. Growth of the bilaminar embryonic disc is slow compared with growth of the trophoblast. The implanted 12-day embryo produces a minute elevation on the endometrial surface that protrudes into the uterine lumen.

As changes occur in the trophoblast and endometrium, the extraembryonic mesoderm increases and isolated **extraembryonic coelomic spaces** appear within it. These spaces rapidly fuse to form a large isolated cavity, the **extraembryonic coelom**. This fluid-filled cavity surrounds the amnion and umbilical vesicle, except where they are attached to the **chorion** by the **connecting stalk**. As the extraembryonic coelom forms, the primary umbilical vesicle decreases in size and a smaller **secondary umbilical vesicle** forms. This smaller vesicle is formed by extraembryonic endodermal cells that migrate from the hypoblast inside the primary umbilical vesicle.

During formation of the secondary umbilical vesicle, a large part of the primary umbilical vesicle is pinched off. The umbilical vesicle contains no yolk; however, it has important functions (e.g., it is the site of origin of primordial germ cells. It may have a role in the selective transfer of nutrients to the embryo.

Development of the Chorionic Sac

The end of the second week is characterized by the appearance of **primary chorionic villi**. Proliferation of cytotrophoblast cells produces cellular extensions that grow into the syncytiotrophoblast. The growth of these extensions is thought to be induced by the underlying **extraembryonic somatic mesoderm**. The cellular projections form primary chorionic villi, the first stage in the development of the chorionic villi of the placenta.

The extraembryonic coelom splits the extraembryonic mesoderm into two layers

- **Extraembryonic somatic mesoderm**, lining the trophoblast and covering the amnion
- **Extraembryonic splanchnic mesoderm**, surrounding the umbilical vesicle

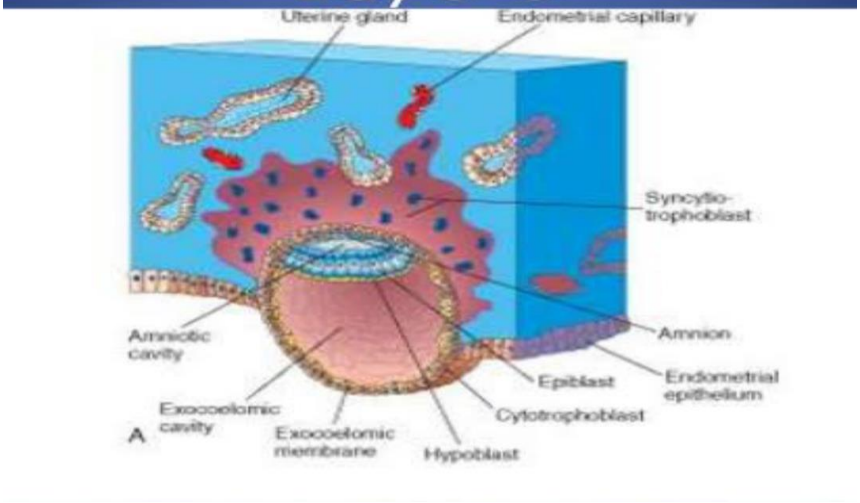
The extraembryonic somatic mesoderm and the two layers of trophoblast form the **chorion**. The chorion forms the wall of the chorionic sac, within which the embryo and its amniotic sac and umbilical vesicle are suspended by the connecting stalk. The extraembryonic coelom is now called the chorionic cavity. The amniotic sac and the umbilical vesicle can be thought of as two balloons pressed together (at the site of embryonic disc) and suspended by a cord (connecting stalk) from the inside of a larger balloon (chorionic sac). Transvaginal ultrasonography (endovaginal sonography) is used for measuring the chorionic (gestational) sac diameter. This measurement is valuable for evaluating early embryonic development and pregnancy outcome.

The **14-day embryo** still has the form of a flat bilaminar embryonic disc, but the hypoblastic cells in a localized area are now columnar and form a thickened circular area-the **prechordal plate** which indicates the future site of the mouth and an important organizer of the head region.

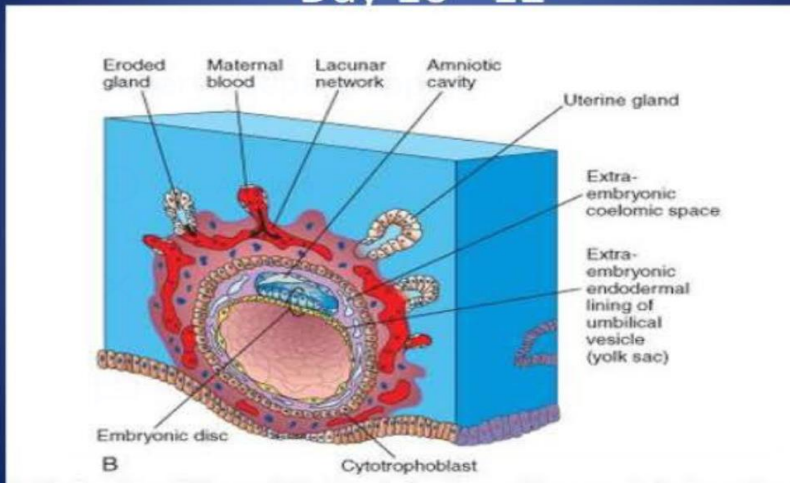
Implantation Sites of Blastocysts

Implantation of blastocysts usually occurs in the endometrium of the uterus, superior in the body of the uterus, slightly more often on the posterior than on the anterior wall. Implantation of a blastocyst can be detected by ultrasonography and highly sensitive radioimmunoassays of hCG as early as the end of the second week.

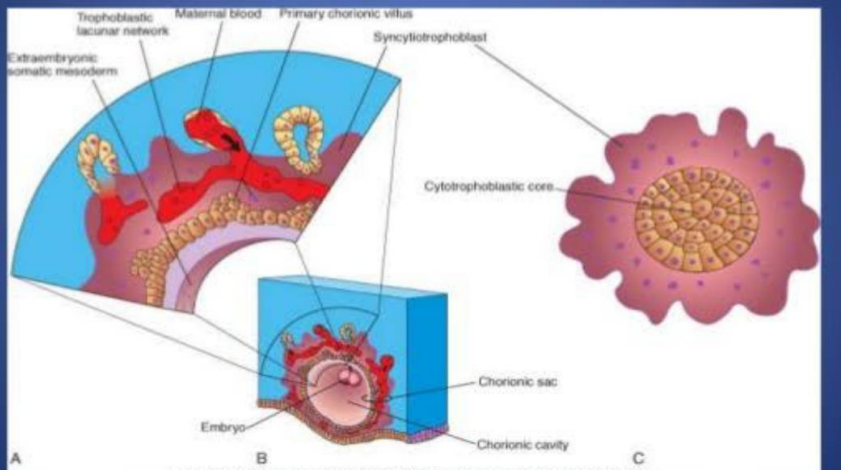
Day 8 -9



Day 10 - 12



Day 14



Highlights of 2nd Week of Development

- **Bilaminar germ disc-** complete implantation on uterine wall

- **Trophoblast-** differentiated in 2 layers

- **2 cavities formed-**
  -amniotic cavity
  -extraembryonic coelomic cavity (chorionic cavity)

- **2layers of extraembryonic mesoderm-** somato and splanchnopleure

- **Beginning of uteroplacental circulation**

References

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