Chapter 02: Embryogenesis

Embryonic development is associated with complex cellular and molecular processes and with very rapid cellular migrations during the first month. It also involves interactions with maternal tissues.

Introduction

Human embryonic development involves complex cellular and molecular processes, as well as cellular migrations. It is also closely associated with maternal tissues, leading to the formation of the placenta. In this course, we will cover the first four weeks of gestation:

- The first week is characterized by segmentation and migration of the embryo in the fallopian tube.
- The second week is marked by the implantation process into the endometrium.
- The third week features gastrulation.
- The fourth week involves neurulation, delimitation, and the beginning of organogenesis.

Embryonic Periods:

- Pre-embryonic period (Weeks 1–3): Formation of the three embryonic layers.
- Embryonic period (Weeks 4–8): Development of the organ primordia.

First month of development

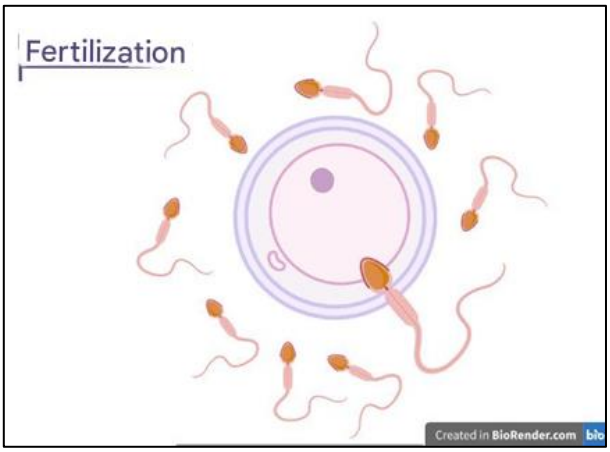
I. First Week of Embryonic Development:

This week corresponds to the pre-morphogenetic period, during which three major events occur:

- Fertilization.
- Segmentation (formation of the morula).
- Tubal migration.

1. Fertilization:

Fertilization marks the beginning of the embryonic period. It is characterized by successive mitotic divisions and the appearance of the first cellular differentiations. The zygote results from the fusion of an oocyte and a spermatozoon. It is the first embryonic cell, surrounded by the zona pellucida, and contains the male and female pronuclei that will form the embryonic genome.

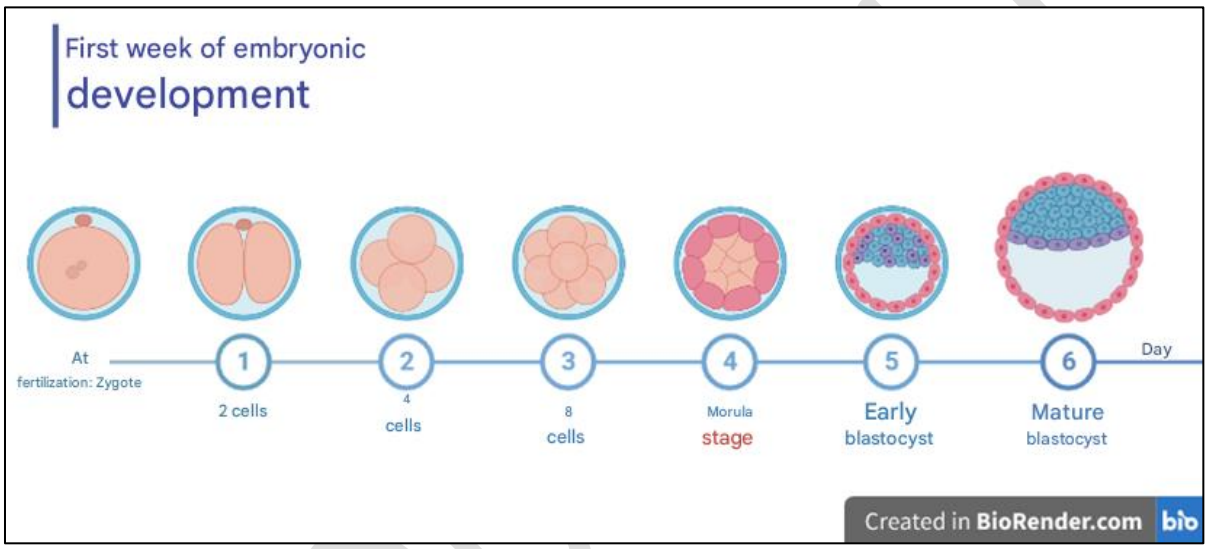


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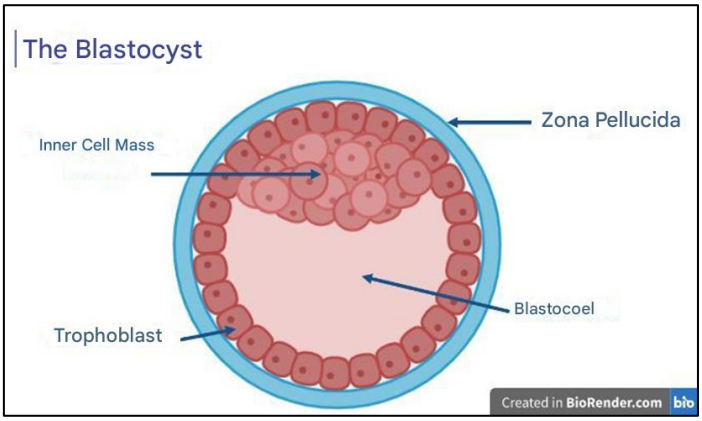
2. Segmentation:

During the early segmentation divisions, embryonic cells are totipotent. Segmentation corresponds to the development of the embryo from the zygote and its migration through the uterine tube. It progresses as follows:

- Day 1: The first cell division produces two blastomeres.
- Day 2: The embryo has four symmetric cells of similar size.
- Day 3: The embryo has eight blastomeres.
- Day 4: The embryo is a solid cell mass called a morula (resembling a mulberry).
- Day 5: Fluid begins to accumulate in the morula, forming a cavity called the blastocoel. The embryo is now at the blastocyst stage, still surrounded by the zona pellucida.



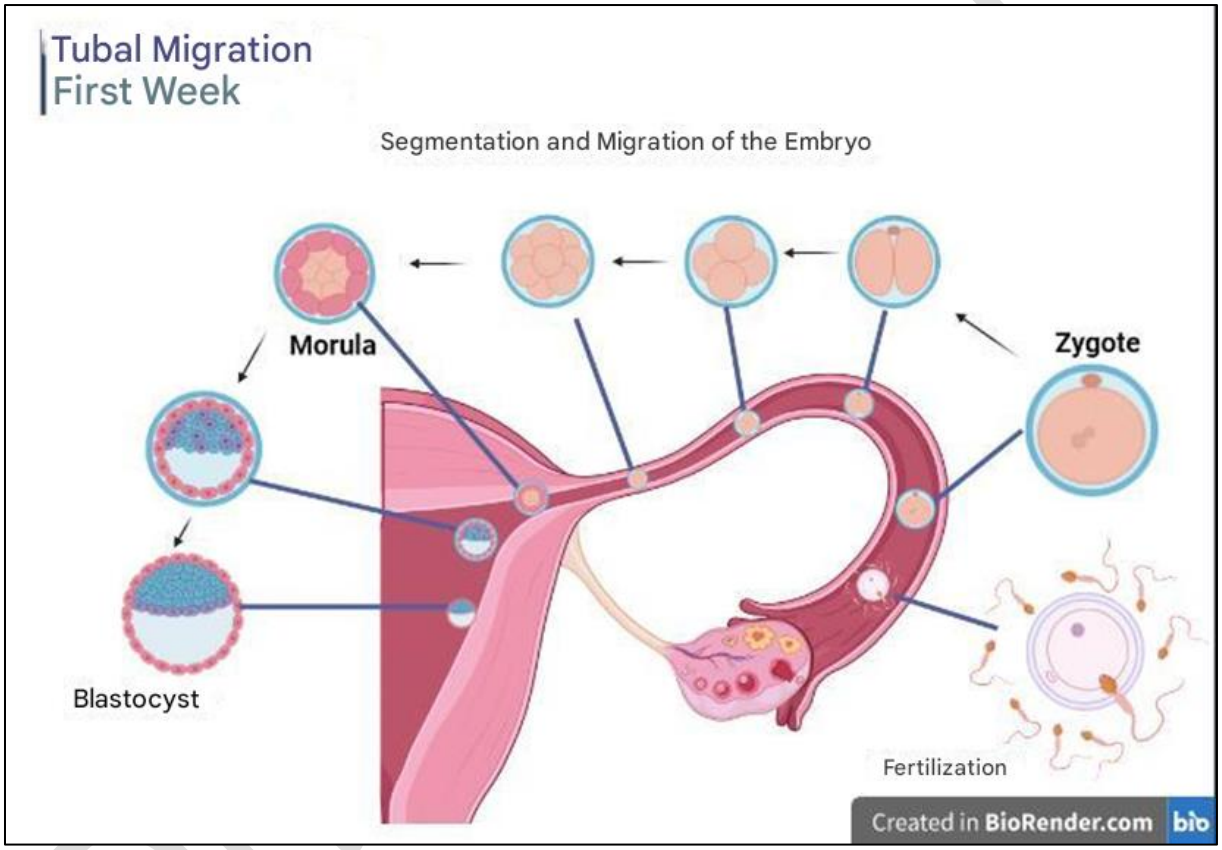
- **Blastocyst Concept:**
  By day 6, the embryo has a defined shape and begins cell differentiation. The blastocyst has two cell types:
  - Peripheral cells form the trophoblast (or trophectoderm), which will become the placenta.
  - The inner cell mass will become the fetus.
  - The internal fluid-filled cavity is called the blastocoel.



3. Tubal Migration:

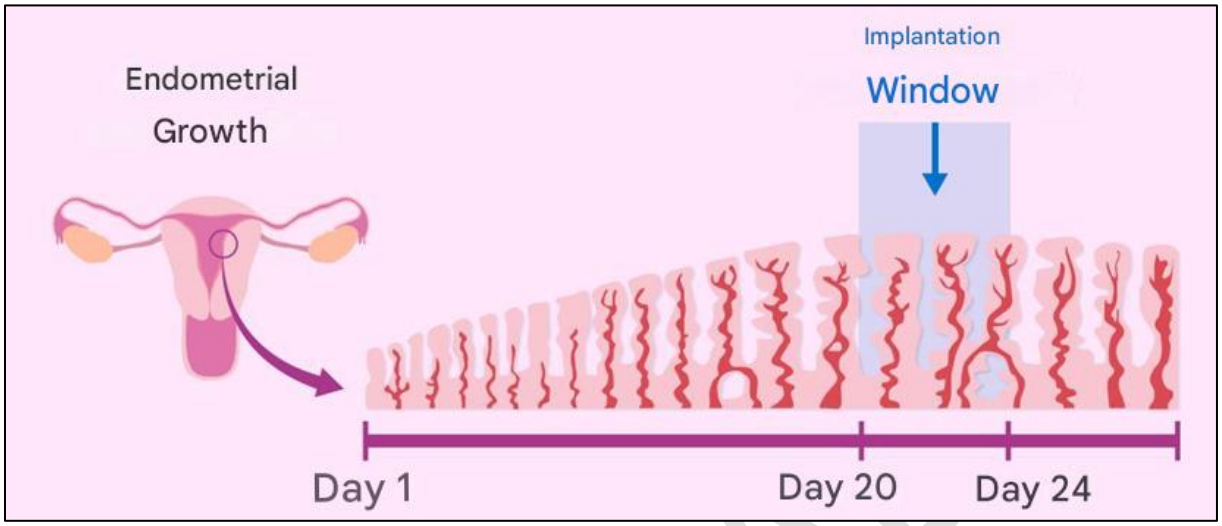
These early stages occur in the fallopian tube as the embryo moves toward the uterus. Migration is progressive due to smooth muscle contractions in the tube wall, secretions from mucosal cells, and ciliary movement. Migration progresses as follows:

- Fertilization and 2-cell stage: outer third of the tube.
- 4- to 8-cell stages (Day 3): isthmus of the tube.
- Morula stage (Day 4): interstitial segment.
- Days 5–6: The blastocyst is free in the uterine cavity.
- Day 7: It attaches to the endometrium via its embryonic pole.

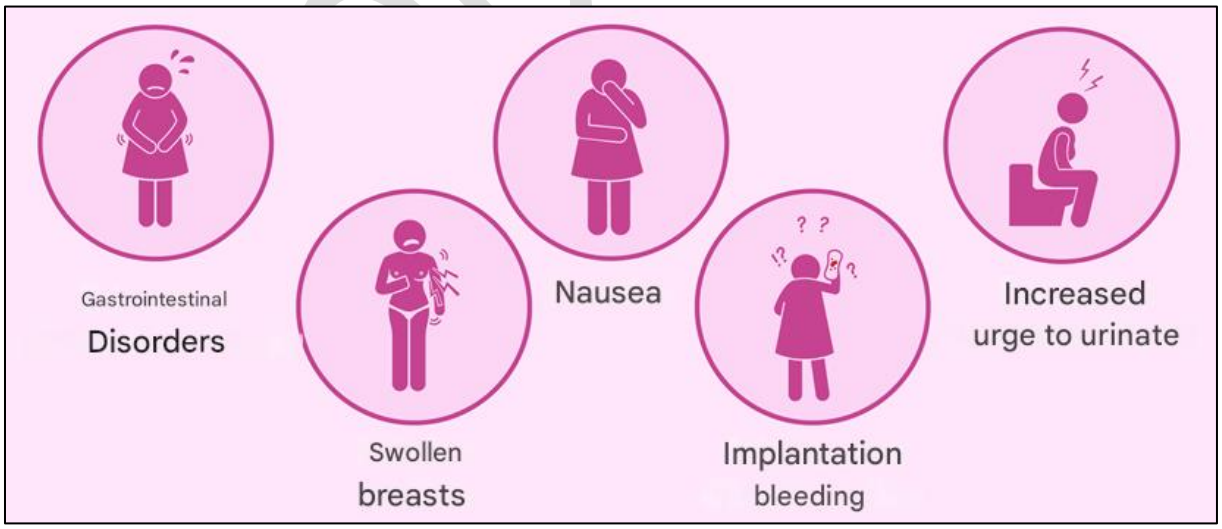


II. Second Week of Embryonic Development:

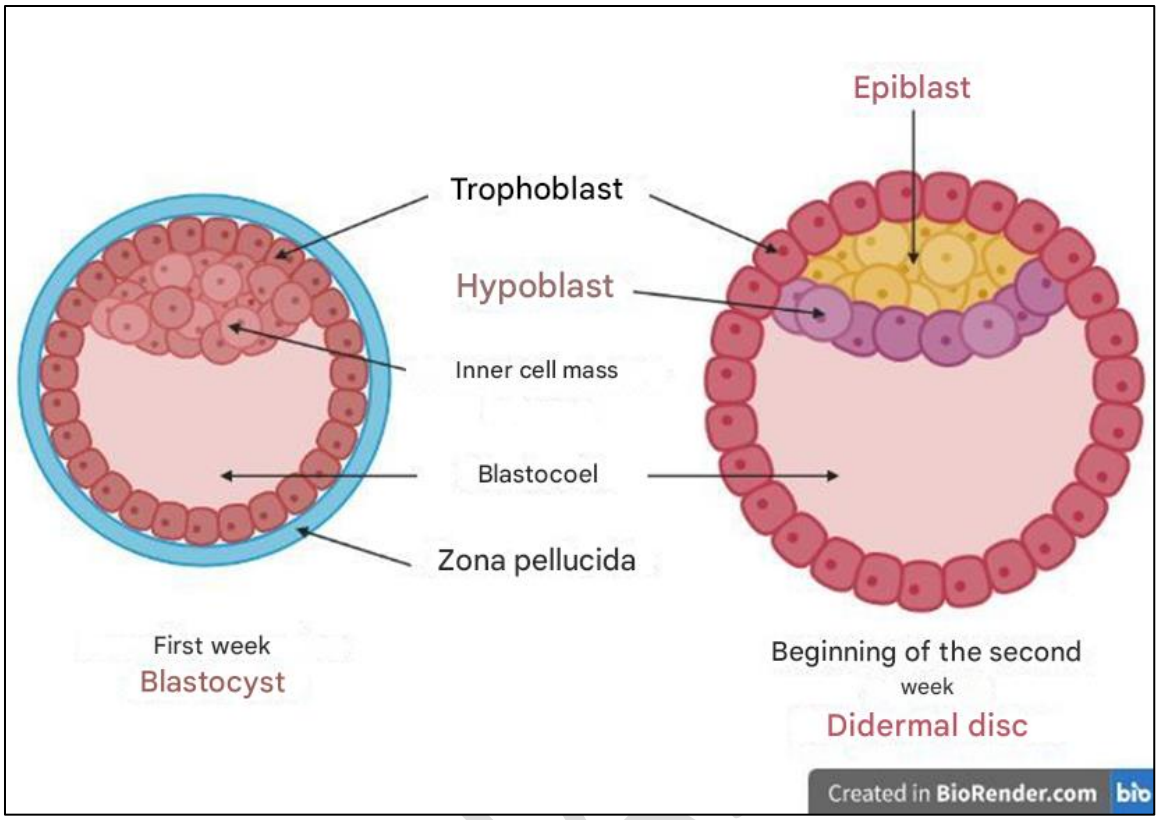
During the second week, the embryo begins implantation into the uterine cavity. This step is called "nidation."



- **Changes during the second week:**
  - Embryo attaches to the uterine wall (implantation/nidation).
  - Zygote changes: formation of the bilaminar disc from the embryonic button.
  - Maternal body modifications.
  - Start of placenta formation from the trophoblast.
  - Gonadotropin secretion.

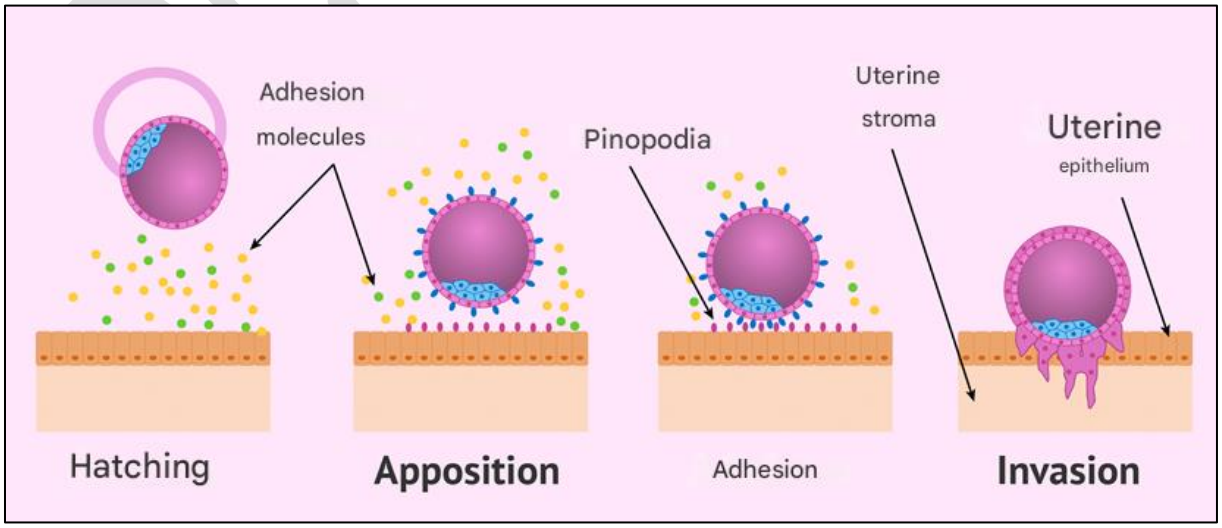


1. Formation of the Bilaminar Embryonic Disc

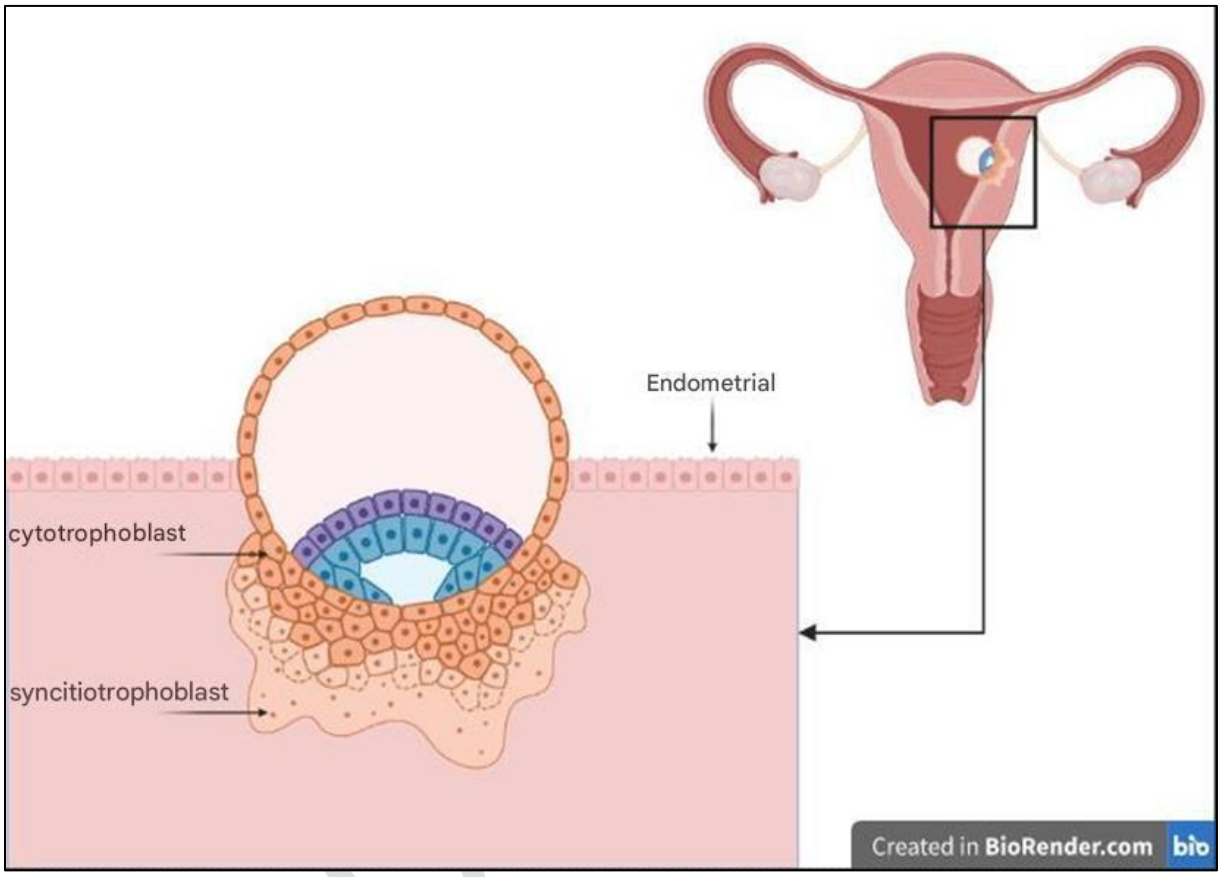


2. Nidation (Days 7–8):

At the end of the first week, the blastocyst, previously free in the uterine cavity, attaches to the uterine epithelium and penetrates the endometrium, initiating nidation. This marks the beginning of pregnancy and the formation of the bilaminar disc from the embryonic button. Implantation isolates the embryo from the external environment and initiates a synergy between mother and fetus, forming the future feto-placental unit.



- **Conditions for nidation:**
  The blastocyst must actively and completely penetrate the endometrium. The environment must be rich in progesterone (to ensure proper endometrial thickness) and glycogen. Nidation occurs during the edema phase of the chorion (Days 20–22 of the menstrual cycle), which is optimal for egg implantation.

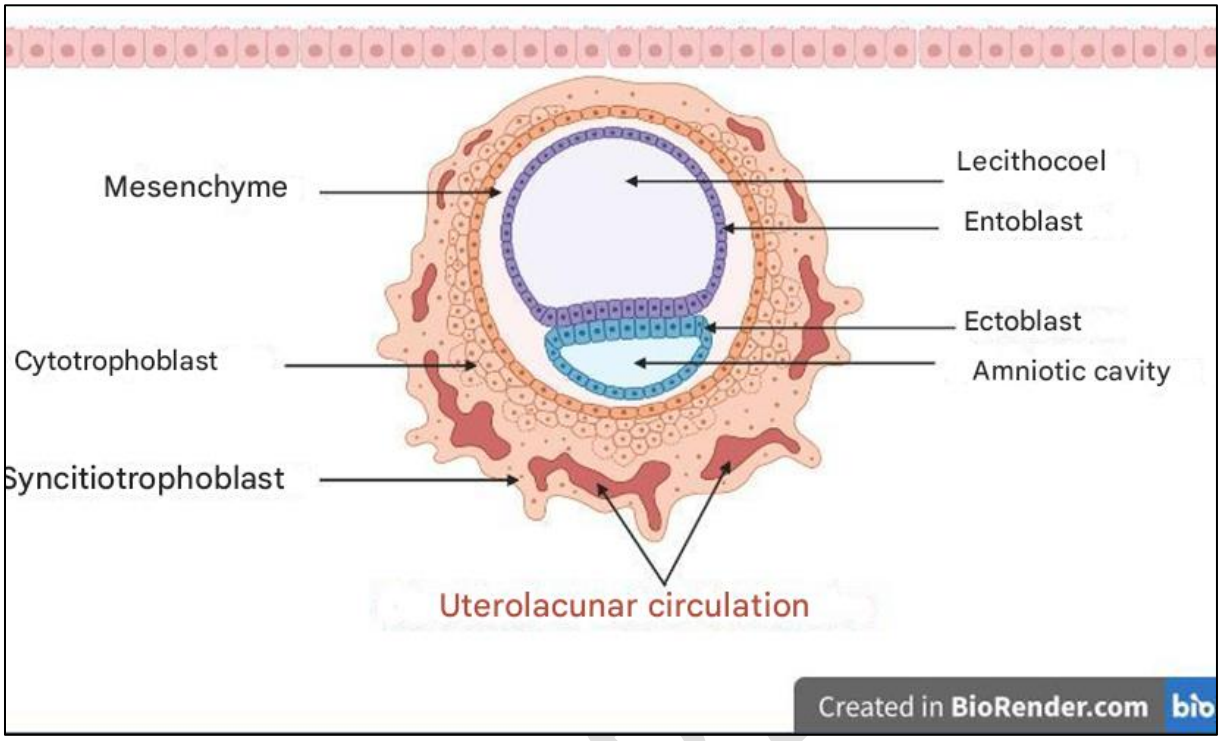


Consequences of nidation on the maternal body:

If nidation occurs, the endometrial cycle halts and the endometrium remains in its edematous state due to progesterone secretion from the corpus luteum and later the placenta. The blastocyst secretes human chorionic gonadotropin (hCG) to prevent menstruation by maintaining high levels of progesterone and estrogen.

Steps of Nidation:

a. Hatching: the blastocyst breaks free from the zona pellucida to implant.
b. Apposition: the blastocyst contacts the endometrial epithelium.
c. Adhesion: trophoblast cells adhere to endometrial cells and begin to proliferate by mitosis.
d. Invasion: ***By Day 7,*** trophoblast cells organize into two layers:
- Cytotrophoblast: inner, distinct cells.
- Syncytiotrophoblast: outer, multinucleated mass from fused cytotrophoblast cells.

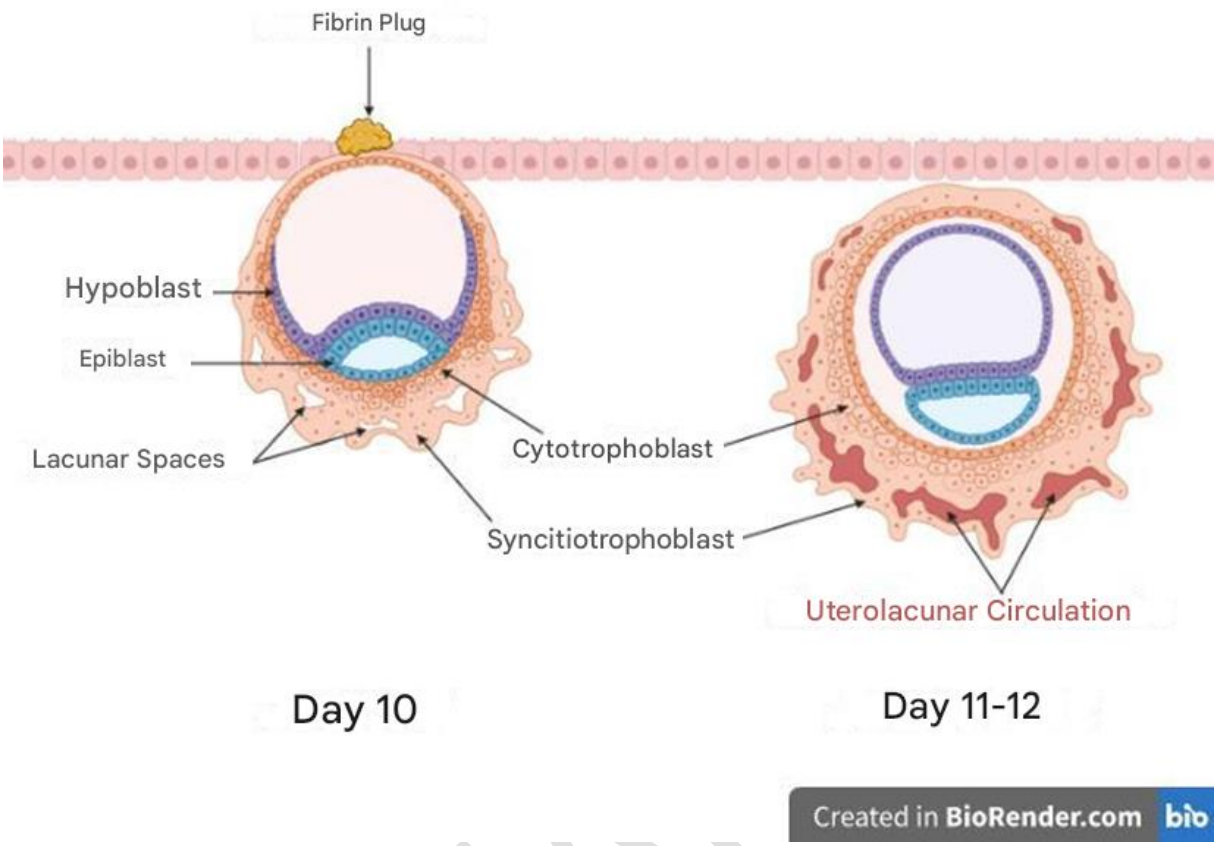


The syncytiotrophoblast is highly active, proliferates rapidly, and digests endometrial tissues using proteolytic enzymes, allowing the entire embryo to penetrate the endometrium.

From Day 9:

Due to trophoblast invasion, the embryo is fully embedded in the endometrium. The uterine breach is closed by a fibrin plug. Vacuoles form in the syncytiotrophoblast and merge into lacunae. The chorionic cavity, amniotic cavity, yolk sac, cytotrophoblast, and syncytiotrophoblast form the embryonic annexes, which ensure nutrition, hydration, and protection. The mesenchyme is a supportive embryonic tissue that gives rise to several adult structures: muscles, vessels, skeleton, and cartilage.

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Summary of the second week

