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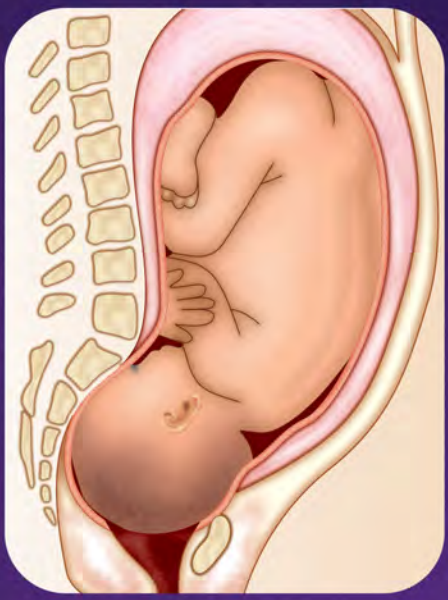
Handbook of Obstetrics & Gynecology for Asia and Oceania



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Development of Placenta

4

Sangeeta Gupta

The placenta besides being an anatomical anchor between the fetus and the mother also plays a crucial role in the providing an interface for exchange of nutrients, gases and hormones. It fulfills these functions through its unique anatomical structure. The important aspects of the development of the placenta have been discussed in this chapter.

The fertilized ova transforms into a morula after a series of mitotic divisions in the fallopian tube.

Postfertilization Day 3 or 4

The morula enters the uterine cavity, sheds the zona pellucida and blastocyst is formed by differentiation of the cells into inner cell mass and outer cell mass (Fig. 4.1). The inner cell mass will develop into the embryo, amnion and the yolk sac, and the outer cell mass are the precursors of the trophoblasts.

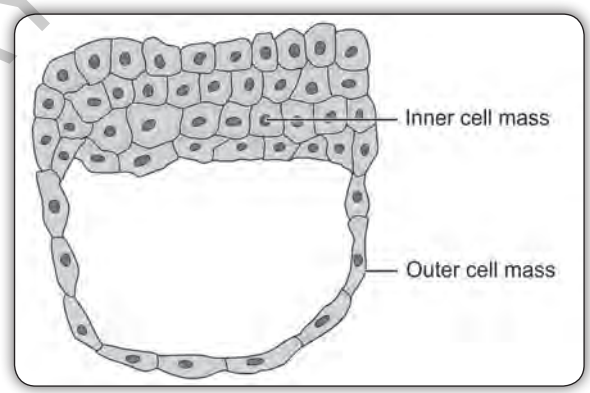

Fig. 4.1 Blastocyst *(For color version, see Plate 1)*

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Days 8–12

The blastocyst starts implanting in the endometrium. Implantation involves interaction between blastocyst and endometrial surface followed by stable adhesions and transient disruption and resealing of luminal epithelium as the embryo positions interstitially. Singh and Aplin have reviewed the cascade of signaling events which mediate implantation.[1]

Outer cell mass differentiates into cytotrophoblast (inner layer of mononucleated cells) and syncytiotrophoblasts (outer layer of multinucleated zone with indistinct margins). The syncytiotrophoblasts are derived from the cytotrophoblasts.

Small cavities appear in the syncytiotrophoblasts and coalesce to form lacunae and with progressive erosion of the endometrium and maternal vessels the lacunae become filled with maternal blood (Fig. 4.2). This network is particularly prominent at the embryonic pole and forms the future placenta.

Third Week

The columns of syncytiotrophoblasts in between the lacunae are penetrated by a core of proliferating cytotrophoblastic cells. These trophoblastic columns of peripheral syncytium and core cytotrophoblasts are radially arranged and form the primary villous stems. Cells of endometrium become polyhedral and are enriched in glycogen and fats, that is, decidual reaction.

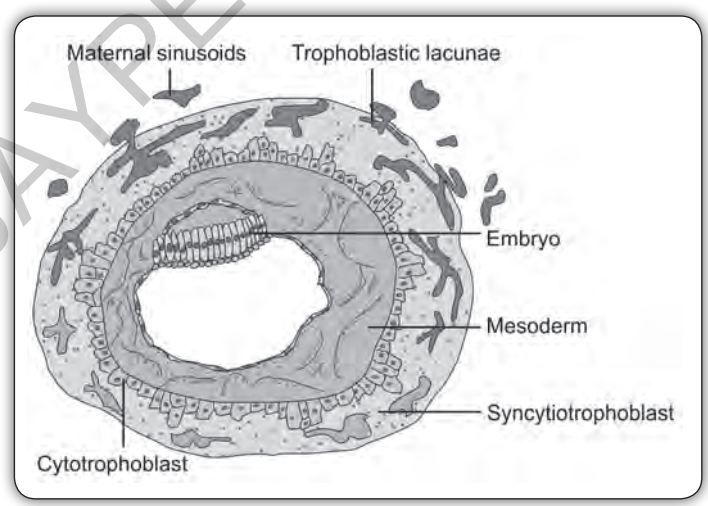

Fig. 4.2 Blastocyst day 12 *(For color version, see Plate 1)*

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With further development, the core of primary villi is penetrated by extraembryonic mesoderm and grows towards the decidua; this newly formed structure is called secondary villi. By the end of third week, the mesodermal angiogenesis gives rise to blood vessels in the core of villi, the resultant structure named tertiary villi. Capillaries in the tertiary villi will establish continuity with other vessels in the chorionic plate and body stalk.

Cytotrophoblasts from the distal part of the stem villi spread laterally to form the cytotrophoblastic shell and split the syncytiotrophoblasts into two layers: definitive syncytium on the fetal aspect and peripheral syncytium between the shell and the decidua. The peripheral syncytium gradually disappears and is replaced by fibrinoid material, the Nitabuch's layer.

The villi that extend from the chorionic plate to the decidua basalis are called stem or anchoring villi. Those which branch from the side of the stem villi into the intervillous spaces are the terminal villi; through which the exchange of the gases and nutrients occur (Fig. 4.3).

The chorionic cavity enlarges and by the end of third week the embryo is attached to the chorionic plate by the connecting stalk which will later form the umbilical cord.

Extravillous Trophoblasts

The cytotrophoblastic cells from the trophoblastic shell migrate into the maternal tissues and are classified as extravillous trophoblasts. Cells which penetrate decidua and myometrium are known as interstitial extravillous trophoblasts, while the trophoblastic cells which invade the maternal vessels are known as endovascular extravillous trophoblasts.[2] The transformation of the high resistance, small caliber vessels to low resistance, large caliber vessels by

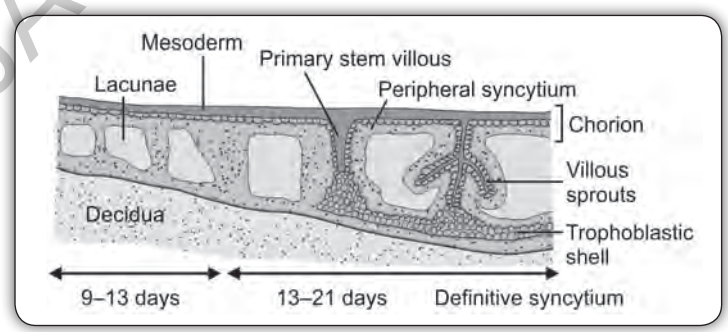

Fig. 4.3 Developmental stages of villi *(For color version, see Plate 1)*

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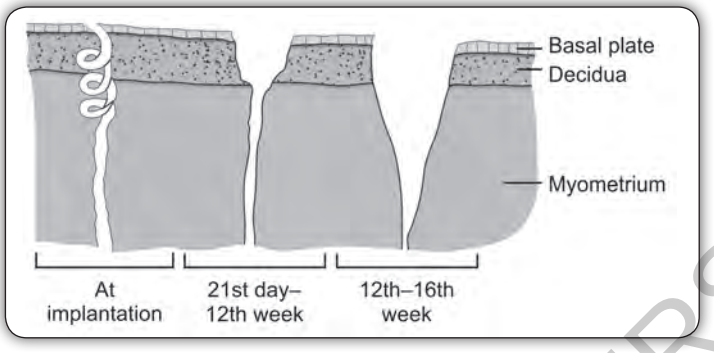

Fig. 4.4 Endovascular invasion *(For color version, see Plate 2)*

endovascular invasion is a crucial event in ensuring optimal uteroplacental circulation. This endovascular invasion occurs in two phases: first wave occurs before 12 weeks postfertilization when the spiral arteries of the decidua are modified whereas the second wave occurs between 12 weeks and 16 weeks postfertilization which involves invasion of myometrial spiral arteries (Fig. 4.4). The failed shallow trophoblastic invasion of maternal spiral arterioles compromises placental circulation and result in pathological conditions such as pre-eclampsia and intrauterine growth restriction.[3]

By the fourth week postfertilization, the villi facing the uterine cavity degenerate and form the chorion laeve. This process is complete in 8–10 weeks (Fig. 4.5). By the fourth month of gestation the chorion laeve fuse with the decidua parietalis to obliterate any residual space between the fetus and the uterine cavity. The villi abutting the decidua basalis progressively branch to for the chorion frondosum and develop into the definitive placenta.

By the end of fourth month of gestation, the placenta has achieved its definitive form. However, the terminal villi undergo progressive alteration with increasing gestational age. There is progressive decrease in the size of villi and numbers of cytotrophoblastic cells while the caliber of the fetal vessels increase (Fig. 4.6).

Structure of the Placenta

The placenta has two components, a fetal portion formed by the chorion frondosum and the maternal portion formed by the decidua basalis. The fetal side of the placenta is limited by the chorionic plate and the maternal side by the decidual plate. Between them are the intervillous spaces filled with maternal blood. During the third

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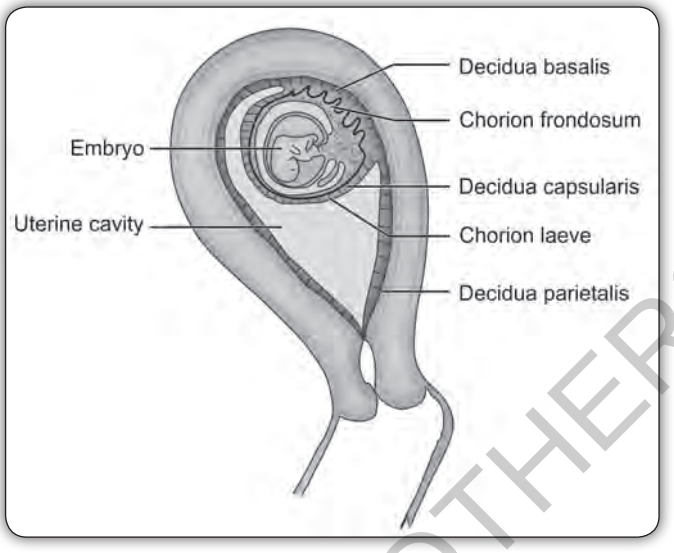

Fig. 4.5 Chorion and decidua at 2nd month *(For color version, see Plate 2)*

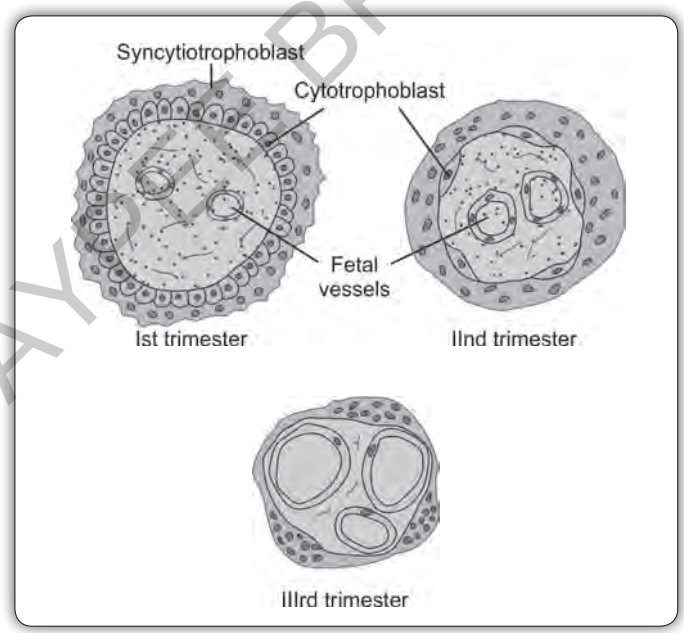

Fig. 4.6 Villi at various gestational age *(For color version, see Plate 3)*

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month of gestation 15–20 anatomical placental lobes are formed by extension of the basal plate from the maternal surface.

In the first trimester, the placental growth is more than the fetus, but by 17 weeks the placental and fetal weights are approximately equal. By term, the placental weight is about 15–20% of the fetal weight.

Normal placenta and placental development are critical for a normal pregnancy and mediate important steps like implantation, immune protection of the fetus, maternal blood flow to the fetus and delivery of nutrients to the fetus.

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