eventually reaches the bottom of the scrotal sac. The descending testis enters this pouch to reach the scrotum. Note that the pouch is formed before the testis enters it. The cavity of the inguinal bursa becomes the **inguinal canal**, while the various layers of its wall form the coverings of the testis and spermatic cord.

**The gubernaculum:** This is a band of mesenchyme which extends from the lower pole of the testis to the scrotum. For many years it was believed that descent of the testis was caused by shortening of the gubernaculum. However, we now know that this is not possible because the gubernaculum does not contain any contractile tissue. According to some authorities, the gubernaculum does not reach the scrotum but reaches the bottom of the inguinal bursa. In spite of this, the gubernaculum does play an important part in the descent of the testis as follows:

When the embryo increases in size, the gubernaculum does not undergo a corresponding increase in length. There is thus a relative shortening of the gubernaculum and, as a result, the testis assumes a progressively lower position.

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**Fig. 16.32:** The gubernaculum, which helps in descent of the testis.

**Fig. 16.33:** Relation of descending testis to processus vaginalis. Note that as the testis descends it progressively invaginates the processus vaginalis.
Chapter 16 – Urogenital System

- The gubernaculum helps to dilate the inguinal bursa.
- It provides a continuous pathway for the descending testis.

**Processus vaginalis:** This is a diverticulum of the peritoneal cavity. It actively grows into the gubernacular mesenchyme of the inguinal canal and the scrotum (Fig. 16.32). As the testis descends, it invaginates the processus vaginalis from behind. After the descent of the testis is completed, the processus vaginalis loses all connection with the peritoneal cavity and becomes the tunica vaginalis (Fig. 16.33).

- The descent of the testis is greatly influenced by hormones secreted by the pars anterior of the hypophysis cerebri.

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**Clinical Correlation**

**Anomalies of Testis**

- The testis may be absent, on one or both sides.
- The testis may be duplicated.
- The two testes may be fused together.

**Anomalies of descent (Cryptorchidism):** Descent of the testis may fail to occur, or may be incomplete. The organ may lie in the lumbar region, in the iliac fossa, in the inguinal canal, or in the upper part of the scrotum. Some interesting facts about this condition are as follows:
  - The testis may complete its descent after birth.
  - Spermatogenesis often fails to occur in an undescended testis.
  - An undescended testis is more likely to develop a malignant tumour than a normal testis.
  - This condition can be surgically corrected.

**Abnormal positions (Ectopia):** The testis may lie (Fig. 16.34):
  - Under the skin of the lower part of the abdomen.
  - Under the skin of the front of the thigh.
  - In the femoral canal.
  - Under the skin of the penis.
  - In the perineum behind the scrotum.

- Also see hermaphroditism.

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Fig. 16.34: Ectopic positions of the testis. A = under skin of the abdomen. B = over front of thigh. C = in femoral canal. D = under skin of penis. E = in perineum.
Clinical Correlation contd...

**Anomalies of Duct System of Testis**

- The seminiferous tubules may fail to establish connection with the vasa efferentia.
- The ductus deferens may be absent, in whole or in part, on one or both sides.
- The ductus deferens may have no connection with the epididymis.

**Anomalies of the Processus Vaginalis**

We have seen that the part of the processus vaginalis, that extends from the deep inguinal ring up to the tunica vaginalis, normally disappears. This may persist in whole, or in part. Abdominal contents may enter it to produce various forms of **inguinal hernia**. Alternatively, fluid may accumulate in it producing the condition called **hydrocoele**. Various forms of hernia and of hydrocoele are shown in Fig. 16.35.

**Vestigial Structures in the Region of the Testis**

A number of vestigial structures are to be seen in the neighbourhood of the testis. Their importance lies in the fact that any one of them may enlarge to form a cyst. These structures are:

- Appendix of testis (also called hydatid of Morgagni).
- Appendix of epididymis.
- Superior aberrant ductules.
- Inferior aberrant ductules.
- Paradidymis.

![Fig. 16.35: Anomalies of processus vaginalis. Abnormal persistence of the processus vaginalis can lead to hernia (passage into it of abdominal contents, indicated by arrows); or hydrocoele (collection of fluid, shown as dots). Various types of hernia and hydrocoele are shown.](image)
Decidua Trophoblast → Extra Eutrophonic Mesoderm

Syncitotroph
Cytoplasm
Extraembryonic lacuna in syncitium

Trabeculae

Lacuna couple stalk tract
Cytotrophoblast

Group of Extra Eutrophonic Mesoderm

Fully formed Septum

Material vessels open in IV space

Inter villous space

Anchoring villous

Umblical Cord
Chapter 6

The Placenta
Fetal Membranes
Twinning

**HIGHLIGHTS**

- A developing embryo gets attached to the uterine endometrium. This is called implantation.
- In human beings the embryo gets buried in the substance of the endometrium. This type of implantation is called interstitial implantation.
- After implantation the endometrium is called the decidua.
- The placenta is formed partly from embryonic structures and partly from the decidua. It is responsible for transport of nutrients and oxygen to the fetus, and for removal of waste products.
- The essential elements of the placenta are chorionic villi. The villi are surrounded by maternal blood. Fetal blood circulates through capillaries in villi.
- The maternal blood and the fetal blood are separated by a very thin placental membrane (or barrier). All substances passing from mother to fetus (and vice versa) traverse this membrane.
- The fetal tissue that takes part in forming the placenta is chorion. It consists of trophoblast (one layer of cells) resting on extra-embryonic mesoderm.
- Proliferation of cells of the trophoblast leads to formation of two layers: cytotrophoblast, which is cellular and syncytiotrophoblast, which is a syncytium (cytoplasm with nuclei, but no cell boundaries).
- The first-formed villi are called primary villi. They consist of a central core of cytotrophoblast covered by syncytiotrophoblast.
- Secondary villi have three layers. From inside out these are extra-embryonic mesoderm, cytotrophoblast and syncytiotrophoblast.
- In tertiary villi, blood capillaries are formed in the extra-embryonic mesoderm.
- Villi are surrounded by an intervillous space that contains maternal blood. As the placenta enlarges, septa grow into the intervillous space dividing the placenta into lobes. The fully formed placenta is about six inches in diameter and about 500 g in weight.
- The placenta is normally attached to the upper part of the body of the uterus. A placenta attached lower down is called placenta praevia. It can cause problems during child birth.
- The embryo is surrounded by three large cavities. These are the amniotic cavity, the extra-embryonic coelom, and the uterine cavity. Enlargement of the amniotic cavity obliterate the extra-embryonic coelom, leading to fusion of amnion and chorion. Further enlargement of amniotic cavity obliterate the uterine cavity. Fused amnion and chorion (called membranes) bulge into the cervical canal (during child birth) and help to dilate it.
FORMATION OF PLACENTA

IMPLANTATION

After the ovum is shed from the ovary, it travels through the uterine tube towards the uterus. If fertilization occurs, segmentation of the ovum begins. By the time the fertilized ‘ovum’ reaches the uterus, it has already become a morula. The morula is still surrounded by the zona pellucida, which prevents it from ‘sticking’ to the wall of the uterine tube. The cells lining the surface of the morula, constitute the trophoblast. The trophoblast has the property of attaching itself to, and invading, any tissue it comes in contact with. Once the zona pellucida disappears, the cells of the trophoblast stick to the uterine endometrium. This is called implantation (Fig. 6.1). In humans, implantation begins on the 6th day after fertilization. The trophoblast of the human blastocyst invades the endometrium of the uterus. The blastocyst burrows deeper and deeper into the uterine mucosa till the whole of it comes to lie within the thickness of the endometrium (Fig. 6.2). This is called interstitial implantation (Fig. 6.3).

The process of implantation is aided by proteolytic enzymes produced by the trophoblast. The uterine mucosa also aids the process. The trophoblastic cells that are situated over the inner cell mass, start penetrating the epithelium of the endometrium.

Fig. 6.1: Relationship of blastocyst to uterine endometrium.

Fig. 6.2: Stages in implantation of blastocyst.
Implantation results due to the mutual interaction between trophoblastic cells and endometrium. This interaction is mediated by receptors present on uterine epithelium and by the secretion of L-selectin and integrins by trophoblastic cells.

**DECIDUA**

After the implantation of the embryo, the uterine endometrium is called the **decidua**. When the morula reaches the uterus, the endometrium is in the secretory phase. After implantation, the features of the endometrium, which are seen during the secretory phase of the menstrual cycle, are maintained and intensified. The stromal cells enlarge, become vacuolated, and store glycogen and lipids. This change in the stromal cells is called the **decidual reaction**. The portion of the decidua where the placenta is to be formed (i.e. deep to the developing blastocyst) is called the **decidua basalis** (Fig. 6.4). The part of the decidua that separates the embryo from the uterine lumen is called the **decidua capsularis**, while the part lining the rest of the uterine cavity is called the **decidua parietalis**. The decidua basalis consists predominantly of large decidual cells that contain large amounts of lipids and glycogen (that presumably provide a source of nutrition for the embryo). The decidua basalis is also referred to as the **decidual plate**, and is firmly
united to the chorion. At the end of pregnancy, the decidua is shed off, along with the placenta and membranes. It is this shedding off which gives the decidua its name (c.f. deciduous trees).

**FORMATION OF CHORIONIC VILLI**

The essential functional elements of the placenta are very small finger-like processes or villi. These villi are surrounded by maternal blood. In the substance of the villi, there are capillaries through which fetal blood circulates. Exchanges between the maternal and fetal circulations take place through the tissues forming the walls of the villi (Fig. 6.5). The villi are formed as offshoots from the surface of the trophoblast. As the trophoblast, along with the underlying extra-embryonic mesoderm, constitutes the chorion, the villi arising from it, are called chorionic villi.

The chorionic villi are first formed all over the trophoblast and grow into the surrounding decidua (Fig. 6.6A). The villi related to the decidua capsularis are transitory. After some time, they degenerate. This part of the chorion becomes smooth and is called the chorion laeaeae. In contrast, the villi that grow into the decidua basalis undergo considerable development. Along with the tissues of the decidua basalis, these villi form a disc-shaped mass which is called the placenta (Fig. 6.6B). The part of the chorion that helps to form the placenta is called the chorion frondosum.

The essential features of the formation of chorionic villi are as follows. The trophoblast is at first made up of a single layer of cells (Fig. 6.7A).

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**Fig. 6.5:** Scheme to show that fetal blood circulating through capillaries of villi is in close relation to maternal blood in the intervillous space.

**Fig. 6.6:** Two stages in the formation of chorionic villi. Note their relationship to the decidua. In (B) note that the villi over the decidua capsularis have disappeared.
Fig. 6.7: Early stages in formation of chorionic villi: (A) Cytotrophoblast in contact with decidua; (B) Syncytiotrophoblast formed; (C) Lacunae appear in syncytiotrophoblast; (D) The lacunae enlarge.

As these cells multiply, two distinct layers are formed (Fig. 6.7B). The cells that are nearest to the decidua (i.e. the most superficial cells) lose their cell boundaries. Thus, one continuous sheet of cytoplasm containing many nuclei is formed. Such a tissue is called a syncytium. Hence, this layer of the trophoblast is called the *syncytiotrophoblast* or *plasmodiotrophoblast*. Deep to the syncytium, the cells of the trophoblast retain their cell walls and form the second layer called the *cytotrophoblast* (also called *Langhan's layer*). The cytotrophoblast rests on extra-embryonic mesoderm. All these elements (syncytium, cytotrophoblast and mesoderm) take part in forming chorionic villi.

The following three stages in formation of chorionic villi are seen:

1. **Primary villi** consist of a central core of cytotrophoblast covered by a layer of syncytiotrophoblast. Adjoining villi are separated by an intervillous space.

2. **Secondary villi** show three layers: outer syncytiotrophoblast, an intermediate layer of cytotrophoblast, and an inner layer of extra-embryonic mesoderm.