Gross Anatomy
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Introduction

The words "placenta" and "afterbirth" in the Greater Oxford English Dictionary and found some interesting associations. Placenta comes from the Latin word for cake, and placent, an obsolete English word, means a round, flat cake - placent also means pleasing and gratifying. Listed under afterbirth was the quotation, "All afterbirths of penitential moans are consumed in living streams of bliss". The word placenta is common to French, Spanish, Italian and English. In German two words for placenta are Mutterkuchen, literally mother cake, and Fruchtkuchen, fruit cake. Our birthday celebrations always include a ceremonial cake with candles, traditionally a rich fruit cake made with nuts and dried fruits. Maybe, this cake is symbolic of the placenta at birth. The placenta, as we know, is the life support system of the baby in utero and is sometimes referred to by poets as the tree of life, so perhaps it is symbolized in an anniversary celebration of the rite of birth.

The Decidua

Decidua is the term for the uterine lining (endometrium) during a pregnancy, which forms the maternal part of the placenta. Before the fertilized ovum reaches the uterus, the mucous membrane of the body of the uterus undergoes important changes and is then known as the decidua. It is formed under the influence of progesterone and forms highly-characteristic cells. The thickness and vascularity of the mucous membrane are greatly increased; its glands are elongated and open on its free surface by funnel-shaped orifices, while their deeper portions are tortuous and dilated into irregular spaces. The interglandular tissue is also increased in quantity, and is crowded with large round, oval, or
polygonal cells, termed **decidual cells**. Their enlargement is due to glycogen and lipid accumulation in the cytoplasm allowing these cells to provide a rich source of nutrition for the developing embryo.

**Etymology:** The word "decidua" comes from the Latin deciduus, meaning falling off or shedding.

**Background:** After ovulation, in mammals, the endometrial lining becomes transformed into a secretory lining in preparation of accepting the embryo. Without implantation, the secretory lining will be absorbed (estrous cycle) or shed (menstrual cycle). With implantation the lining now termed decidua evolves further during the pregnancy.

**Structure:** These changes are well advanced by the second month of pregnancy, when the mucous membrane consists of the following strata: (1) **stratum compactum**, next to the free surface; in this the uterine glands are only slightly expanded, and are lined by columnar cells; (2) **stratum spongiosum**, in which the gland tubes are greatly dilated and very tortuous, and are ultimately separated from one another by only a small amount of interglandular tissue, while their lining cells are flattened or cubical; (3) **stratum basale**, a thin unaltered or boundary layer of the decidua that interacts with the trophoblast, next to the uterine muscular fibers, containing the deepest parts of the uterine glands, which are not dilated, and are lined with columnar epithelium; it is from this epithelium that the epithelial lining of the uterus is regenerated after pregnancy.

After implantation of blastocyst, distinctive names are applied to different portions of the decidua. The part which covers in the blastocyst is named the **decidua capsularis**; the portion which intervenes between the blastocyst and the uterine wall is named the **decidua basalis** or **decidua placentalis**; it is here that the placenta is subsequently
developed. The part of the decidua which lines the remainder of the body of the uterus is known as the decidua vera or decidua parietalis.

The decidua has a histologically-distinct appearance, displaying large polygonal decidual cells in the stroma. These are enlarged endometrial stromal cells, which resemble epithelium (and are referred to as "epithelioid"). Formation of a specialized decidua is called decidualization, which is a special property of endometrium seen only in hemochorial placentation. Decidualization includes the process of differentiation of the spindle-shape stromal fibroblasts into the plump secretory decidual cells, which create a pericellular extracellular matrix rich in fibronectin and laminin (similar to epithelial cells). Vascularity, as well as vascular permeability, is enhanced in the decidualizing endometrium.

Its leukocyte population is distinct, with the presence of large endometrial granular leukocytes being predominant, while polynuclear leukocytes and B-cells are scant. The large granular lymphocytes (CD56 bright) are called "uterine NK cells" or "uNK cells" in mice, and "decidual NK cells" or "dNK cells" in humans.

Role: As the maternal interface to the embryo the decidua participates in the exchanges of nutrition, gas, and waste with the gestation. It also protects the pregnancy from the maternal immune system. Further, the decidua has to allow a very controlled invasion of the trophoblast. In invasive placental disorders like placenta accreta decidualization have been consistently found to be deficient.

Hormone production: The decidua secretes hormones, growth factors, and cytokines. It has receptors for estrogen, progesterone, growth hormone, and others. Among its products are hormones commonly associated with other organs such as cortisol, CRF, GnRH, prolactin, and
relaxin. Decidual prolactin is not under dopaminergic control. Pregnancy protein 14 (PP-14), also called placental protein 12, and Insulin-like growth factor-binding protein 1 (IGFBP1) appear to be specific products of the secretory and decidual lining. Other factors released include interleukin-15 and vascular endothelial growth factor (VEGF). A reasonable understanding of the role and interplay of these hormones and factors has not been evolved.

Other: In case of an extrauterine pregnancy, the endometrium nevertheless becomes decidualized. A woman may shed the lining in the form of a decidual cast, which may be mistaken as a miscarriage, when, in fact, the ectopic pregnancy still persists. A decidual reaction can be observed in tissue of the peritoneum and ovary during a pregnancy, and represents a response of stromal tissue to progesterone.

**Trophoblast**

Trophoblasts (from Greek trephein: to feed, and blastos: germinator) are cells forming the outer layer of a blastocyst, which provide nutrients to the embryo and develop into a large part of the placenta. They are formed during the first stage of pregnancy and are the first cells to differentiate from the fertilized egg. This layer of trophoblasts is also collectively referred to as "the trophoblast", or, after gastrulation, the trophectoderm, as it is then continuous with the ectoderm of the embryo. The trophoblast consists of cytotrophoblast or layer of Langhans, and an external layer of richly nucleated protoplasm devoid of cell boundaries, syncytiotrophoblast. It undergoes rapid proliferation and forms numerous processes, the chorionic villi, which invade and destroy the uterine decidua and at the same time absorb from it nutritive materials for the growth of the embryo.
The structure actively concerned in the process of excavation is the trophoblast of the blastocyst, which possesses the power of dissolving and absorbing the uterine tissues. The border to the trophoblast is called Nitabuch's layer.

Function: Trophoblasts are specialised cells of the placenta that play an important role in embryo implantation and interaction with the decidualised maternal uterus. The core of placental villi contains mesenchymal cells and placental blood vessels that are directly connected to the fetal circulation via the umbilical cord. This core is surrounded by two layers of trophoblast; a single layer of mononuclear cytotrophoblast that fuse together to form the overlying multinucleated syncytiotrophoblast layer that covers the entire surface of the placenta. It is this syncytiotrophoblast that is in direct contact with the maternal blood that reaches the placental surface, and thus facilitates the exchange of nutrients, wastes and gases between the maternal and fetal systems.

In addition, cytotrophoblast in the tips of villi can differentiate into another type of trophoblast called the extravillous trophoblast. Extravillous trophoblast grows out from the placenta and penetrates into the decidualised uterus. This process is essential not only for physically attaching the placenta to the mother, but also for altering the vasculature in the uterus to allow it to provide an adequate blood supply to the growing fetus as pregnancy progresses. Some of this trophoblast even replaces the endothelial cells in the uterine spiral arteries as they remodel these vessels into wide bore conduits that are independent of maternal vasoconstriction. This ensures the fetus receives a steady supply of blood, and the placenta is not subjected to fluctuations in oxygen that could cause it damage.
Differentiation: The trophoblast proliferates and differentiates into 2 cell layers at approximately 6 days after fertilization for humans:

**Cytotrophoblast**: Single celled, inner layer of the trophoblast. 

**Syncytiotrophoblast**: outer layer Thick layer that lacks cell boundaries and grows into the endometrial stroma. It secretes hCG in order to maintain progesterone secretion and sustain a pregnancy.

Intermediate trophoblast (IT) implantation site, chorion, villi (dependent on subtype) anchor placenta (implation site IT), unknown (chorionic & villus IT)

**Pathology:** The invasion of a specific type of trophoblast (extravillous trophoblast) into the maternal uterus is a vital stage in the establishment of pregnancy: Failure of the trophoblast to invade sufficiently is important in the development of some cases of pre-eclampsia. Too firm an attachment may lead to placenta accreta.

**Cytotrophoblast:** The cytotrophoblast (or layer of Langhans) is the inner layer of the trophoblast, interior to the syncytiotrophoblast in an embryo. Cytotrophoblast is considered to be the trophoblastic stem cell; it differentiates into the other forms of trophoblastic tissue (intermediate trophoblast and syncytiotrophoblast).

**Syncytiotrophoblast:** Syncytiotrophoblasts are multinucleated cells found in the placenta of embryos. They are the outer syncytial layer of the trophoblasts and actively invade the uterine wall. They form the outermost fetal component of the placenta (also known as 'syntrophoblast') and massively increase the surface area available for nutrient exchange between the mother and the fetus.

Cells from the syncytiotrophoblast secrete progesterone in addition to human chorionic gonadotropin (hCG) and human placental lactogen (HPL); hCG prevents degeneration of the corpus luteum.
Progesterone serves to maintain the integrity of the uterine lining and, until the syncytiotrophoblast is mature enough to secrete enough progesterone to support pregnancy (in the fourth month of embryonic development), it is aided by the corpus luteum graviditatis.

**Chorionic villi**

Chorionic villi are villi that sprout from the chorion in order to give maximum area of contact with the maternal blood. The chorionic villi are at first small and non-vascular, and consist of trophoblast only, but they increase in size and ramify, while the mesoderm, carrying branches of the umbilical vessels, grows into them, and in this way they are vascularized. Blood is carried to the villi by the branches of the umbilical arteries, and after circulating through the capillaries of the villi, is returned to the embryo by the umbilical veins. Thus, the villi are part of the border between maternal and fetal blood during pregnancy.

Until about the end of the second month of pregnancy the villi cover the entire chorion, and are almost uniform in size but after this they develop unequally. The greater part of the chorion is in contact with the decidua capsularis and over this portion the villi, with their contained vessels, undergo atrophy, so that by the fourth month scarcely a trace of them is left, and hence this part of the chorion becomes smooth, and is named the chorion leave; as it takes no share in the formation of the placenta, it is also named the non-placental part of the chorion. On the other hand, the villi on that part of the chorion which is in contact with the decidua placentalis increase greatly in size and complexity, and hence this part is named the chorion frondosum.

**Development**: The chorion undergoes rapid proliferation and forms numerous processes, the chorionic villi, which invade and destroy the
uterine decidua and at the same time absorb from it nutritive materials for the growth of the embryo. They undergo several stages, depending on their composition.

**Contents:**

- **Primary:** The chorionic villi are at first small and non-vascular. End of 4th week trophoblast only.
- **Secondary:** The villi increase in size and ramify, while the mesoderm grows into them. End of 5th week trophoblast and mesoderm.
- **Tertiary:** Branches of the umbilical vessels grow into the mesoderm, and in this way the chorionic villi are vascularized. 5th - 6th week trophoblast, mesoderm, and blood vessels.

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**Relations:**

- **Floating villi:** These villi are found floating freely in the intervillous space. They exhibit a bi-layered epithelium consisting of cytotrophoblasts with overlaying syncytium (syncytiotrophoblast).
- **Anchoring (stem) villi:** These villi act to stabilise mechanical integrity of the placental-maternal interface.

**Tissue composition and cell types:** The bulk of the villi consist of connective tissues in which blood vessels are found. Most of the cells in the connective tissue core of the villi are fibroblasts. Macrophages known as Hofbauer cells are also present.

- **Stem cell:** Chorionic villi are rich of stem cells: Chorionic stem cells, like amniotic stem cells, are multipotent stem cells without any ethical problem and now it’s possible to criopreserve amniotic stem cell for autologous use.

**Intervillous space:** As a brief introduction, "inter" means between, and "villous" means vessels, so the intervillous space is the "space
between the vessels" of the mother and the embryo. The trophoblast, which is a collection of cells that invades the maternal endometrium to gain access to nutrition for the fetus, proliferates rapidly and forms a network of branching processes which cover the entire embryo and invade and destroy the maternal tissues. With this physiologic destructive process, the maternal blood vessels of the endometrium are opened, with the result that the spaces in the trophoblastic network are filled with maternal blood; these spaces communicate freely with one another and become greatly distended and form the intervillous space from which the fetus gains nutrition.

Maternal arteries and veins directly enter the intervillous space after 8 weeks of gestation, and the intervillous space then contains about a unit of blood (400-500 mL). Much of this blood is returned to the mother with normal uterine contractions; thus, when a woman has a cesarean section, she is liable to lose more blood than a woman who has a vaginal delivery, as the blood from the intervillous space is not pushed back toward her body during such a delivery.

**Umbilical cord**

In placental mammals, the umbilical cord (also called the birth cord or funiculus umbilicalis) is the connecting cord from the developing embryo or fetus to the placenta. During prenatal development, the umbilical cord comes from the same zygote as the fetus and (in humans) normally contains two arteries (the umbilical arteries) and one vein (the umbilical vein), together with the canal of the allantois buried within Wharton's jelly. The umbilical cord attaches the fetus to the placenta; its length at full time, as a rule, is about equal to the length of the fetus, i.e., about 50 cm, but it may be greatly diminished or increased. The
vitelline vessels and duct, together with the right umbilical vein, undergo atrophy and disappear; and thus the cord, at birth, contains a pair of umbilical arteries and one (the left) umbilical vein.

Development and composition: The umbilical cord develops from and contains remnants of the yolk sac and allantois (and is therefore derived from the same zygote as the fetus). It forms by the fifth week of fetal development, replacing the yolk sac as the source of nutrients for the fetus. The cord is not directly connected to the mother's circulatory system, but instead joins the placenta, which transfers materials to and from the mother's blood without allowing direct mixing. The umbilical cord in a full term neonate is usually about 50 centimeters (20 in) long and about 2 centimeters (0.75 in) diameter. This diameter decreases rapidly within the placenta. The fully-patent umbilical artery has two main layers: an outer layer consisting of circularly arranged smooth muscle cells and an inner layer which shows rather irregularly and loosely arranged cells embedded in abundant ground substance staining metachromatic. The smooth muscle cells of the layer are rather poorly differentiated, contain only a few tiny myofilaments and are thereby unlikely to contribute actively to the process of postnatal closure. The umbilical cord is composed of Wharton's jelly, a gelatinous substance made largely from mucopolysaccharides.

It contains one vein, which carries oxygenated, nutrient-rich blood to the fetus from the placenta and two arteries that carry deoxygenated, nutrient depleted blood away. Occasionally, only two vessels (one vein and one artery) are present in the umbilical cord. This is sometimes related to fetal abnormalities, but it may also occur without accompanying problems. It is unusual for a vein to carry oxygenated blood, and for arteries to carry deoxygenated blood (the only other examples being the pulmonary
veins and arteries, connecting the lungs to the heart). However, this naming convention reflects the fact that the umbilical vein carries blood towards the fetus's heart, while the umbilical arteries carry blood away.

The blood flow through the umbilical cord is approximately 35 mL/min at 20 weeks, and 240 mL/min at 40 weeks of gestation. Adapted to the weight of the fetus, this corresponds to 115 mL/min/kg at 20 weeks and 64 mL/min/kg at 40 weeks.

**Connection to fetal circulatory system:** The umbilical cord enters the fetus via the abdomen, at the point which (after separation) will become the umbilicus (or navel). Within the fetus, the umbilical vein continues towards the transverse fissure of the liver, where it splits into two. One of these branches joins with the hepatic portal vein (connecting to its left branch), which carries blood into the liver. The second branch (known as the ductus venosus) allows the majority of the incoming blood (approximately 80%) to bypass the liver and flow via the left hepatic vein into the inferior vena cava, which carries blood towards the heart. The two umbilical arteries branch from the internal iliac arteries, and pass on either side of the urinary bladder before joining the umbilical cord.

**Physiological postnatal occlusion:** In absence of external interventions, the umbilical cord occludes physiologically shortly after birth, explained both by a swelling and collapse of Wharton's jelly in response to a reduction in temperature and by vasoconstriction of the blood vessels by smooth muscle contraction. In effect, a natural clamp is created, halting the flow of blood. If left to proceed naturally, this physiological clamping will take as little as five minutes and up to 20 minutes. In water birth in a warm water birth tub, where the temperature of the water may be equal to inside the body, normal pulsation can be 5 minutes and longer.
Closure of the umbilical artery by vasoconstriction consists of multiple constrictions which increase in number and degree with time. There are segments of dilatations with trapped uncoagulated blood between the constrictions before complete occlusion. Both the partial constrictions and the ultimate closure are mainly produced by muscle cells of the outer circular layer. In contrast, the inner layer seems to serve mainly as a plastic tissue which can easily be shifted in an axial direction and then folded into the narrowing lumen to complete the closure. The vasoconstrictive occlusion appears to be mainly mediated by 5-hydroxytryptamine and thromboxane A2. The artery in cords of preterm infant contract more to angiotensin II and arachidonic acid and are more sensitive to oxytocin than in term ones. In contrast to the contribution of Wharton's jelly, cooling causes only temporary vasoconstriction.

Within the child, the umbilical vein and ductus venosus close up, and degenerate into fibrous remnants known as the round ligament of the liver and the ligamentum venosum respectively. Part of each umbilical artery closes up (degenerating into what are known as the medial umbilical ligaments), while the remaining sections are retained as part of the circulatory system.

Problems and abnormalities: A knotted cord on a newborn baby. A number of abnormalities can affect the umbilical cord, which can cause problems that affect both mother and child:

- Nuchal cord, when the umbilical cord becomes wrapped around the fetal neck
- Velamentous cord insertion
- Single umbilical artery
- Umbilical cord prolapse
- Vasa praevia
Umbilical cord clamp: General hospital-based obstetric practice introduces artificial clamping as early as 1 minute after the birth of the child. In birthing centers, this may be delayed by 5 minutes or more, or omitted entirely. Clamping is followed by cutting of the cord, which is painless due to the lack of any nerves. The cord is extremely tough, like thick sinew, and so cutting it requires a suitably sharp instrument. Provided that umbilical severance occurs after the cord has stopped pulsing (5-20 minutes after birth), there is ordinarily no significant loss of either venous or arterial blood while cutting the cord. There are umbilical cord clamps which combine the cord clamps with the knife. After the cord is clamped and cut, the newborn wears a plastic clip on the navel area until the compressed region of the cord has dried and sealed sufficiently. The remaining umbilical stub remains for up to 7-10 days as it dries and then falls off.

Umbilical nonseverance: Some parents choose to omit cord severance entirely, a practice called "lotus birth" or umbilical nonseverance. The entire intact umbilical cord is allowed to dry like a sinew, which then separates naturally (typically on the 3rd day after birth), falling off and leaving a healed umbilicus.

Storage of cord blood: Recently, it has been discovered that the blood within the umbilical cord, known as cord blood, is a rich and readily available source of primitive, undifferentiated stem cells (of type CD34-positive and CD38-negative). These cord blood cells can be used for bone marrow transplant.

Umbilical artery
The umbilical artery is a paired artery (with one for each half of the body) that is found in the abdominal and pelvic regions. In the fetus, it extends into the umbilical cord.

**Umbilical arteries in the fetus:** Umbilical arteries supply deoxygenated blood from the fetus to the placenta in the umbilical cord. There are usually two umbilical arteries present together with one umbilical vein in the cord. The umbilical arteries are actually the latter of the internal iliac arteries that supply the hind limbs with blood and nutrients in the fetus. The umbilical arteries surround the urinary bladder and then carry all the deoxygenated blood out of the fetus through the umbilical cord. The pressure inside the umbilical artery is approximately 50 mmHg. Inside the placenta, the umbilical arteries connect with each other at a distance of approximately 5 mm from the cord insertion in what is called the Hyrtl anastomosis. Subsequently, they branch into chorionic arteries or intraplacental fetal arteries.

**Umbilical artery in the adult:** The umbilical artery is a branch of the anterior division of the internal iliac artery and represents the patent (open) part of the embryonic umbilical artery. (The non-patent obliterated part of the artery is the medial umbilical ligament.) The umbilical artery is found in the pelvis, and gives rise to the superior vesical arteries. In males, it also gives rise to the artery to the ductus deferens.

**Umbilical vein**

The umbilical vein is a vein present during fetal development that carries oxygenated blood from the placenta to the growing fetus. The blood pressure inside the umbilical vein is approximately 20 mmHg.
Development: During embryologic development, there are two umbilical veins, left and right, which drain blood from the placenta to the heart. The right umbilical vein regresses and under normal circumstances is completely obliterated during the second month of development. The left umbilical vein persists and delivers blood from the placenta to the developing fetus. The diameter of the intra-abdominal umbilical vein increases linearly, from 3 mm at 15 weeks of gestation to 8 mm at term.

Closure: Within a week of birth, the infant’s umbilical vein is completely obliterated and is replaced by a fibrous cord called the round ligament of the liver. It extends from the umbilicus to the transverse fissure, where it joins with the falciform ligament of the liver to separate the left and right lobes of the liver. Closure of the umbilical vein usually occurs after the umbilical arteries have closed. This prolongs the communication between the placenta and fetal heart, allowing for a sort of auto-transfusion of remaining blood from the placenta to the fetus.

Placenta proper

The placenta connects the fetus to the uterine wall, and is the organ by means of which the nutritive, respiratory, and excretory functions of the fetus are carried on. It is composed of fetal and maternal portions.

Fetal Portion-The fetal portion of the placenta consists of the villi of the chorion frondosum; these branch repeatedly, and increase enormously in size. These greatly ramified villi are suspended in the intervillous space, and are bathed in maternal blood, which is conveyed to the space by the uterine arteries and carried away by the uterine veins. A branch of an umbilical artery enters each villus and ends in a capillary
plexus from which the blood is drained by a tributary of the umbilical vein. The vessels of the villus are surrounded by a thin layer of mesoderm consisting of gelatinous connective tissue, which is covered by two strata of ectodermal cells derived from the trophoblast: the deeper stratum, next the mesodermic tissue, represents the cytотrophoblast or layer of Langhans; the superficial, in contact with the maternal blood, the syncytiotrophoblast. After the fifth month the two strata of cells are replaced by a single layer of somewhat flattened cells.

The fetal part of the placenta is supplied by the cotyledonary arteries, which branch into fetal stem arteries that are the tributary to single villous trees. Over their whole course towards the maternal side, these give off arterioles entering secondary villi. The tertiary or terminal villous vasculature consists of capillaries, which are organized in serial capillary loops. This system is progressively elaborated in the course of gestation. In the 4th month there are only finger-like loops, whereas from the 6th month large fan-like structures can be observed.

Maternal Portion- The maternal portion of the placenta is formed by the decidua placentalis containing the intervillous space. The endothelial lining of the uterine vessels ceases at the point where they terminate in the intervillous space which is lined by the syncytiotrophoblast. Portions of the stratum compactum persist and are condensed to form a series of septa, which extend from the basal plate through the thickness of the placenta and subdivide it into the lobules or *cotyledons* seen on the uterine surface of the detached placenta.

The vasculature of the maternal compartment is supplied by large caruncular stalk or spiral arteries, which release short maternal stem arteries. In the 3rd month of gestation, these arteries branch into several arterioles at their base, thus providing the vascular framework
for the lower part of the septal walls of the primary crypts. In the 4th month, due to progressive longitudinal growth of the stem arteries, branching into arterioles occurs not only at the base, but over the whole length of the stem arteries. These arterioles supply the capillary complexes of the septa which resemble the major part of the septal vasculature and face the secondary crypts. Further indentation results in the formation of tertiary crypt capillary complexes, encircling the earlier secondary unit. From the 6th month of gestation the architecture resembles the fully developed maternal placenta with stem arteries running directly to the fetal side to branch into 4 to 6 arterioles, which turn back to enter secondary and tertiary septa. Maternal venules, collecting the blood from the capillary bed of secondary and tertiary septa, converge onto stem veins leaving the caruncle via branches of the uterine vein.

The fetal and maternal blood currents traverse the placenta, the former passing through the blood vessels of the placental villi and the latter through the intervillous space. The two currents do not intermingle, being separated from each other by the delicate walls of the villi. Nevertheless, the fetal blood is able to absorb, through the walls of the villi, oxygen and nutritive materials from the maternal blood, and give up to the latter its waste products. The blood, so purified, is carried back to the fetus by the umbilical vein. It will thus be seen that the placenta not only establishes a mechanical connection between the mother and the fetus, but subserves for the latter the purposes of nutrition, respiration, and excretion.

In early gestation the maternal and fetal blood vessels meet predominantly in a countercurrent fashion, changing to the less efficient crosscurrent exchange when the tertiary unit develops. These results
indicate the development of a highly elaborated feto-maternal villous-crypt exchange system, already established in the 1st half of gestation, thus meeting the increasing needs of the fetus.

**Comparison with other species**

The placenta is a large, highly complex organ, capable of a multiplicity of synthetic, secretory, filtration, analytic, and transport functions. It serves as the interface of the maternal and fetal physiological systems. Despite similarities in function, characteristics of placenta -- specifically chorio-allantoic placenta -- vary widely among mammals.

Morphologically, placentas may be disc-shaped (discoid, as in higher primates and rodents); a band around the amnionic sac (zonary, as in most carnivores); a group of from several to over a hundred islands of tissue (cotyledonary or multiplex, as in most ruminants); or diffuse (diffuse or microcotyledonary, as in some nonruminant ungulates).

Placenta types also differ histologically and can be distinguished by the number of tissue layers separating the maternal and fetal blood supplies: epitheliochorial placentas are those in which the maternal and fetal circulations are separated by three maternal and three fetal tissue layers (as in ungulates, aquatic mammals, and some prosimians); endotheliochorial, in which one maternal and three fetal tissue layers separate the systems (as in most carnivores); and haemochorial, in which the maternal tissue layers are entirely absent (as in higher primates, rodents, lagomorphs, and insectivores).

Finally, afterbirths can be categorized by the portion (fetal or maternal) of the placenta delivered during parturition: deciduate afterbirths are those in which both the fetal and maternal portions of
the placenta are delivered (as in humans and rodents); adeciduate afterbirths are those in which only the fetal portion of the placenta is delivered (as in carnivores and ungulates); and contra-deciduate afterbirths are those in which both the fetal and maternal portions of the placenta remain in the uterus and are resorbed (as in marsupials).

During labor, the placenta detaches from the wall of the uterus, and, as the fetus begins to emerge, rapidly loses its significance as a life-support system. Expulsion of the placenta occurs from seconds to hours after the delivery of the neonate, depending on the species. Survival of the neonate requires the freeing of the head and face from fetal membranes and detachment from the placenta by severing of the umbilicus.

In the human, the system of serially linked capillary convolutions of terminal villi is longer than that in ruminants. Therefore, in guaranteeing blood flow against flow resistance, the human vessels particularly need a straight course, anastomoses, and sinusoidal dilations. Specifically in the ruminants studied, the venous vessels outweigh the arterial ones by volume and by number. They are suggested to be absorptive for substances metabolized in the zone of the capillary complex. The most extreme interspecies difference relates to the maternal vasculature, which, in contrast to the fetal system, is a closed system in the ruminant septas and an open lacunal intervillous space in the human.