

Placenta

Authored by
mohammad looti

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Placenta

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1. Core Definition

The **placenta**, often colloquially known as the **afterbirth**, is a remarkable and transient organ that develops within the uterus during pregnancy, serving as the vital interface between the mother and the developing fetus. Its primary function is to facilitate nutrient uptake, waste elimination, and gas exchange between the maternal and fetal blood supplies, essentially acting as the fetus's lungs, kidneys, and gastrointestinal tract before organ systems are fully functional. This complex structure is indispensable for supporting embryonic and fetal growth, development, and survival throughout gestation.

More than just a passive conduit, the placenta is an active endocrine organ, producing a range of hormones essential for maintaining the pregnancy, regulating maternal physiological adaptations, and influencing fetal growth. It establishes an immunological barrier, preventing the maternal immune system from rejecting the fetus, which carries paternal antigens, while simultaneously allowing for the transfer of maternal antibodies to confer passive immunity to the developing infant. The placenta is uniquely distinguished by its temporary nature, forming at the onset of pregnancy and being expelled shortly after childbirth.

Its critical role extends beyond mere physiological exchange; the placenta also provides crucial functions such as thermo-regulation, ensuring the fetus maintains a stable internal temperature, and protecting the fetus from certain harmful substances, though it is not an impermeable barrier. The intricate design and multifaceted capabilities of the placenta underscore its central importance in reproductive biology and the successful propagation of viviparous species, including humans.

2. Etymology and Historical Development

The term "placenta" originates from the Latin word "placenta," meaning "flat cake" or "circular cake," a descriptor likely derived from the organ's typically discoid shape when observed in humans. This etymological root reflects an early, purely macroscopic understanding of the organ. While ancient civilizations and early medical practitioners, such as Hippocrates and Galen, were aware of the placenta's existence and its expulsion after birth, their understanding of its complex physiological functions was rudimentary, often attributing its role to containing or nourishing the fetus without grasping the intricate exchange mechanisms.

Significant advancements in comprehending the placenta's true nature began to emerge with the advent of microscopy and detailed anatomical studies in the Renaissance and Enlightenment

periods. Pioneering anatomists started to meticulously describe its gross structure and its connection to the fetus via the umbilical cord. However, the sophisticated understanding of gas and nutrient exchange across the placental barrier, and its endocrine functions, only truly began to solidify in the 19th and 20th centuries with advances in biochemistry, physiology, and experimental embryology. Researchers began to unravel the selective permeability of the placental membrane and the active transport mechanisms involved in nutrient delivery and waste removal.

The 20th century witnessed a rapid expansion of knowledge regarding placental biology, driven by advancements in cellular and molecular biology, immunology, and reproductive medicine. The identification of key placental hormones, the detailed mapping of placental blood flow, and the understanding of its role in various pregnancy complications have transformed clinical obstetrics. Modern research continues to explore the placenta's complex genetic and epigenetic regulation, its adaptive responses to maternal and fetal health challenges, and its long-term implications for both maternal and offspring health, highlighting its status as one of the most enigmatic and vital organs in human biology.

3. Anatomy and Structure

The human placenta is typically a discoid-shaped organ, roughly 15-25 cm in diameter and 2-4 cm thick at term, weighing approximately 500-600 grams. It usually implants in the anterior or posterior wall of the uterus, away from the cervical opening. Structurally, the placenta is bipartite, composed of both maternal and fetal components. The maternal component is derived from the decidua basalis, a specialized region of the uterine endometrium, while the fetal component originates from the chorion frondosum, which develops from the trophoblast cells of the blastocyst. These two components interdigitate intimately to form the functional unit of exchange.

On the maternal side, the placenta consists of numerous compartments known as cotyledons, formed by decidual septa extending into the intervillous space. Maternal arterial blood from the uterine spiral arteries is propelled into this intervillous space, where it bathes the fetal chorionic villi. On the fetal side, the chorionic villi, finger-like projections containing fetal capillaries, extend into the intervillous space. These villi are covered by two layers of trophoblast cells: an inner layer of cytotrophoblast and an outer, multinucleated layer of syncytiotrophoblast. The syncytiotrophoblast is the primary site of nutrient, gas, and waste exchange, forming a barrier that separates maternal and fetal blood without allowing them to mix directly.

Connecting the fetus to the placenta is the **umbilical cord**, a rope-like structure typically about 50-60 cm long at term. It contains two umbilical arteries, which carry deoxygenated blood and metabolic waste products from the fetus to the placenta, and one umbilical vein, which transports oxygenated, nutrient-rich blood from the placenta to the fetus. These vessels are encased in a protective gelatinous substance called Wharton's jelly, which prevents compression and knotting of

the cord, ensuring uninterrupted blood flow. The integrity and proper functioning of both the placenta and the umbilical cord are paramount for sustaining fetal life and development.

4. Physiological Functions

The placenta performs a myriad of essential physiological functions that are critical for fetal survival and development. One of its primary roles is **nutrient uptake**, selectively transporting vital substances from the maternal circulation to the fetus. This includes the active transport of glucose, amino acids, and fatty acids, which serve as the primary energy sources and building blocks for fetal growth. Additionally, essential vitamins, minerals (such as iron and calcium), and electrolytes are efficiently transferred across the placental barrier, ensuring the fetus receives all necessary micronutrients for healthy development of its organs and tissues.

Equally crucial is the placenta's role in **waste elimination**. As the fetus produces metabolic byproducts, such as urea, creatinine, and bilirubin, these waste products are efficiently diffused from the fetal blood into the maternal circulation via the placenta. Once in the mother's bloodstream, these waste products are then processed and excreted by the maternal kidneys and liver, effectively acting as the fetal excretory system until the fetal organs mature sufficiently. This constant detoxification process prevents the accumulation of harmful substances in the fetal environment.

Gas exchange is another vital function, mirroring the role of the lungs. Oxygen-rich maternal blood flows into the intervillous space, where oxygen diffuses across the thin placental barrier into the fetal capillaries, binding to fetal hemoglobin, which has a higher affinity for oxygen than adult hemoglobin. Simultaneously, carbon dioxide, a metabolic waste product from the fetus, diffuses from the fetal blood into the maternal blood to be exhaled by the mother. This bidirectional gas transfer ensures that the fetus receives an adequate supply of oxygen for aerobic respiration while effectively removing carbon dioxide.

Beyond exchange, the placenta acts as a powerful **endocrine organ**, synthesizing and secreting a wide array of hormones that are crucial for maintaining pregnancy and supporting fetal development. Key hormones include human chorionic gonadotropin (**hCG**), which sustains the corpus luteum and prevents menstruation; progesterone, vital for maintaining uterine quiescence and supporting the endometrial lining; estrogens, which promote uterine growth and prepare the mammary glands for lactation; and human placental lactogen (**hPL**), which influences maternal metabolism to ensure a constant nutrient supply to the fetus. These hormones orchestrate profound physiological changes in the mother's body to accommodate the growing fetus.

Furthermore, the placenta offers a degree of **immunological protection** and plays a significant role in **thermo-regulation**. It allows for the selective transfer of maternal antibodies, particularly IgG, to the fetus during the later stages of pregnancy, conferring passive immunity against various

pathogens to which the mother has been exposed. This provides crucial protection to the newborn in the initial months of life. In terms of thermoregulation, the placenta helps maintain a stable internal temperature for the fetus, acting as a heat exchanger to dissipate excess fetal heat into the cooler maternal circulation, thereby protecting the delicate developing tissues from thermal fluctuations.

5. Fetal-Maternal Connection and Umbilical Cord

The establishment of the fetal-maternal connection is a highly synchronized biological process initiated by the implantation of the blastocyst into the uterine wall. Following successful implantation, specialized trophoblast cells rapidly proliferate and invade the maternal decidua, ultimately forming the placenta. This intimate connection is critical for ensuring the continuous and efficient transfer of substances between the mother and the developing fetus, supporting all aspects of fetal growth and homeostasis. The placenta effectively anchors the fetus within the uterus while simultaneously providing the vast surface area required for robust physiological exchange.

The anatomical and physiological bridge between the placenta and the fetus is the **umbilical cord**. This cord develops from the connecting stalk and is typically attached to the central portion of the fetal surface of the placenta, although variations in insertion site can occur. Within the umbilical cord, the two umbilical arteries carry deoxygenated blood and metabolic waste products away from the fetus to the placenta, while the single umbilical vein transports oxygenated, nutrient-rich blood from the placenta back to the fetus. The integrity of these vessels and the surrounding Wharton's jelly, which protects them from compression, is paramount for maintaining the fetal lifeline.

The intricate vascular arrangement within the placenta ensures that maternal and fetal blood streams flow in close proximity, separated only by the thin placental barrier, but never directly mix. This separation is vital for several reasons, including preventing maternal immune responses against fetal antigens and protecting the fetus from potential maternal infections or toxins. The efficiency of this exchange system is influenced by factors such as placental surface area, thickness of the placental barrier, and the blood flow rates in both maternal and fetal circulations. The dynamic nature of this connection allows the placenta to adapt its functions to the changing demands of the growing fetus throughout the gestation period.

6. Placental Expulsion and Postpartum Care

The expulsion of the placenta marks the third and final stage of labor, typically occurring within 5 to 30 minutes after the birth of the baby. This physiological process begins with a surge of uterine contractions that cause the placenta to detach from the uterine wall. As the uterus contracts, its reduced volume causes the placental site to shrink, leading to shearing forces that separate the

placenta from its implantation site. Once detached, the placenta descends into the lower uterine segment and vagina, from where it is then expelled, often assisted by gentle traction on the umbilical cord by the attending medical professional.

Following its expulsion, the placenta is commonly referred to as the **afterbirth**. Medical professionals meticulously inspect the expelled placenta to ensure its completeness and integrity. This examination is crucial to verify that no fragments of placental tissue remain within the uterus, as retained placental tissue can lead to serious postpartum complications. The surface of the placenta is examined for any missing cotyledons or membranes, and the umbilical cord is inspected for its normal structure and insertion point. Any abnormalities or suspicion of retained tissue necessitates further intervention to prevent adverse outcomes.

The importance of ensuring complete placental expulsion cannot be overstated. If fragments of the placenta remain in the uterus, they can prevent the uterus from contracting effectively, leading to excessive blood loss, known as **postpartum hemorrhage**, which is a leading cause of maternal mortality. Furthermore, retained placental tissue provides a nidus for bacterial growth, significantly increasing the risk of potentially fatal infection, such as endometritis or puerperal sepsis. Therefore, diligent management of the third stage of labor and thorough assessment of the expelled placenta are critical components of safe childbirth practices.

7. Clinical Significance and Complications

The placenta's health and proper functioning are intrinsically linked to the success of pregnancy and the well-being of both mother and fetus. Beyond the crucial issue of complete expulsion, various complications related to placental development, implantation, and function can arise, posing significant risks. One such condition is **placenta previa**, where the placenta partially or completely covers the cervical os, potentially leading to severe bleeding during pregnancy or labor and often necessitating a Cesarean section. Another serious complication is **placental abruption**, the premature detachment of the placenta from the uterine wall before birth, which can cause significant maternal hemorrhage, fetal distress, and preterm birth.

A spectrum of conditions collectively known as **placenta accreta spectrum** disorders involves abnormal adherence of the placenta to the uterine wall, where the trophoblast cells invade too deeply into the myometrium. This can range from placenta accreta (adherence to the myometrium) to increta (invasion into the myometrium) and percreta (invasion through the myometrium, possibly into adjacent organs). These conditions are increasingly common, often linked to previous uterine surgeries, particularly Cesarean sections, and carry a high risk of massive hemorrhage, hysterectomy, and maternal morbidity and mortality during delivery. Early diagnosis and careful management are essential.

Beyond these structural and implantation issues, placental insufficiency, characterized by reduced

capacity of the placenta to fulfill its exchange functions, can profoundly impact fetal development. Conditions such as preeclampsia, chronic hypertension, or maternal diabetes can compromise placental blood flow and function, leading to **intrauterine growth restriction (IUGR)**, fetal distress, and increased risks of stillbirth or preterm delivery. The placenta's intricate role makes it a key determinant of both short-term fetal outcomes and potential long-term health trajectories for the offspring, highlighting its importance as a focus of ongoing research in maternal and child health.

Further Reading

[Placenta - Wikipedia](#)

[Umbilical cord - Wikipedia](#)

[Postpartum hemorrhage - Wikipedia](#)

[Placenta previa - Wikipedia](#)

[Placental abruption - Wikipedia](#)

[Placenta accreta - Wikipedia](#)

[Physiology, Placenta - StatPearls - NCBI Bookshelf](#)

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