

## Understanding the Pathophysiology of the Placenta

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### Abstract:

The placenta plays a role in the development and maintenance of a healthy pregnancy. In this article, we will provide some information about the pathophysiology of the placenta, eliciting structure, functions and disorders of placenta. The placenta contains fetal villi and maternal decidua. Fetal villi will play a role regarding the exchange of nutrients, gases and waste products between the mother's blood and fetal blood. Maternal decidua nourishes developing embryo and later the fetus. Placenta vplays arole regarding nutrient exchange, waste removal, hormone transfer and other functions also. Placenta produces hCG, progesterone, estrogen, human placental lactose, relaxin and corticotropic releasing hormone. It is finally concluded that placenta releases different immunoglobulin suppressive factors namely cytokines and hormones to lessen the maternal immune response and enhance tolerance.

**Key Words:** Placenta, fetal villi, maternal decidua, developing embryo, mayernal\_ fetal barrier, syncytiotrophoblast. Implantation, decidua basalis, decidua parietalis, decidua Vera, ptmrogesterone, estrogen, regeneration of uterine lining, oxygen, glucose, amino acids, fatty acids, human chorion gonadotropin. Relaxin, immunological barrier, trophoblast cells, immunoglobulin suppressive factors and microbial barrier.

### Introduction

The placenta is a remarkable organ that plays a crucial role in the development and maintenance of a healthy pregnancy. While often overshadowed by the fetus it nourishes, the placenta is a complex and dynamic structure in its own right. In this article, we will delve into the pathophysiology of the placenta, exploring its structure, function, and the disorders that can affect it.

## ***The Placental Structure***

The placenta is a temporary organ that develops during pregnancy. It is formed primarily from maternal and fetal tissues and serves as the interface between the mother and the developing fetus. This unique structure consists of the following components:

1. Fetal villi
2. Maternal Decidua

### ***1. Fetal Villi***

Fetal villi are finger-like projections in the placenta that play a crucial role in fetal-maternal exchange. Let's look on fetal villi In detailed:

#### ***Structure:***

Fetal villi are composed of trophoblast cells, which are the outermost layer of cells surrounding the developing embryo. They branch out like tiny fingers, creating a large surface area for exchange.

#### ***Function:***

Fetal villi facilitate the exchange of nutrients, gases, and waste products between the mother's bloodstream and the fetal blood. This exchange is vital for the nourishment and oxygenation of the developing fetus.

#### ***Maternal-Fetal Barrier:***

Fetal villi form a barrier that separates the maternal blood in the intervillous spaces from the fetal blood within the capillaries of the villi. This barrier prevents direct mixing of the two blood supplies while allowing essential substances to pass through.

#### ***Exchange of Nutrients:***

Maternal blood within the intervillous spaces provides nutrients, including oxygen and glucose, to the fetal blood. Waste products, such as carbon dioxide and urea, are removed from the fetal circulation into the maternal circulation for elimination.

#### ***Villous Types:***

There are two main types of fetal villi – floating villi and anchoring villi. Floating villi are surrounded by maternal blood in the intervillous spaces, while anchoring villi are embedded in the maternal uterine tissue.

#### ***Development:***

Fetal villi develop early in pregnancy and undergo various changes throughout gestation to optimize their function. As pregnancy progresses, villous trees become more complex.

#### ***Syncytiotrophoblast:***

The outer layer of fetal villi is primarily composed of a specialized, multinucleated cell called syncytiotrophoblast, which is involved in the exchange of substances between mother and fetus.

#### ***Role in Hormone Production:***

Fetal villi also contribute to the production of hormones, such as human chorionic gonadotropin (hCG), which is important for maintaining pregnancy.

Overall, fetal villi are essential structures in the placenta that enable the exchange of essential substances between the mother and the developing fetus, ensuring the nourishment and oxygen supply vital for fetal growth and development.

## ***2. Maternal Decidua***

The maternal decidua is an important component of the placenta during pregnancy. Some key points on maternal decidua:

### ***Definition:***

Maternal decidua refers to the specialized endometrial tissue in the uterus that undergoes significant changes during pregnancy to support and nourish the developing embryo and later the fetus.

### ***Function:***

The decidua plays a crucial role in implantation, nourishment, and protection of the developing embryo. It serves as a maternal-fetal interface.

### ***Changes During Pregnancy:***

The decidua undergoes structural and functional changes throughout pregnancy. Initially, it provides a site for embryo implantation and then becomes an integral part of the placenta.

### ***Decidual Reaction:***

This is the process through which the decidua transforms in response to the presence of an embryo. It becomes highly vascularized and secretory.

### ***Decidua Basalis:***

This is the portion of decidua located at the site of embryo implantation. It forms the maternal part of the placenta and is essential for the exchange of nutrients and waste products between the mother and the fetus.

### ***Decidua Parietalis:***

This is the part of the decidua that lines the rest of the uterine cavity. It does not directly interact with the embryo but is important for the overall function of the decidua.

### ***Decidua Vera:***

This is a term sometimes used to describe the decidua as a whole, encompassing both the basalis and parietalis regions.

### ***Hormonal Regulation:***

Hormones like progesterone and estrogen play a role in maintaining the decidua's function and supporting the pregnancy.

**Role in Immunology:** The decidua also has immunological functions. It helps protect the developing fetus from rejection by the maternal immune system.

### ***Postpartum Changes:***

After childbirth, the decidua is partially shed during the process of placental expulsion and is replaced by the regeneration of the uterine lining.

## ***Function of the Placenta***

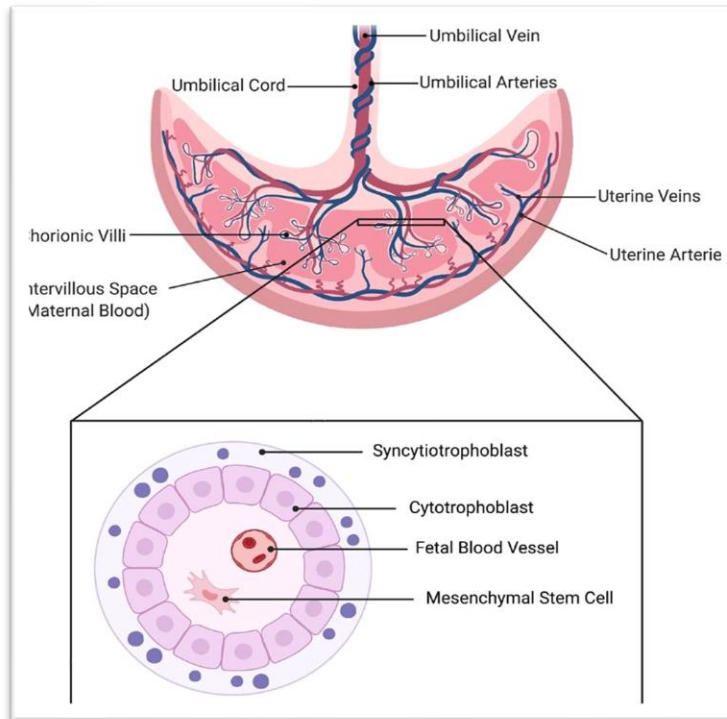
The placenta is often referred to as the fetus's lifeline, and for good reason. It performs a wide range of vital functions, including:

### ***Nutrient Exchange:***

The placenta acts as a bridge between the mother's bloodstream and the fetal circulation, facilitating the transfer of essential nutrients from the mother to the developing fetus. This exchange occurs through several mechanisms:

**Oxygen:** Oxygen from the mother’s blood diffuses into the fetal blood in the placenta, ensuring the fetus receives the oxygen necessary for its growth and metabolism.

**Nutrients:** Nutrients such as glucose, amino acids, and fatty acids are transported from the mother’s bloodstream to the fetal blood through specialized transport proteins in the placental membrane.



**Waste Removal:** Metabolic waste products, such as carbon dioxide, are carried from the fetus to the mother’s blood for elimination.

**Hormone Transfer:** The placenta also facilitates the transfer of certain hormones, such as estrogen and progesterone, which are essential for maintaining the pregnancy.

**Barriers and Protection:** The placenta acts as a selective barrier to prevent harmful substances from crossing from the mother to the fetus. While it allows the passage of nutrients and gases, it blocks the transmission of many toxins and pathogens.

**Maternal and Fetal Blood Do Not Mix:** Importantly, maternal and fetal bloodstreams do not directly mix in the placenta. They remain separated by a thin membrane to prevent immune responses and mixing of blood types.

**Endocrine Function:** In addition to nutrient exchange, the placenta has an endocrine function. It produces hormones like human chorionic gonadotropin (hCG), which sustains early pregnancy, and later, it produces hormones to support pregnancy and prepare the body for labor.

**Development and Growth:** The placenta grows throughout pregnancy to meet the increasing nutritional needs of the developing fetus.

## ***Hormone Production:***

The placenta plays a crucial role in hormone production during pregnancy. Here are some important hormones produced by the placenta:

***hCG (Human Chorionic Gonadotropin):*** This hormone is one of the earliest indicators of pregnancy. It is produced by the placenta shortly after implantation and helps maintain the corpus luteum, which, in turn, produces progesterone to support the pregnancy.

***Progesterone:*** The placenta takes over the production of progesterone during pregnancy. This hormone is essential for maintaining the uterine lining and preventing contractions that could lead to a miscarriage.

***Estrogen:*** The placenta is a significant source of estrogen production during pregnancy. Estrogen plays a vital role in promoting uterine growth, breast development, and the development of the fetus.

***Human Placental Lactogen (hPL):*** This hormone is produced by the placenta and is similar to growth hormone. It helps regulate maternal glucose and fat metabolism to provide essential nutrients to the developing fetus.

***Relaxin:*** The placenta also produces relaxin, which helps relax the uterine muscles and other pelvic ligaments, allowing for easier expansion of the uterus and facilitating childbirth.

***Corticotrophin-Releasing Hormone (CRH):*** The placenta produces CRH, which is involved in regulating the length of pregnancy and fetal development. It also affects the timing of labor and delivery.

These hormones work together to support the pregnancy, ensure fetal development, and prepare the mother's body for childbirth. The placenta's endocrine functions are critical for a healthy pregnancy.

## ***Immunological Barrier***

The placenta acts as a barrier to protect the developing fetus from potential immune responses and infections. Here are some key notes on the immunological barrier carried out by the placenta:

***Physical Barrier:*** The placenta serves as a physical barrier between the maternal and fetal circulatory systems. It consists of multiple layers of tissue that separate the two, preventing direct contact.

***Immunological Tolerance:*** The placenta helps establish immunological tolerance in the mother's body toward the developing fetus. This means that the mother's immune system does not mount an attack against the fetus, which is genetically distinct.

***Trophoblast Cells:*** The outer layer of the placenta contains trophoblast cells, which play a critical role in preventing immune responses. These cells actively inhibit the maternal immune system's recognition of the fetus as foreign.

***Immunosuppressive Factors:*** The placenta releases various immunosuppressive factors, such as cytokines and hormones, to dampen the maternal immune response and promote tolerance.

***Limited Antibody Transfer:*** While the placenta allows some essential substances to pass from the mother to the fetus, it selectively restricts the transfer of maternal antibodies. This helps protect the fetus from any potentially harmful antibodies that the mother might produce.

**Microbial Barrier:** The placenta also acts as a microbial barrier, preventing the passage of harmful microorganisms from the mother to the fetus. This is essential for protecting the developing fetus from infections.

**Selective Nutrient Transfer:** The placenta allows for the transfer of vital nutrients and oxygen from the mother to the fetus, ensuring the growing baby's health and development.

**Role in Immune Memory:** Some research suggests that the placenta may also play a role in transmitting immune memory from the mother to the baby, providing initial protection against certain infections after birth.

**Postpartum Changes:** After childbirth, the placental barrier disappears, and the mother's immune system may become more active against potential pathogens. This change helps protect the newborn as their own immune system develops.

## **Pathophysiology of the Placenta**

While the placenta is a resilient and adaptable organ, various disorders can disrupt its normal function. Let's discuss some common pathophysiological conditions that can affect the placenta:

### ***Placenta Previa***

Placenta previa is a medical condition during pregnancy where the placenta partially or completely covers the cervix. Here are some key points about placenta previa:

#### ***Types of Placenta Previa:***

There are three main types:

**Complete Placenta Previa:** The placenta completely covers the cervix.

**Partial Placenta Previa:** The placenta partially covers the cervix.

**Marginal Placenta Previa:** The placenta is near the cervix but doesn't cover it.

#### ***Symptoms:***

The most common symptom is painless vaginal bleeding during the second or third trimester.

#### ***Risk Factors:***

Risk factors for placenta previa include previous C-sections, multiple pregnancies (e.g., twins), older maternal age, and smoking.

#### ***Diagnosis:***

Placenta previa is usually diagnosed through ultrasound.

#### ***Complications:***

Placenta previa can lead to serious complications such as excessive bleeding (hemorrhage) during labor and delivery.

#### ***Management:***

Management often involves bed rest and close monitoring. If bleeding is severe or other complications arise, a C-section may be necessary for delivery.

#### ***Precautions:***

Pregnant women with placenta previa should avoid sexual intercourse and heavy lifting to reduce the risk of bleeding.

## ***Follow-Up:***

Regular prenatal check-ups and consultations with an obstetrician are essential for proper management.

## ***Delivery:***

In most cases, a C-section is scheduled for delivery to avoid the risk of severe bleeding during vaginal delivery.

## ***Post-Delivery:***

After delivery, the placenta previa usually resolves. However, it's essential to monitor for postpartum bleeding and other complications.

## ***Placental Abruption***

Placental abruption is a serious medical condition during pregnancy where the placenta partially or completely separates from the uterus before the baby is born.

## ***Causes:***

Placental abruption can be caused by various factors, including high blood pressure, trauma, smoking, drug use, a previous history of abruption, and certain pregnancy complications.

## ***Symptoms:***

Symptoms may include vaginal bleeding, abdominal pain, back pain, uterine contractions, and fetal distress. However, some cases may be asymptomatic.

## ***Diagnosis:***

Diagnosis is typically made through physical examination, ultrasound, and monitoring the baby's heart rate. The severity of abruption can vary.

## ***Complications:***

Placental abruption can lead to significant complications, such as fetal distress, premature birth, and in severe cases, maternal and fetal mortality.

## ***Treatment:***

Treatment depends on the severity of abruption. Mild cases may require close monitoring, while severe cases may necessitate an emergency C-section to deliver the baby.

## ***Risk Factors:***

Women with risk factors such as smoking, drug use, high blood pressure, or a previous history of abruption should receive prenatal care and be vigilant for symptoms.

## ***Prevention:***

While some risk factors are not preventable, maintaining a healthy lifestyle, attending regular prenatal check-ups, and managing underlying medical conditions can reduce the risk of placental abruption.

## ***Prognosis:***

The prognosis for placental abruption varies depending on its severity and how quickly it is diagnosed and treated. Early intervention can significantly improve outcomes.

## ***Preeclampsia***

Preeclampsia is a serious pregnancy complication characterized by high blood pressure and damage to organs, typically occurring after the 20<sup>th</sup> week of pregnancy.

## ***Symptoms:***

Preeclampsia symptoms can include high blood pressure, swelling (edema), and protein in the urine (proteinuria). Other signs may include headaches, vision changes, abdominal pain, and weight gain.

Risk factors: Women with a history of high blood pressure, preeclampsia in a previous pregnancy, obesity, or certain medical conditions are at higher risk. It can also affect first-time mothers.

## ***Complications:***

Preeclampsia can lead to serious complications for both the mother and the baby, including organ damage, premature birth, low birth weight, and even stillbirth.

## ***Diagnosis:***

Diagnosis involves regular blood pressure monitoring and urine tests during prenatal check-ups. Blood tests, ultrasounds, and other assessments may also be used to evaluate the condition.

## ***Treatment:***

The only definitive treatment for preeclampsia is delivering the baby. Depending on the severity and gestational age, a healthcare provider may recommend inducing labor or performing a cesarean section.

## ***Management:***

In cases where it's too early for delivery, management strategies may include bed rest, medications to control blood pressure, and close monitoring.

## ***Postpartum:***

Preeclampsia can persist or develop postpartum. It's important to continue monitoring blood pressure and seek medical care if symptoms worsen.

## ***Prevention:***

Although preeclampsia cannot always be prevented, regular prenatal care and managing risk factors can help reduce the risk. Low-dose aspirin may be prescribed in some cases.

## ***Long-term effects:***

Preeclampsia can increase the risk of future cardiovascular problems for the mother, so ongoing healthcare and monitoring are crucial.

## ***Gestational Diabetes***

Gestational diabetes is a type of diabetes that develops during pregnancy.

## ***Definition:***

Gestational diabetes occurs when the body can't produce enough insulin to meet the increased needs during pregnancy, leading to high blood sugar levels.

## ***Risk Factors:***

Risk factors include being overweight, older age during pregnancy, family history of diabetes, and certain ethnic backgrounds.

## ***Screening:***

Pregnant women are typically screened for gestational diabetes between 24 and 28 weeks of pregnancy. It involves a glucose tolerance test.



## ***Complications:***

Untreated gestational diabetes can lead to complications for both the mother and the baby. These may include preeclampsia, high birth weight, and an increased risk of type 2 diabetes for the mother.

## ***Management:***

Treatment often involves lifestyle changes, such as a balanced diet and regular physical activity. Some women may need insulin or other medications to control blood sugar.

## ***Monitoring:***

Regular monitoring of blood sugar levels is essential during pregnancy to ensure they remain within a healthy range.

## ***Postpartum:***

Gestational diabetes usually goes away after childbirth, but both the mother and child are at increased risk of developing type 2 diabetes later in life.

## ***Follow-up:***

Women who have had gestational diabetes should continue to be monitored after giving birth and adopt a healthy lifestyle to reduce the risk of type 2 diabetes.

## ***Placental Insufficiency***

Placental insufficiency is a condition in which the placenta doesn't function properly, leading to inadequate oxygen and nutrient supply to the fetus.

***Causes:*** Placental insufficiency can result from various factors, including maternal conditions (e.g., hypertension, diabetes), placental abnormalities, smoking, drug use, or multiple pregnancies.

## ***Consequences:***

Inadequate blood flow through the placenta can result in fetal growth restriction, which may lead to low birth weight and preterm birth.

## ***Diagnosis:***

It's typically diagnosed through ultrasound, measuring the fetal growth rate, Doppler flow studies, and other tests to assess placental function.

## ***Symptoms:***

There might not be obvious symptoms in the mother, but warning signs can include decreased fetal movement, high blood pressure, or abnormal fetal heart rate.

## ***Management:***

Management includes careful monitoring of both the mother and fetus, dietary and lifestyle changes, and sometimes early delivery if the condition becomes severe.

## ***Complications:***

Placental insufficiency can increase the risk of stillbirth, neonatal complications, and long-term health issues for the baby.

## ***Prevention:***

Prenatal care is crucial to detect and manage placental insufficiency early. Maintaining a healthy lifestyle and managing underlying health conditions can help reduce the risk.

## ***Conclusion***

Understanding the pathophysiology of the placenta is essential for the proper management of pregnancy and the early detection of complications. The placenta is a remarkable organ that plays a pivotal role in fetal development and maternal well-being. Knowledge of its structure and function, as well as the potential disorders that can affect it, is critical in ensuring healthy pregnancies and safe deliveries.

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