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## Human life root with branches: Placenta

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### Abstract

**Introduction:** The Placenta is root of life look like tree with many braches. The placenta is the organ that provides fetal respiration and maintains the metabolic and nutrient exchange between the maternal and fetal circulations. The placenta is attached to the uterine wall and establishes connection between the mother and the fetus through the umbilical cord.

**Placental circulation:** Maternal placental or utero placental circulation. Fetal placental circulation

**Placental ageing:** As the placenta has got a limited life span, it is likely to undergo degenerative changes as a mark of senescence.

**Placental function:** respiration, nutrition, excretion, protection, storage, Hormonal secretion

**The fetal membranes:** The basic function are formation of liquor, Prevent ascending uterine infection by intact membrane, During labour, facilitate cervical dilatation. enzymatic activity for steroidal hormonal metabolism. Source of glycerophospholipids

**Amniotic:** Provide a medium for fetal movement, Protects the fetus against injury from external causes, Assists in maintaining temperature, Distends the amniotic sac

**Keywords:** Placenta, Maternal placental or utero placental circulation. Fetal placental circulation, liquor, glycerophospholipids

### 1. Introduction

#### Placental Circulation

**a) Maternal placental or utero placental circulation:-** then mature placenta has a volume of about 500 ml of blood; 350 ml being occupied in the villi system and 150 ml lying in the intervillous space, the blood in the intravillous space is completely replaced about 3-4 times per minutes. The villi depend on the maternal blood for their nutrition.

**Arterial Circulation:** the cytotrophoblastic invasion into the spiral arteries initially upto the intra decidual portion within 12 weeks of pregnancy. Ther is secondary invasion of trophoblast between 12 -16 weeks extending upto radial arteries within the myometrium. Thus spiral arteries are converted to large bore Uteroplacental arteries.

**Venous circulation:** the venous blood of the intervenous space drains through the uterine veins which pierce the basal plate randomly like the arteries. The concept of the utero placental circulation is based on the studies of ramsey and co-workers.

The oxygenated blood enters the intervillous spaces from the deciduas basalis. The maternal blood pressure directs towards the choroionic villi 70 – 80 mm Hg and the deoxygenated blood leaves the intervillous spaces 8 mm Hg pressure through openings in the cytotrophoblast and enters the endometrial veins with uterine contraction intervillous spaces, forcing the blood into the uterine veins. The short circuit of the arterial blood into the neighbouring venous channel is prevented by the increased pressure of the endometrial arteries driving the blood in jet towards the chorionic plate. During uterine contraction, the veins are occluded but the arterial blood is forced into the intravillous space: while uterine relaxation facilitates venous drainage. This brought about by the fact that the spiral arteries are perpendicular and the veins are parallel to the uterine wall. Thus during contraction, larger volume of blood is available for exchange even though the rate of flow is decreased. The blood in the intervillous space is procted from clotting by some fibrinolytic enzyme activity of the trophoblast.

**b) Fetal placental circulation:** The Two umbilical arties carry impure blood from the fetus the deoxygenated blood leaves the fetus through the two umbilical arteries and these two umbilical arteries divided into multiple branches as they enter the chorionic villi. the blood flows into the corresponding venous channels either through the terminal capillary networks

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or though the shunts. Maternal and fetal blood stream flow side by side, but in opposite direction. This counter current flow facilitate material exchange between the mother and the fetus. The villus capillary pressure varies 20 -40 mm Hg. The fetal blood flow through the placenta is about 400 ml per minutes.. The oxygenated blood returns via venouls and veins in the chorionic villi. The veins in the choroionic villi join to form the umbilical vein. This is mainly facilitated by the pumping action of the fetus heart

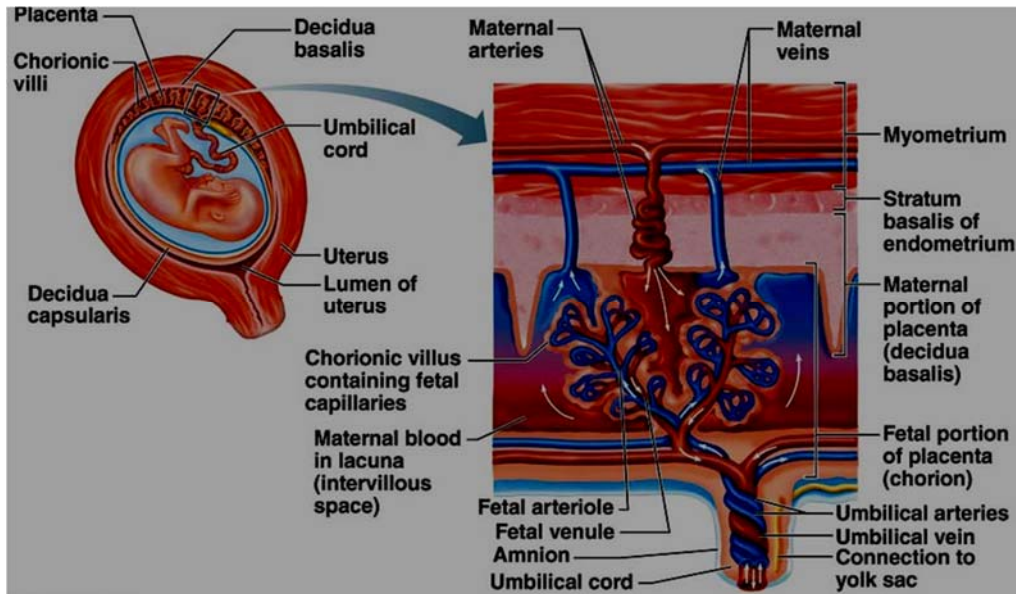
**Placental Membrane (Placental barrier):** inspite of close proximity, there is no mixing of maternal and fetal blood. The two separates by tissue called placental membrane or placental barrier, consisting of the following:

In early pregnancy it consist of (1) Syncytiotrophoblast,

- (2) Cytotrophoblast,
- (3) basement membrane,
- (4) stromal tissue and
- (5) endothelium of the fetus capillary wall with its basement membrane.

**It is about 0.025 mm thick**

**Near term,** there is sttenuation of the syncytial layer. Sprase cytotrophoblast and distended fetal capillaries almost fill the villus. The specialized zones of the villi where the syntiotrophoblast is thin and anuclear is known as Vasculo Syncytial membrane. These two zones (0.002mm) of terminal villialphazone are for gas exchange. The thick 'Beta Zone' of the terminal villi with the layers remaining thick in patches is for hormone synthesis



### Placental Ageing

As the placenta has got a limited life span, it is likely to undergo degenerative changes as a mark of senescence. The aging process varies in degree and should be differentiated from the morbid process likely to affect the organ in some pathological states. The ageing process involves both the fetal and maternal components.

**Villi Change:** the following changes are observed as pregnancy advances towards term

- 1 Decreasing thickness of the syncytium and appearance of syncytial knots (aggregation of the syncytium in the small areas on the side of the villus.
- 2 Partial disappearance of langhan's cell.
- 3 Decreased in stromal tissue including Hofbauer cells
- 4 Obliteration of some vessels and marked dialation of the capillaries
- 5 Thickening of basement layers of the fetal endothelium and cyntotrophoblast
- 6 Deposition of fibrin on the surface of the villi.

**Decidual Changes:** there is an area of fibrinoid degeneration, where trophoblast cells (covered with syncytium) meet the deciduas. The zones is known as Nitabuch Layer. This layer limits further invasion of the

deciduas by the trophoblast. The membrane is absent in Placenta Accreta.

**Intervillous Space:** the syncytium, covering the villi and extending into the deciduas or intervillous space, undergoes fibrinoid degeneration and from a mass entangling variables number of villi. These are called white infract which vary in size from few millimeters to a centimeters or more. Calcification or even cyst formation may occur on it. Such type of degeneration is usually near to the placental margin. There may be inconsistent deposition of fibrin called Rohr's Stria at the bottom of the intervillous space and surrounding the fastening villi.

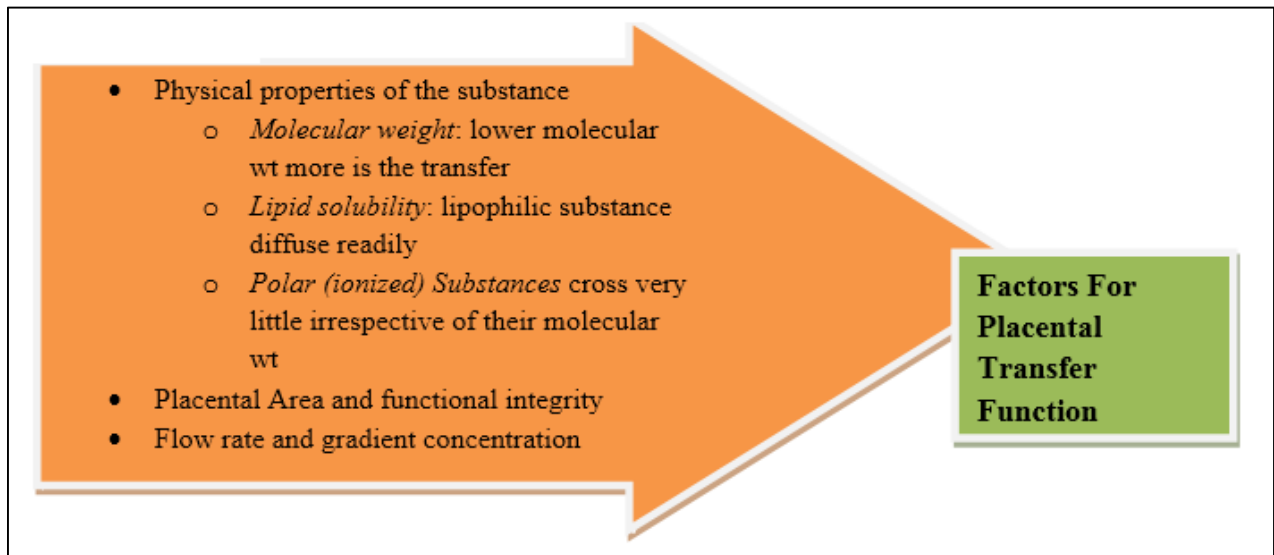
### Mechanism of Placental Transfer

- a) **Active transport:** it is the passage of substances from the mother to fetus against a concentration gradient. It requires expenditure of energy by the cells and it can be inhibited by the substances that interfere with energy production, amnion acids, iron, cacium, iodine, and water-soluble vitamins are transported by this process.
- b) **Breaks in the placental membranes:** defects or breakds allow for the transfer of large cells, such as red blood cells. This process is responsible for Rh sensitization, only when the mother is Rh negative and fetus is Rh positive, the Rh positive fetal cells enter the maternal system through a breaks or defects in the

placenta. The maternal system develops antibodies to the Rh positive fetal cells. This process occurs most frequently during delivery.

- c) **Bulk flow:** that transfer substances by osmosis through micropores in the membrane. This process maintains the maternal fetal exchange of water.
- d) **Diffusion:-** it is the passage of a substance on the basis of its concentration, the speed of diffusion depends on -
  - Level of concentration: molecules in higher levels of concentration move more rapidly toward lower concentration.
  - Size of molecule can affect the movement rate, the larger molecule s move at different rate, the higher temperature, the greater activity.
  - It provide the mechanism for the transfer of respiratory gases ( O<sub>2</sub> and CO<sub>2</sub> ) electrolytes and some lipid soluble vitamins

- Limitation and diffusion are a major factor in placental failure.
- e) **Facilitate diffusion:** it occurs when the concentration of material on the maternal side greater than the concentration levels on the fetal side. It occurs without energy expenditure and rate is greater than that of simple diffusion. The D-Glucose, galactose, and some O<sub>2</sub> are transported by this process.
- The substances that are highly soluble cross the placenta at a faster rate, uncharged particles, such as dissolved CO<sub>2</sub>, pass rapidly and explains the rapid effect that maternal metabolic acidosis or alkalosis has on the fetus, versus the effect of the maternal metabolic acidosis
- f) **Pinocytosis:** - the microdrops of plasma are taken by the trophoblasts and it transport immunoglobulins from the plasma to the fetus.



### Transfer Disorders

1. Separation of the placenta from the uterine wall
  - a. Placenta Previa
  - b. Placental infarcts
  - c. Abruptio Placentae
2. Intervillous coagulation and ischemic necrosis
3. Alternations in the membranes as a result of calcification, thickening and degeneration may alter permeability
4. Usually result from a problem in the maternal circulation
  - a. Hypertensive disorders in pregnancy
  - b. Diabetes mellitus
  - c. Severe maternal malnutrition
5. For Placental insufficiency to occur, a major portion of the placenta must be involved.

### Placental Function

1. Respiration
  - a. Oxygen in the maternal blood crosses the placenta must be enters the fetal blood supply by diffusion.
  - b. Carbon dioxide returns to the maternal system across the placental membranes and membranes.
  - c. The oxygen supply to the fetus is at the rate of 8 ml/kg/min and this is achieved with cord blood flow of 165- 330 ml/min.

- d. Actual fetal pulmonary respiration does not take place in utero.
2. Nutrition
  - a. Water, inorganic salt, carbohydrates, fats, protein and vitamins pass from the maternal blood through placental membranes into the fetal system via enzymatic carriers.
  - b. The fetal glucose level is lower than the maternal indicating rapid rate of utilization of glucose.
  - c. The placenta metabolizes glucose and stores it in the form of glycogen until the fetal liver is able to function.
  - d. Triglycerides and fatty acids are directly transported from the mother to the fetus in early pregnancy but probably are synthesis in the fetus later in pregnancy. Essential fatty acids are transferred more the non essential fatty acids. Cholesterol is capable of direct transfer. Thus, fetal fat has got a dual origin.
  - e. Amino Acid concentration is higher than the maternal blood, some proteins (IgG) cross by the process of endocytosis. Fetal protein are synthesized from transferred amino acids and the level is lower than mother.
  - f. Water and electrolytes Na<sup>+</sup> K<sup>+</sup> and Cl<sup>-</sup> is transferred by simple diffusion and Ca, Ph, Fe are by active transport, since there level is higher than mother

- g. Water soluble Vitamins are transfer by active transport but the fat soluble vitamins are transferred slowly so that they are low level in fetus
  - h. Hormones: insulin, steroids, thyroid, chorionic gonadotrophin or placental lactogen crosses the placenta at very slow rate, so their concentration remain low in fetus plasma. Neither parathormone nor Calcitonin crosses the placenta.
  - i. Enzymatic Function: neumerous enzymes are elaborated in the placenta, like (1) diamine oxidase, which inactivate the pressure amines (2) oxytocinase, which neutralize the Oxytocin, (3) phopholipaseA2 which synthesizes arachidonic acid. Etc
  - j. Barrier Function: fetal membrane considered as protective barrier to the fetus against the anoxious agents circulating in the maternal blood. Antibody and antigens immunological quantities can travel both directions. The transfer of higher molecular is through pincocytosis.
  - k. Immunological Function: placenta offers immunological protection against the rejection by mother tissues. There is shift of maternal cell mediate (T helper 1) to humoral (T Helper 2) immunity
- 1.
  3. Excretion
    - a. Waste products cross the placental membrane and enter the maternal blood.
    - b. Waste products produced by the fetus are minimal
  - 1) Fetal metabolism is mainly anabolic(the process of building)
  - 2) Waste products are produced through catabolic action (the breaking down of tissues).
  4. Protection
    - a. The placental barriers prevent the transfer of many harmful substances from the maternal blood system.
    - b. Maternal immunity is transferred to the fetus across the placenta
  5. Storage
    - a. Placenta stores carbohydrates, protein, calcium and iron until needed.
  6. Hormonal production
    - a. Placenta secrets and synthesizes hormones necessary for the maintenance of the pregnancy and fetal development
    - b. These hormones are the steroid hormones estrogen and progesterone and the protein hormones human choroionic gonadotropin, human chorionic somatomammotropin (HCS) (also known as human placental lactogen - HPL) and thyrotropin.

### **The Fetal Membranes**

Function: the basic function are

1. Formation of liquor
2. Prevent ascending uterine infection by intact membrane
3. During labour, facilitate cervical dialatation. enzymatic activity for steroidal hormonal metabolism.
4. Source of glycerophospholipids containing arachionic acid- precursor of prostaglandins E<sub>2</sub> and E<sub>2a</sub>

### **Amniotic Fluid**

**Function: The main function is protective to the fetus**

#### **During Pregnancy:**

- a. Provide a medium for fetal movement
- b. Protects the fetus against injury from external causes

- c. Assists in maintaining temperature
- d. Distends the amniotic sac
- e. Prevents the amnion from adhering the developing fetus

### **During Labour**

- a. The amnion and chorion are combined to form a hydrostatic wedge which helps in dilatation of the cervix.
- b. May be an important factor in dilating the cervical canal
- c. During uterine contraction, it prevent marked interferences with the placental circulation so long as the membranes remain intact.
- d. The end of first stage of labour the fluid flushes the birth canal by its aseptic and bactericidal action protects the fetus and prevent ascending uterine infection.

### **Clinical importance**

- a. By study of amniotic fluid get the information regarding well-being and maturity of fetus
- b. Instillation of chemical used as method of induction of abortion
- c. Induction of labour by rupture of the membrane.

### **Placental Examination**

#### **Definition**

A thorough inspection and examination of the placenta and membranes, soon after expulsion, for its completeness and normalcy.

#### **Purposes**

1. To ensure that the entire placenta and membranes have expelled and no part has been retained.
2. To make sure that placenta is of normal size, shape, consistency and weight.
3. To detect abnormalities such as infraction, calcification or additional lobes.
4. To ascertain the length of the cord, number of blood vessels and site of insertion of the cord.
5. To prevent PPH and infection.
6. To check weight of placenta and measures length of cord.

#### **Articles**

- Placenta in a bowl
- A washable surface to lay the placenta
- A weighing machine
- Measuring tape
- Kidney tray
- Pair of gloves

#### **Procedure**

1. Don gloves (protects nurse from contamination)
2. Using gloved hands to hold the placenta by the cord allowing the membranes to hang (twisting the cord twice around the fingers will provide a firm grip). Hanging membranes will provide a better view to check its completeness.
3. Identify the hole through which the baby was delivered. If the membranes are not torn into pieces, a single round hole can be identified clearly.
4. Insert hand through the hole and spread out the fingers to view the membranes and blood vessels. This position of cord insertion and the course of blood vessels can be noted in this position.

5. Remove the hand from inside the membranes and lay the placenta on a flat surface with the fetal surface up. Identify the site of cord insertion. Normally the cord is inserted in the center of placenta. Lateral or velamentous insertion may be noted.
6. Examine the two membranes, amnion and chorion for completeness and presence of abnormal vessels indicating succenturiate lobe. Amnion is shiny and chorion is shaggy. Amnion can be peeled from the chorion up to the umbilical cord.
7. Invert the placenta, expose the maternal surface and remove any clots present
8. Examine the maternal surface by spreading it in the palms of your two hands and placing the cotyledons in close approximation (any broken fragment must be replaced before accurate assessment is made). This ensures that no part of placenta or membranes is left inside the uterus.
9. Assess for presence of abnormalities such as infraction, calcification or succenturiate lobes.
10. Inspect cut end of the umbilical cord presence of three umbilical vessels. Two arteries and one vein should normally be seen. Absence of an artery may be associated with renal abnormalities
11. Measure the length of the umbilical cord by holding it extended against a graduated surface/ side of the weighing scale. (The length of cord on the baby may be added to get the total length where applicable). Average length of the cord is 50 cm.
12. Weigh the placenta by placing it on the weighing scale meant for the purpose. Normally the placenta weighs about 1/6th of the baby's weight.
13. Place the placenta in the bin for proper disposal
14. Clean the area used for examination of the placenta and membranes, the weighing scale and the bowl.
15. Remove gloves and wash hands.
16. Record in the patient's chart, the finding of placental examination and weight of placenta, length of the cord and any special observation made. Act as a communication between staff members.

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