Placenta and umbilical cord
structure and function
By
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'placenta is an organ that connects the developing fetus to the uterine wall (endometrium) to allow nutrient uptake, thermo-regulation, waste elimination, and gas exchange via the mother's blood supply; to fight against internal infection; and to produce hormones which support pregnancy.
Placenta

Human placenta develops from two sources
  Fetal component- Chorionic frondosum
  Maternal component- decidua basalis

Placental development begins at 6 weeks and is completed by 12th week
Placenta at Term- Gross Anatomy

- Fleshy
- Weight- 500gm
- Diameter- 15-20 cm
- Thickness- 2.5 cm
- Spongy to feel
- Occupies 30% of the uterine wall
- Two surfaces- Maternal and fetal
- 4/5th of the placenta is of fetal origin and 1/5 is of maternal origin
Fetal surface of the placenta

Covered by smooth and glistening amnion overlying the chorion

Umbilical cord is attached at or near its centre

Branches of the umbilical vessels are visible beneath the amnion as they radiate from the insertion of the cord
Maternal surface of the placenta

Rough and spongy
Maternal blood gives it dull red colour
Remanants of the decidua basalis gives it shaggy appearance
Divided into 15-20 cotyledons by the septa
Maternal Placental Blood Flow

Intervillous space of mature placenta contains about 150 ml of blood which is replenished 3 or 4 times a minute.

Uteroplacental blood flow increases from 50 ml per minute at 10 weeks to 500/600 ml per minute at full term.
Structure of the placenta

Placenta is limited by the amniotic membrane on the fetal side and by the basal plate on the maternal side.

Between these two lies the intervillous space filled with maternal blood and stem villi with their branches.
Amniotic membrane- single layer of cubical epithelium loosely attached to adjacent chorionic plate and does not take part in placental formation

Chorionic plate- forms the roof of the placenta
From outside inwards consists of
Syncitotrophoblast
Cytotrophoblast
Extraembryonic mesoderm with branches of umbilical vessels
**Basal Plate** - forms the floor
From outside inwards it consist of
- **Compact and spongy layer of decidua basalis**
- **Layer of Nitabuch**
- **Cytotrophoblastic shell**
- **Syncytiotrophoblast**

Basal plate is perforated by the spiral arteries allowing entry of maternal blood into intervillous space
Layer of Nitabuch - is a fibrinous layer formed at the junction of cytotothroblastic shell with decidua due to fibrinoid degeneration of syncitotrohoblast

It prevents excessive penetration of the decidua by the trophoblast

Nitabuch membrane is absent in placenta accreta and other morbidly adherent placentas
Intervillous space:

Numerous branch villi arising from the stem villi project into this space.

It is lined internally on all sides by the syncytiotrophoblast and is filled with maternal blood.
Placental Function

Transfer of gases, nutrients and waste products, namely
Respiratory function
Nutritive function
Excretory function
Endocrine and enzymatic function
Barrier function
Immunological function
Factors affecting the transfer between mother and the fetus

Physical properties of the substance- molecular weight, lipid solubility, ionised substances

Area and functional integrity of the placental membrane

Rate of blood flow

Concentration gradient of the substance on either side of the exchange membrane
Mechanism involved in the transfer of substances

Simple diffusion - O2 and CO2

Facilitated diffusion (carrier mediated) – glucose, vitamins

Active transfer (against concentration gradient) - ions

Endocytosis - invagination of cell membrane to form intracellular vesicle

Endocytosis - Release of substances in the vesicles to extracellular space eg IgG immunoglobulin
Respiratory function

Although fetal respiratory movement occurs, no active exchange of gases takes place.

Intake of oxygen and output of carbon dioxide take place by simple diffusion across the fetal membrane.

O2 delivery to the fetus is at the rate of 8 ml/kg which is achieved by cord blood flow of 160-320ml/min.
Excretory function

Waste products from the fetus such as urea, uric acid, cretinine are excreted to the maternal blood by simple diffusion
Nutritive function

Fetus obtains its nutrients from the maternal blood

Glucose transferred to the fetus by facilitated diffusion

Lipids for fetal growth and development have dual origin. They are transferred across the fetal membrane or synthesised in the fetus

Amino acids are transferred by active transport

Water and electrolytes- Na, K, Cl cross by simple diffusion, Ca, P, and Fe cross by active transport

Water soluble vitamins are transferred by active transport but the fat soluble vitamins are transferred slowly
Barrier Function

Placental membrane is thought to be a protective barrier for the fetus against harmful agents in the maternal blood.

Substances with large molecular weight or size like insulin or heparin are transferred minimally.

Only IgG (not IgA or IgM) antibodies and antigens can cross the placental barrier.

Most drugs can cross the placental barrier and some can be teratogenic.

Various viruses, bacteria, protozoa can cross the placenta and affect the fetus in utero.
IMMUNOLOGICAL FUNCTION

Fetus & placenta contain paternally determined antigens, foreign to the mother. Inspite of this, no evidence of graft rejection. Probably:

1. Fibrinoid & sialomucin coating of trophoblast may suppress the troblastic antigen.

2. Placental hormones, steroids, HCG have got weak immunosuppressive effect, may be responsible for producing sialomucin.
3. Nitabuch`s layer which intervenes between decidua basalis and cytotrophoblast probably inactivates the antigenic property of tissue.

4. There is little HLA & blood group antigens on trophoblast surface so antigenic stimulus is poor.

5. Production of block antibodies by mother protects fetus from rejection.
Endocrine and Enzymatic function

Placenta secretes various hormones – Protein hormones like HCG, human placental lactogen, pregnancy specific beta 1 glycoprotein, pregnancy associated plasma protein, steroidal hormones like estrogen and progesterone.

Enzymes secreted are diamine oxidase which activates the circulatory pressor amines, oxytocinase which neutralizes oxytocin, phospholipase A2 which synthesizes arachidonic acid.
PLACENTAL HORMONES

Human Chorionic Gonadotropin (hCG)
Human Chorionic Somatomropin (hCS) or Placental Lactogen (hPL)

OTHER HORMONES

Chorionic Adrenocorticotropin
Chorionic thyrotropin
Relaxin
PTH-rP
hGH-V

Estrogen (E)
Progesterone (P)

HYPOTHALAMIC-LIKE RELEASING HORMONES
GnRH
CRH
cTRH
GH-RH

PLACENTAL PEPTIDE HORMONES
Neuropeptide-Y
Inhibin & Activin
ANP
Human Chorionic Gonadotropin (hCG)

PREGNANCY HORMONE---glycoprotein

Half life – 24 hrs of hCG

Levels peak at 60-70 days then remain at a low plateau for the rest of pregnancy.

Placental GnRH have control of hCG.

FUNCTIONS:

1. RESCUE & MAINTENANCE of function of corpus luteum.
Prevents degeneration of corpus luteum
Stimulates corpus luteum to secrete E + P which, in turn, stimulate continual growth of endometrium.

2. hCG stimulates leydig cells of male fetus to produce testosterone in conjunction with fetal pituitary gonadotrophins. Thus indirectly involved in development of external genitalia.

3. Suppresses maternal immune function & reduces possibility of fetus immunorejection
Human Chorionic Somammatropin (hCS)
or Placental Lactogen
Structure similar to growth hormone •

Produced by the placenta •

throughout pregnancy Levels •

Large amounts in maternal blood but •

DO NOT reach the fetus
Human Chorionic Somammotropin (hCS) or Placental Lactogen

Biological effects are reverse of those of insulin: utilization of lipids; make glucose more readily available to fetus, and for milk production.
Estrogen (E)

FORMS-estriol, estradiol & estrone.
Estriol most important.
Levels increase throughout pregnancy

90% produced by placenta. (syncytiotrophoblast)

Placental production is transferred to both maternal and fetal compartments
Two of the principle effects of placental estrogens are:

**Stimulate growth of the myometrium** and **antagonize the myometrial-suppressing activity of progesterone**. In many species, the high levels of estrogen in late gestation induces myometrial oxytocin receptors, thereby preparing the uterus for parturition.

**Stimulate mammary gland development.** Estrogens are one in a battery of hormones necessary for both ductal and alveolar growth in the mammary gland.
Progesterone (P)

Levels increase throughout pregnancy

80-90% is produced by placenta and secreted to both fetus and mother
Progestins, including progesterone, have two major roles during pregnancy:

Support of the endometrium to provide an environment conducive to fetal survival. If the endometrium is deprived of progestins, the pregnancy will inevitably be terminated.

Suppression of contractility in uterine smooth muscle, which, if unchecked, would clearly be a disaster. This is often called the "progesterone block" on the myometrium. Toward the end of gestation, this myometrial-quieting effect is antagonized by rising levels of estrogens, thereby facilitating parturition.
Progesterone and other progestins also potently inhibit secretion of the pituitary gonadotropins luteinizing hormone and follicle stimulating hormone.

This effect almost always prevents ovulation from occurring during pregnancy.
Endocrine functions of the placenta

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Properties</th>
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<tbody>
<tr>
<td>Human Chorionic Somatomammotropin (HCS)</td>
<td>Similar to growth hormone and prolactin</td>
</tr>
<tr>
<td>Human Chorionic Gonadotrophin (HCG)</td>
<td>Stimulates adrenal and placental steroidogenesis. Analogous to LH</td>
</tr>
<tr>
<td>Human Chorionic Thyrotropin (HCT)</td>
<td>Analogous to Thyrotropin.</td>
</tr>
<tr>
<td>Corticotrophin Releasing Hormone (CRH)</td>
<td>As in adult.</td>
</tr>
<tr>
<td>Oestrogen</td>
<td>Complex. Stimulates uterine blood flow and growth.</td>
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<tr>
<td>Progestogens</td>
<td>Enables implantation and relaxes smooth muscle.</td>
</tr>
<tr>
<td>Adrenocorticoids</td>
<td>Induction of fetal enzyme systems and fetal maturity.</td>
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Placental abnormality

Abnormal shape
Abnormal position
  placenta previa
Abnormal attachment
  placenta accreta
  placenta percreta
  placenta increta
Placental abnormalities

**Placenta succenturiata (3%)**

One or more small lobe or cotyledon of placenta may be placed at a varying distance from the main placental margin.

A leash of vessels connecting the main to the small lobe traverse through the membranes.

Accessory lobe is developed from activated villi on the chorionic laeve.
Clinical significance-

If succenturiate lobe is retained following birth of placenta it may lead to
PPH
Subinvolution
Uterine sepsis
Poly formation

Treatment- exploration of the uterus and removal of the lobe
Circumvallate placenta

Development-
Due to smaller chorionic plate than the basal plate
The chorionic plate does not extend into the placenta margin
The amnion and chorion are folded and rolled back to form a ring leaving a rim of uncovered placental tissue
Morphology

- Fetal surface has a central depressed zone surrounded by a usually complete thickened white ring made up of double fold of amnion and chorion.

- Branching vessels radiate from the cord insertion up to ring only.

- Area outside the ring is thicker, elevated and rounded.
Clinical significance
There are more chances of –
Miscarriage
Hydorrhoea gravidarum
Antepartum haemorrhage
Preterm delivery
Fetal growth restriction
Retained placenta or membrane
A thin fibrous ring is present at the margin of the chorionic plate where the fetal vessels appear to terminate.
Membranous placenta

The whole of the chorion is covered by functioning villi and thus placenta appears as thin membranous structure on ultrasonography
Chorioangioma

Are the most common benign tumors of the placenta and are hamartomas of primitive chorionic mesenchyme

Small tumors may be asymptomatic but large tumors may be associated with hydroamnios and antepartum haemorrhage
Umbilical cord

Connect between placenta and fetus
Contain 2 umbilical arteries (deoxygenated blood) and one vein (oxygenated blood)
Wartan jelly
Normal length about 30 cm
Umbilical cord abnormality

Abnormal vessel
  Hemangioma
    ( single umbil artery)
Abnormal length ( too long , too short)
Abnormal insertion ( vasa previa)
Umbilical knot ( true or kicked )
Thank you