Placenta and umblical cord

structure and function

By

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'placenta is an organ that connects the developing fetus to the uterine wall (endometerium) 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 12 th 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
- $4/5^{th}$ 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

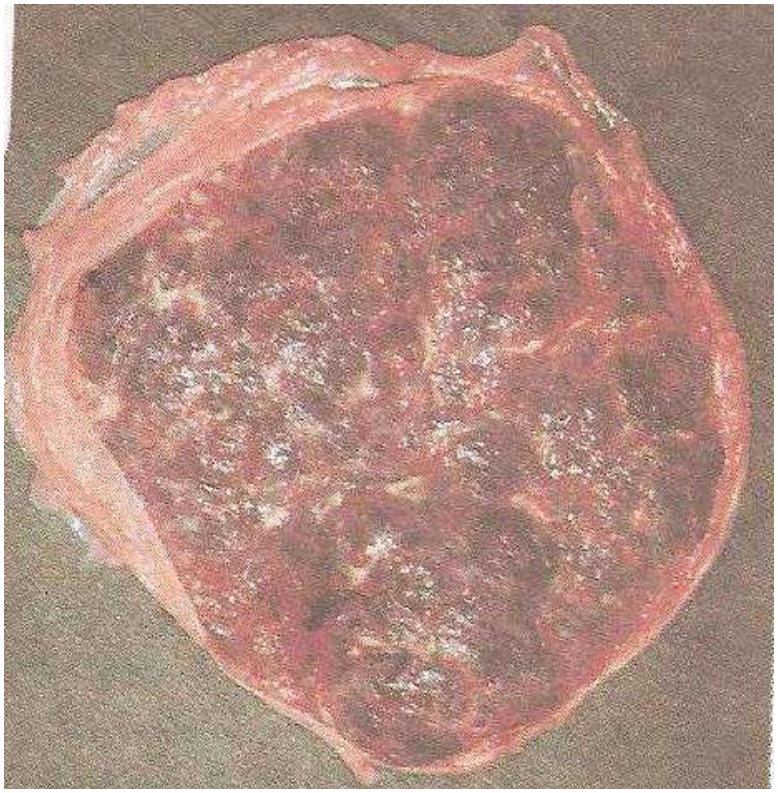
Maternal surface of the placenta

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

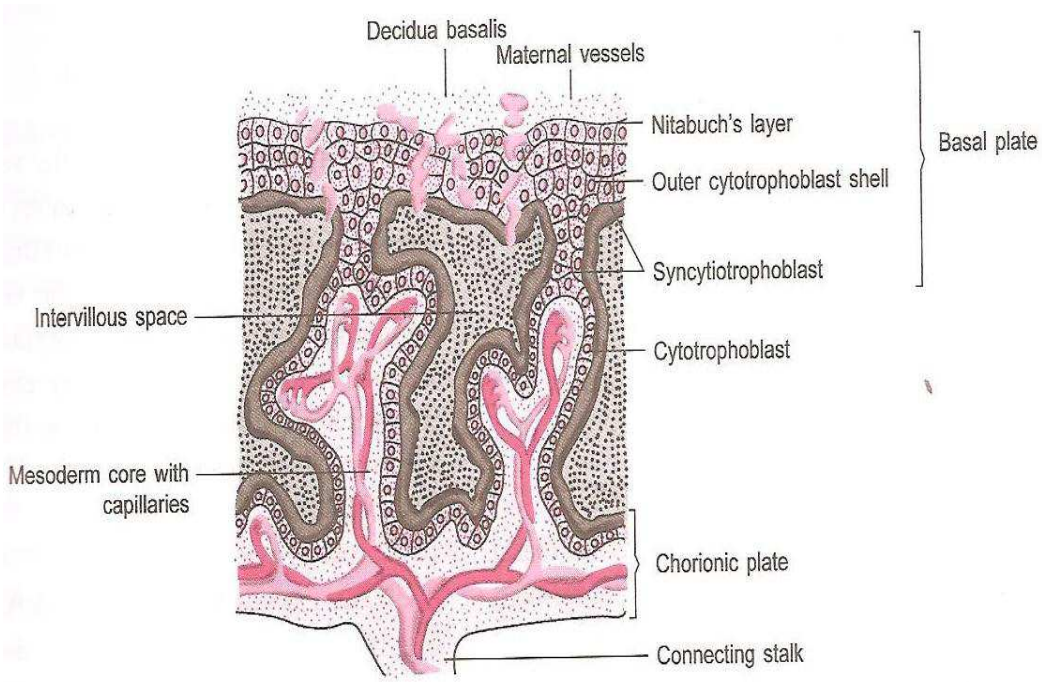
50 ml per minute at 10 weeks

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

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

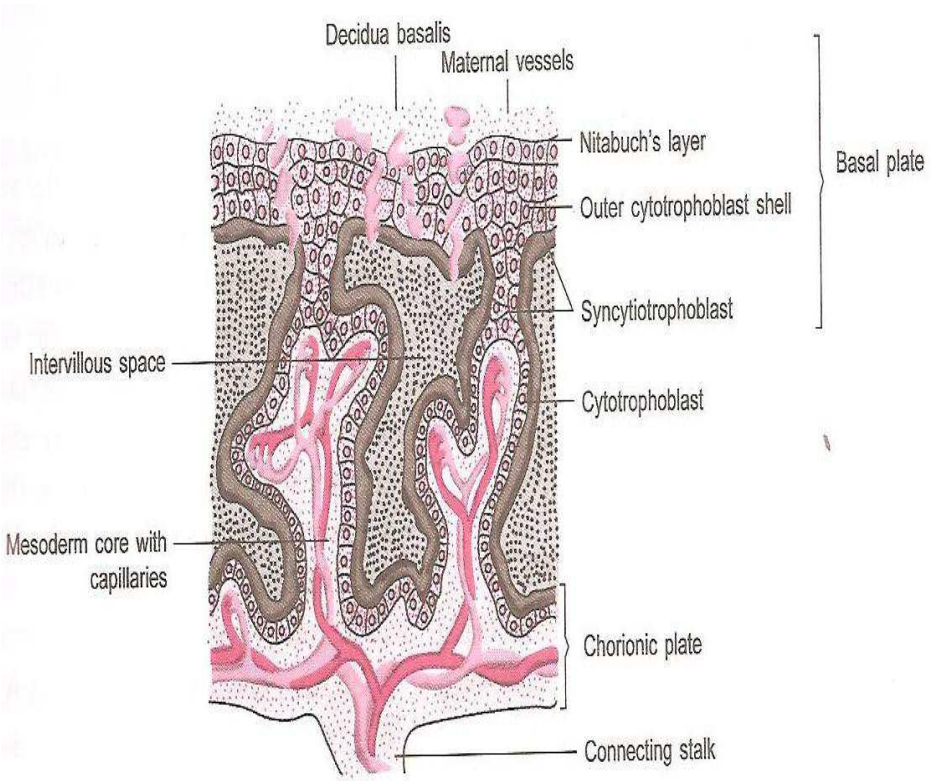
Chorionic plate- forms the roof of the placenta

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

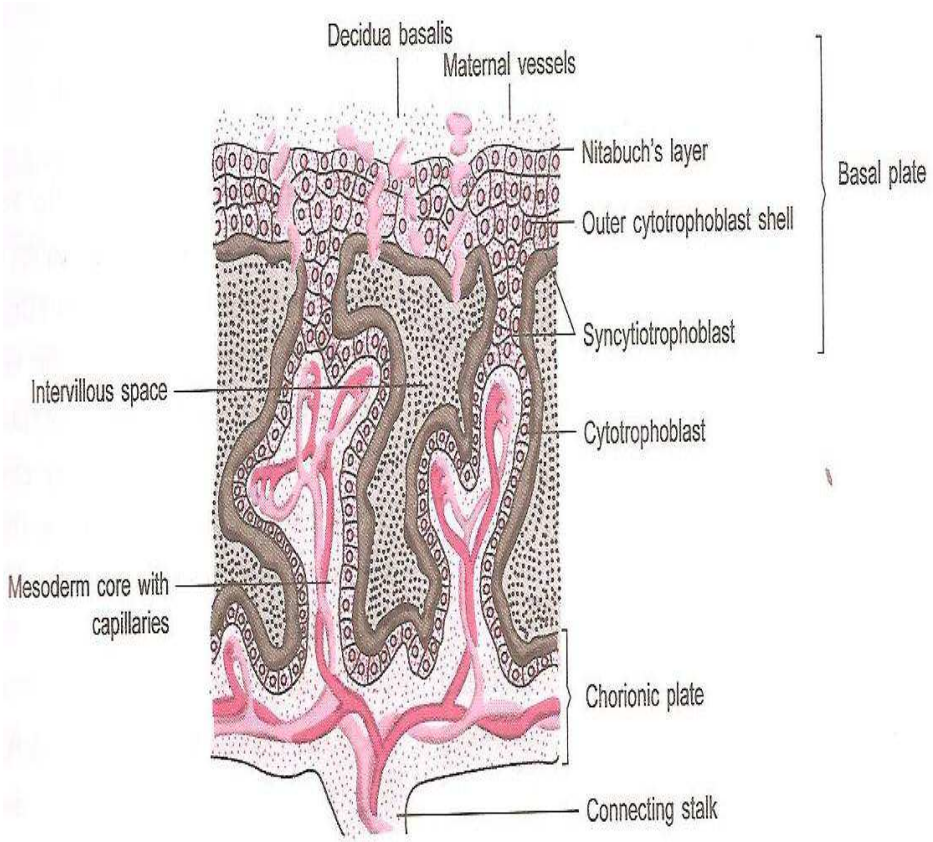
Compact and spongy layer of decidua basalis

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 cytotrohoblastic shell with decidua due to fibrinoid degeneration of syncitotrohoblast

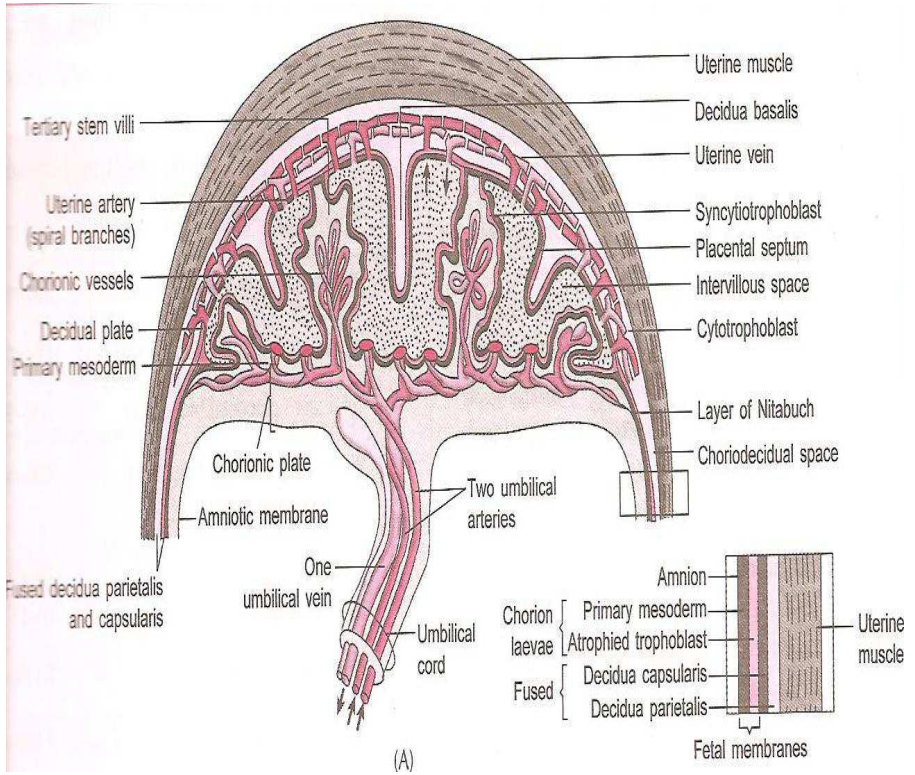
It prevents excessive penetration of the decidua by the trophoblast

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

Immulogical 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-O_2 and CO_2

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 has 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 Ig M)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 ,steriods,HCG have got weak immunosuppressive effect,may be responsible for producing sialomucin.

3.Nitabuch`s layer which intervenes b\n decidua basalis &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 progestrone

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 Somammotropin (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 –24hrs**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.

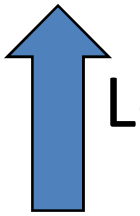
2.hCG stimulates leydig cells of male fetus to produce testosterone in conjunction with fetal pituitary gonadotrophins.Thus indirectly involed in development of external genitalia.

3. Suppresses maternal immune function

& reduces possibility of fetus immunorejection

Human Chorionic Somammotropin (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 occuring during pregnancy

Endocrine functions of the placenta

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

Placental abnormality

Abnormal shape

Abnormal position

placenta previa

Abnormal attachment

placenta accreta

placenta percreta

placenta increta

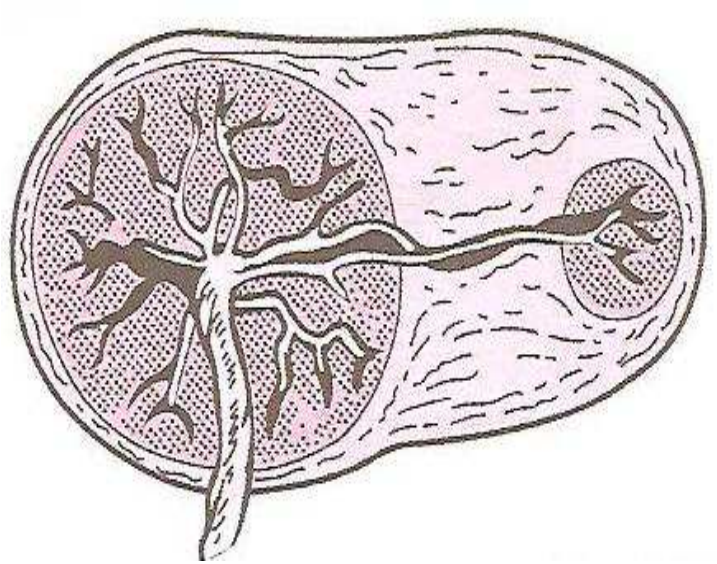
Placental abnormalities

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

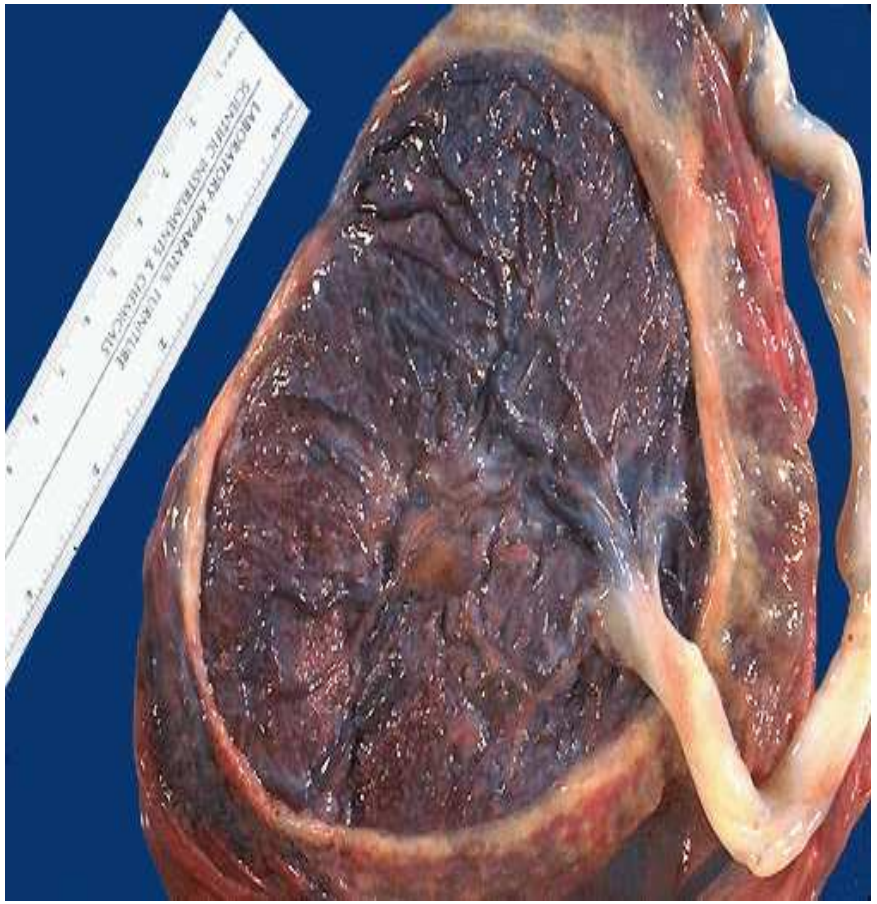
Circumvallate placenta

Development-

Due to smaller chorionic plate than the basal plate

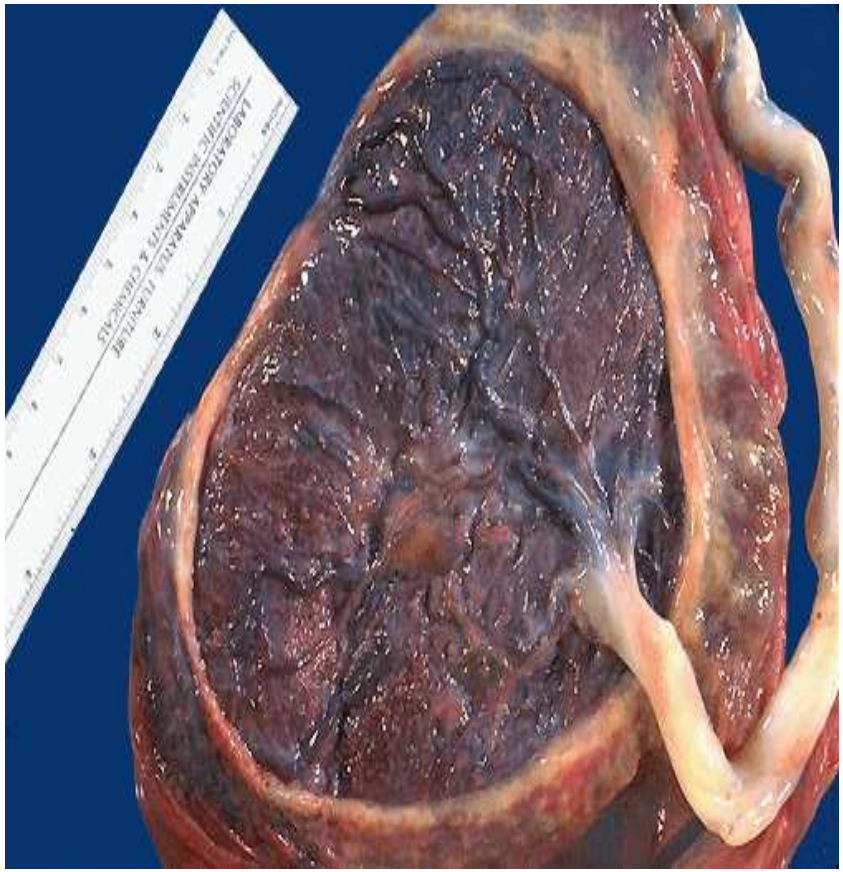
The chorionic plate does not extend into the placenta margin

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 upto ring only
- Area outside the ring is thicker, elevated and rounded



Clinical significance

There are more chances of –

Miscarriage

Hydrorrhoea gravidarum

Antepartum haemorrhage

Preterm delivery

Fetal growth restriction

Retained placenta or membrane

Placenta Marginata

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

Umblical cord

Connect between placenta and fetus

Contain 2 umblical artries (deoxygenated blood) and one vein (oxygenated blood)

Wartan jelly

Normal length about 30 cm

Umblical cord abnormality

Abnormal vessel

Hemangioma

(single umbl artery)

Abnormal length (too long , too short)

Abnormal insertion (vasa previa)

Umbilical knot (true or kicked)

Thank you