Fetal membranes: Chorion and Placenta

Obimbo MM,

Lecture objectives

- At the end of this lecture, you should be able to:
  - Specify the development and functions of chorion and placenta
  - Discuss the disorders related to the development of chorion and placenta

Fetal membranes are membranous/auxiliary structures that surround or associated with vertebrate embryo but do NOT take part in final embryo formation.

Include:

1-Amnion.

2-Yolk sac.

3-Allantois.

4-Connecting stalk and umbilical cord.

5-Chorion

Placenta.

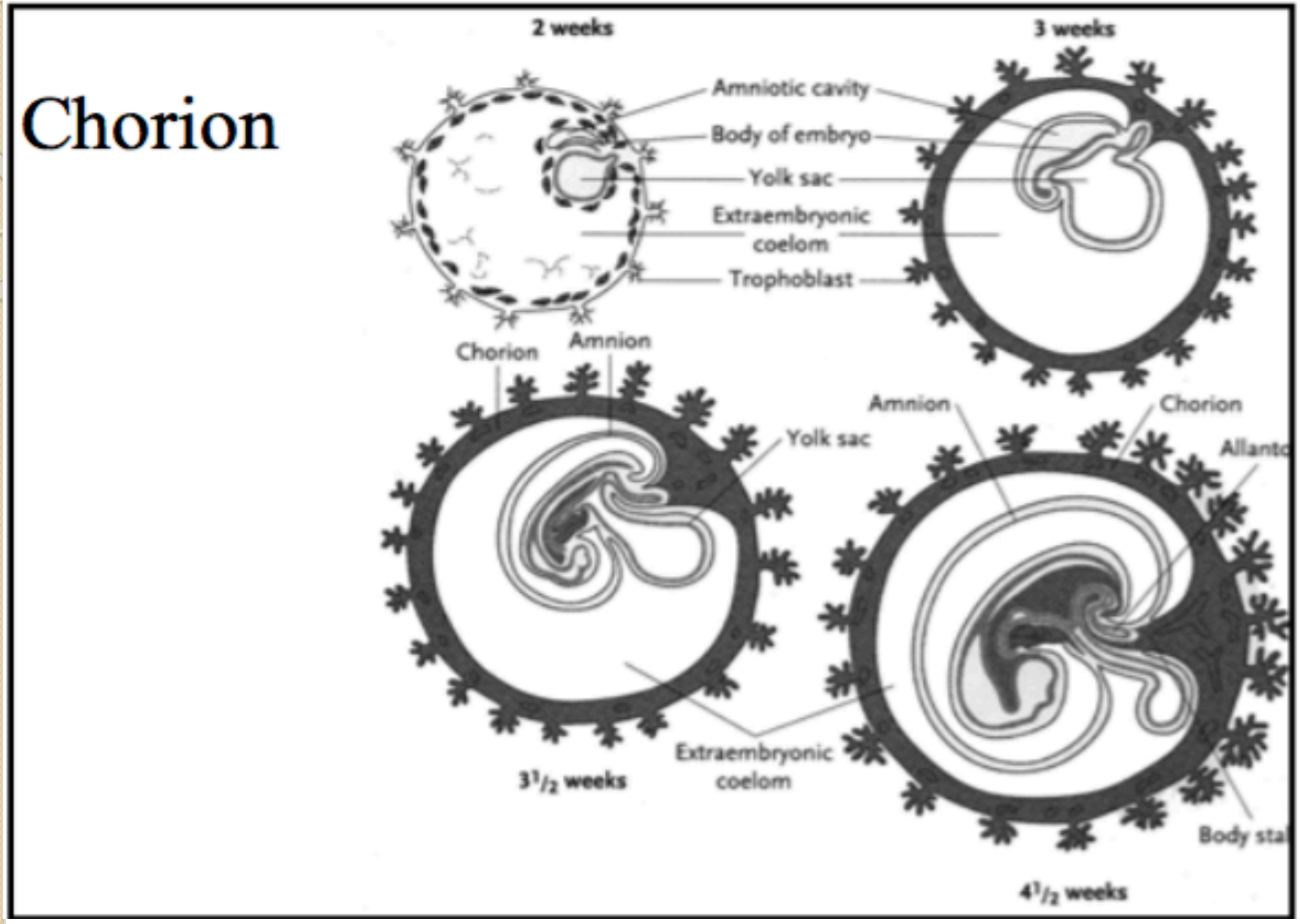
Chorion

- One of the embryonic membranous structures than encloses both the fetus as well as the amnion.

- Consists of two layers: an outer formed by the trophoblast, and an inner by the somatic extraembryonic mesoderm

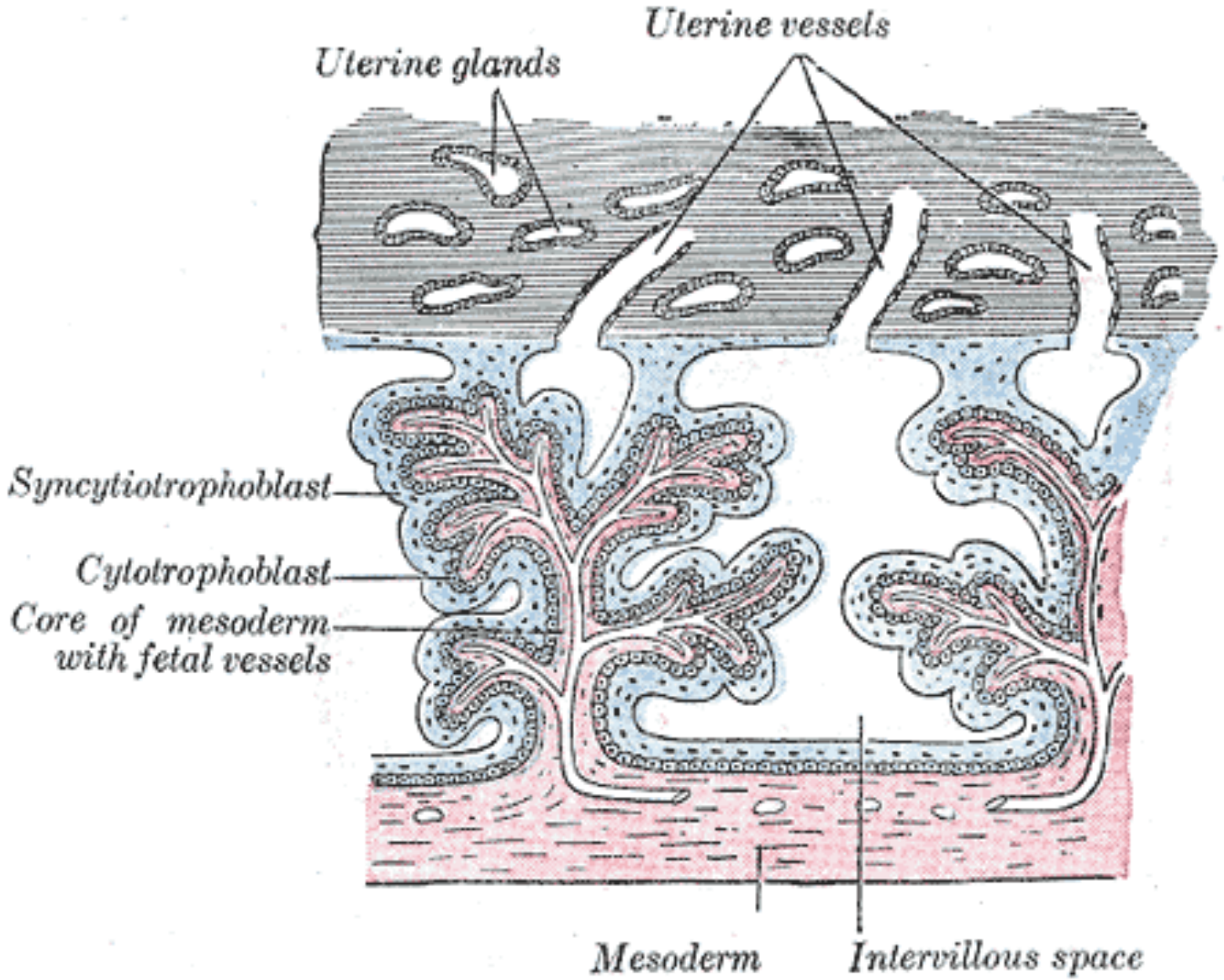
- The chorion begins to form chorionic villi towards its outer surface, which initially serves to provide nutrition to the developing embryo.
- At two months the villi cover the entire chorion, but, after this they develop unequally.
- The greater part of the chorion is in contact with the decidua capsularis
- At 4 months, over this portion the villi, undergo atrophy, and hence this part of the chorion becomes smooth, and is named the chorion læve;

Chorion


2 weeks
3 weeks
Amniotic cavity
Body of embryo
Yolk sac
Extraembryonic coelom
Trophoblast
Chorion
Amnion
Yolk sac
Amnion
Chorion
Allanto
Extraembryonic coelom
3 1/2 weeks
Body sta
4 1/2 weeks

Chorion

- Chorionic cavity (extraembryonic coelom)- lined with extraembryonic mesoderm
- Chorionic cavity expands separating amnion from cytotrophoblast
- Chorionic sac consist of: cytotrophoblastic layer/ syncytiotrophoblastic layer extraembryonic somatic mesoderm
- Chorion forms stem villi; chorion frondosum


Uterine vessels
Uterine glands
Syncytiotrophoblast
Cytotrophoblast
Core of mesoderm with fetal vessels
Mesoderm
Intervillous space

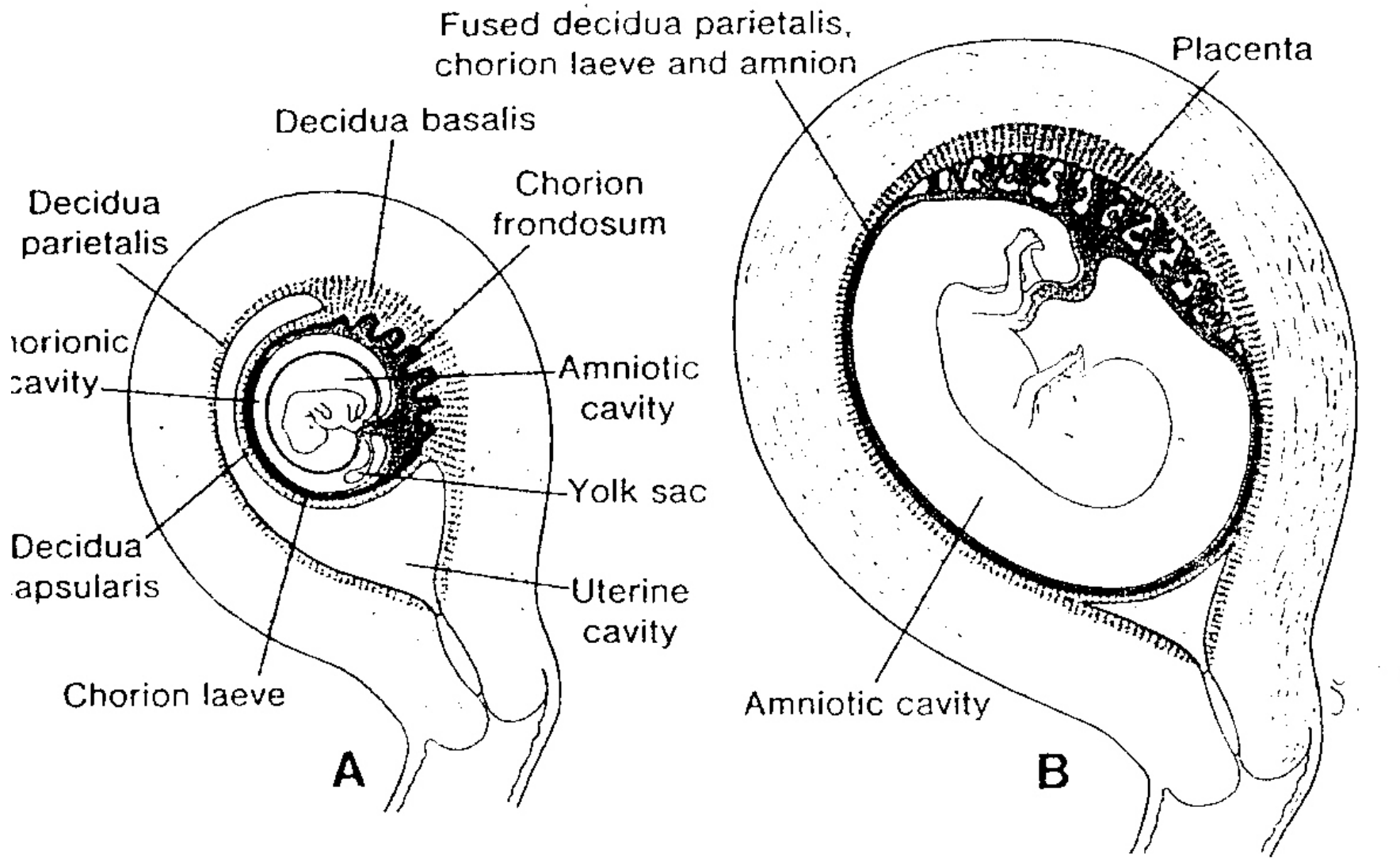
PLACENTA

The placenta is the fetal membrane that carries out nutrition, respiration and excretion of the embryo and fetus.

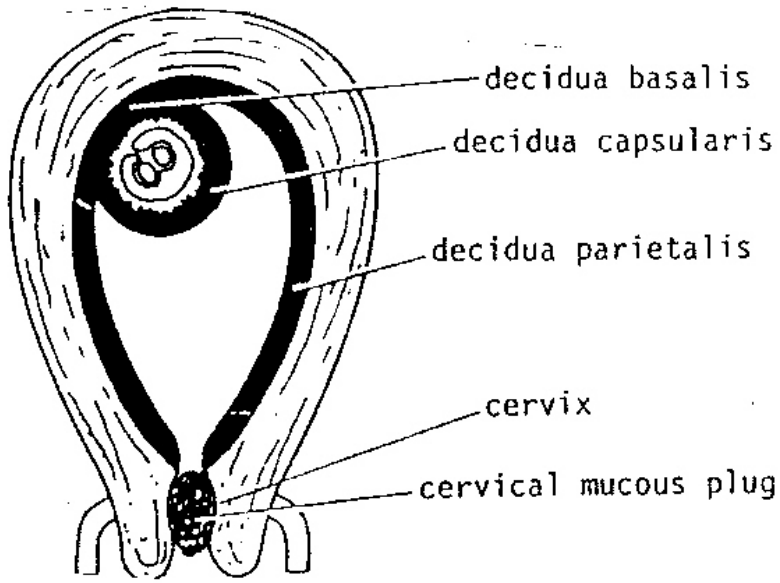
Origin - The placenta has two components of:

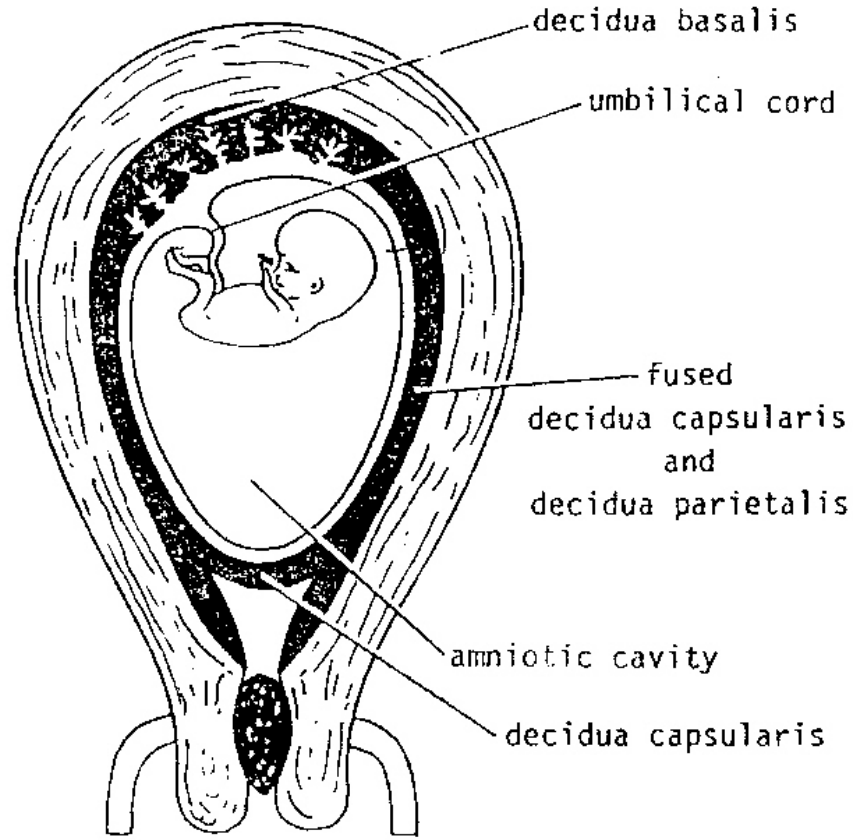
- A fetal part called **chorion frondosum**.
- A maternal part called **decidua basalis**

- **Revisit development of primitive uteroplacental circulation**
- **Decidual formation**.



Fetal and maternal parts of the placenta.





Development and parts of the deciduas.

- With advancement of pregnancy; formation of chorion frondosum and laeve respectively

- The **decidua** is the functional layer of the endometrium of the pregnant uterus.

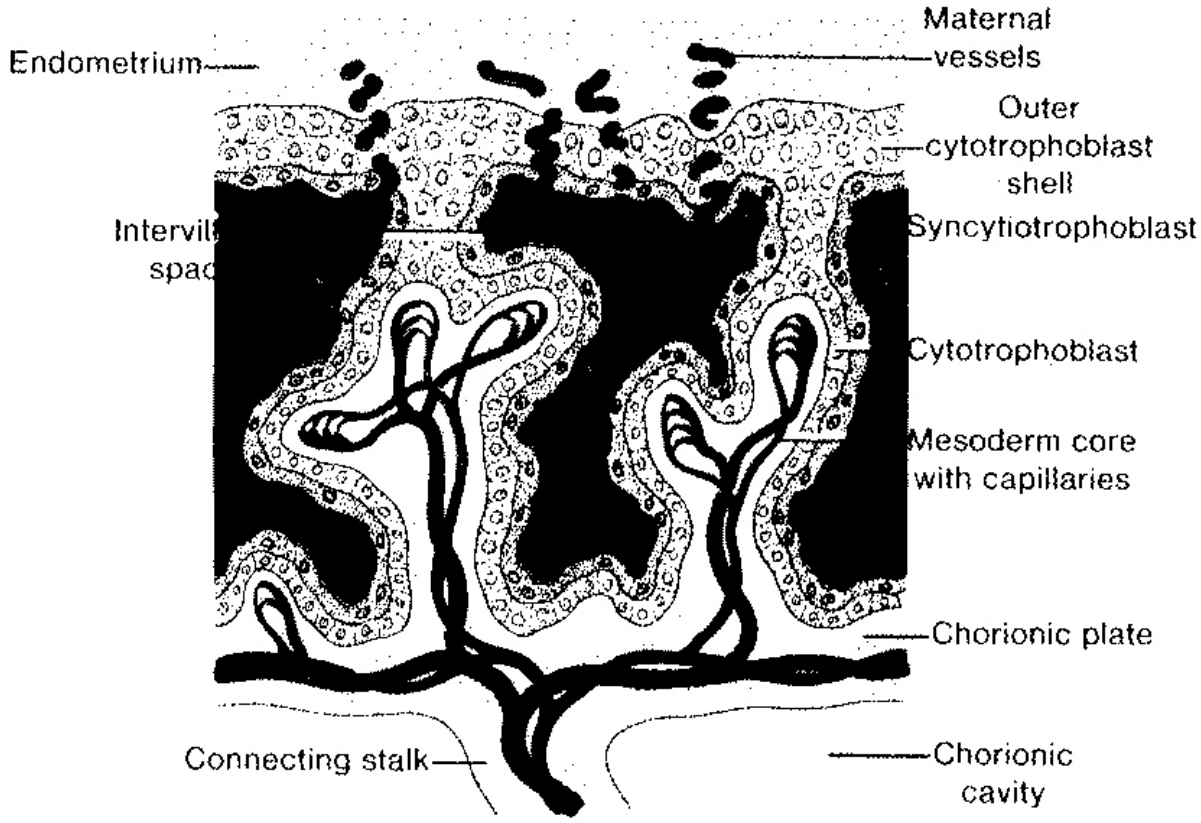
- Decidua over the chorion frondosum, **- decidua basalis -**, consists of compact layer of large cells, decidual cells, with abundant amounts of lipids and glycogen.
- Other parts: decidua capsularis and parietalis

- With increase in volume of amnionitic cavity, amnion and chorion fuse forming **amniochorionic membrane** which obliterates the chorionic cavity.

Development of the placenta

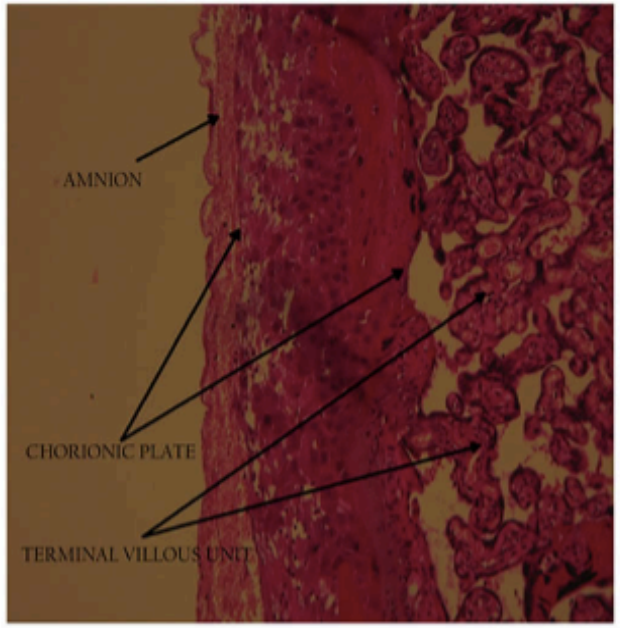
- Starts with primitive (lacunar) uteroplacental circulation:
  - During the 2nd week, the **syncytial lacunae** appear in the syncytiotrophoblast and form the primordial of the intervillous spaces of the placenta.
  - The fluid in the lacunar spaces **- *embryotrph*** – passes to the embryonic disc by diffusion and provides nutritive material to the embryo.

- -By the end of the 4th week, **complex vascular network** is established in the placenta which facilitates maternal-embryonic exchanges of gases, nutrients and waste products.
- Villus at the end week 3



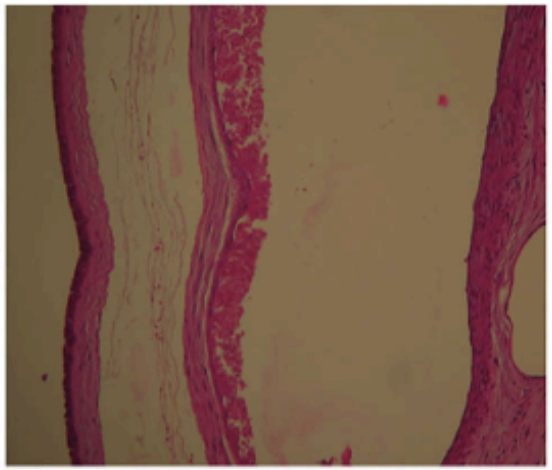
- In its final form the placenta is made up of **stem villi** that extend from the chorionic plate.

- These villi either float within the intervillous space (maternal blood space) as
  - **terminal villi** or
  - extend and attach to the decidua basalis as **anchoring villi**

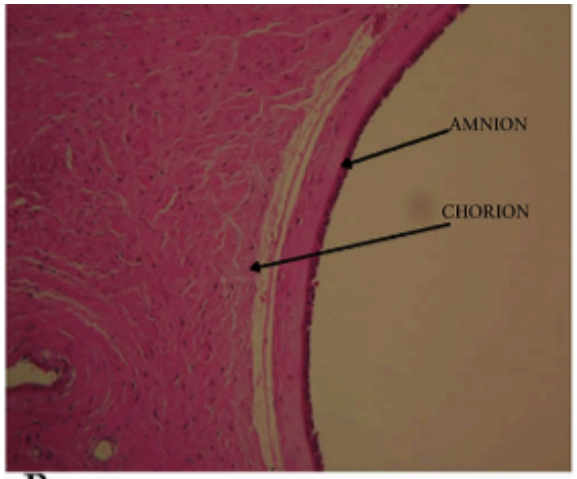


A

B



A MEMBRANE ROLL



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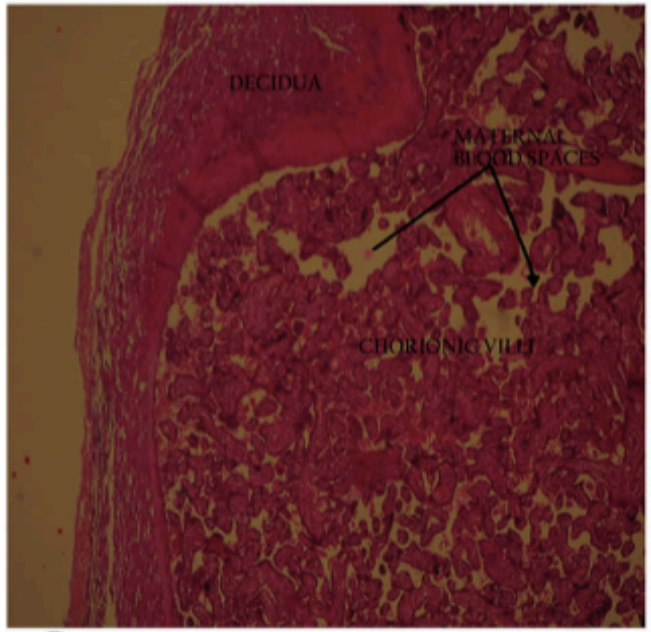
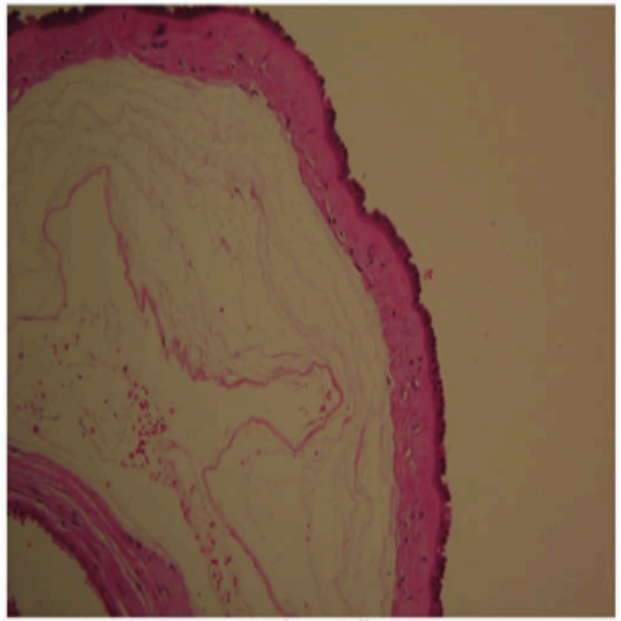
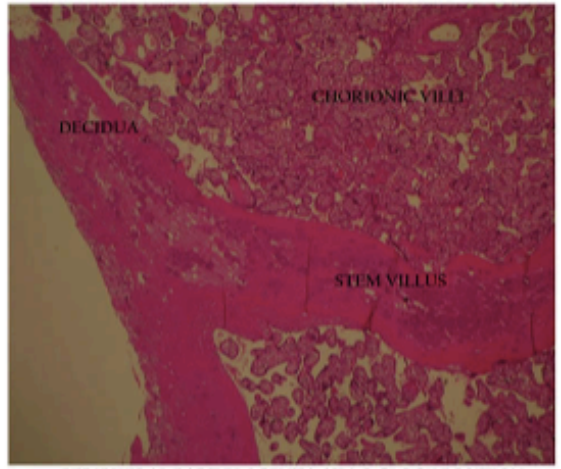


C

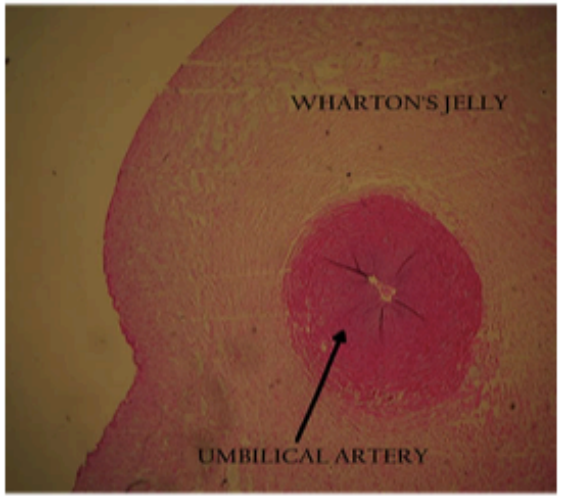


Membrane Roll

D



C PERIPHERAL PART PLACENTA AT 3 O'CLOCK POSITION



D

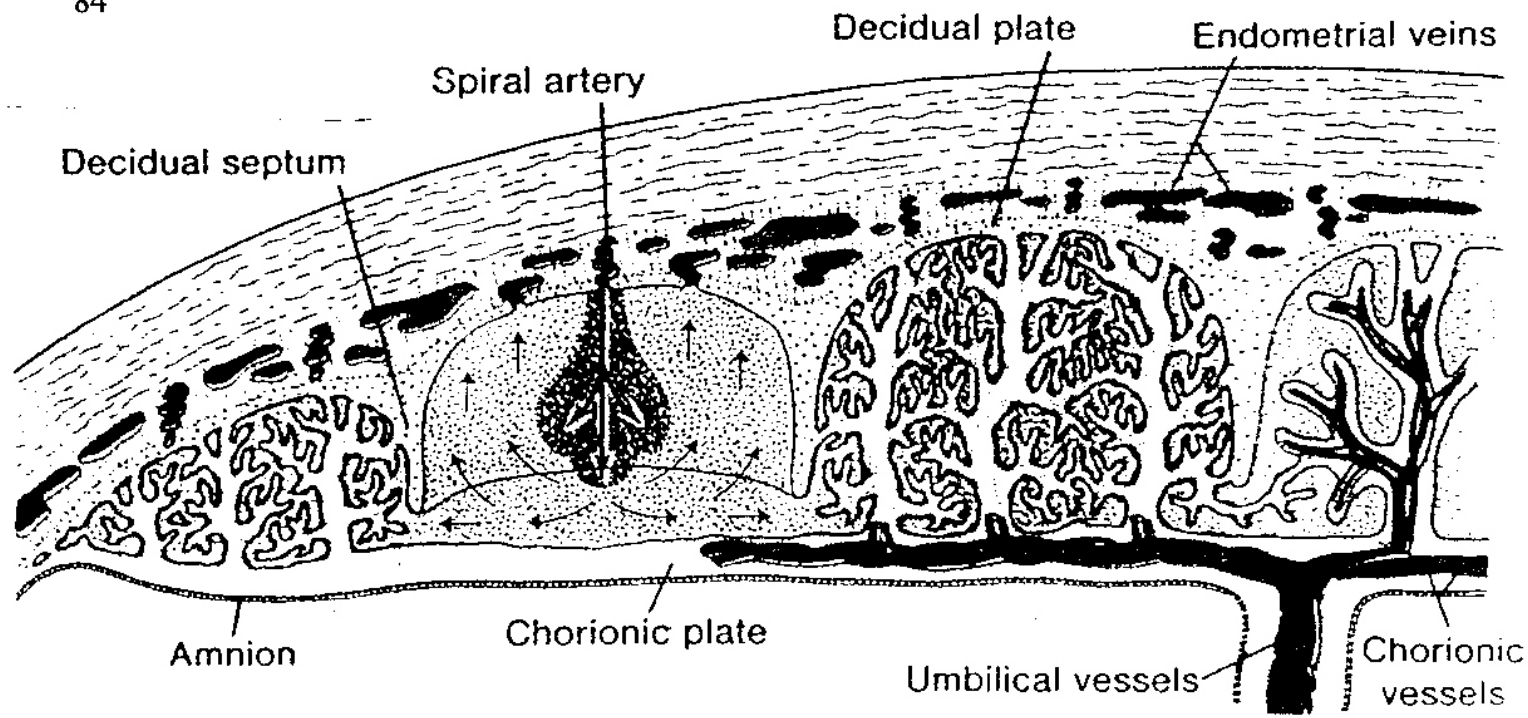
- As pregnancy progresses during the 4th month, most of the cytotrophoblast cells degenerate.

- On the fetal side, the placenta is bordered by the **chorionic plate**;

- On its maternal side, it is bordered by the **decidual plate**.
- In between, trophoblast and decidua cells intermingle.
  - This zone is characterized by decidual and syncytial giant cells and is rich in amorphous extracellular material.

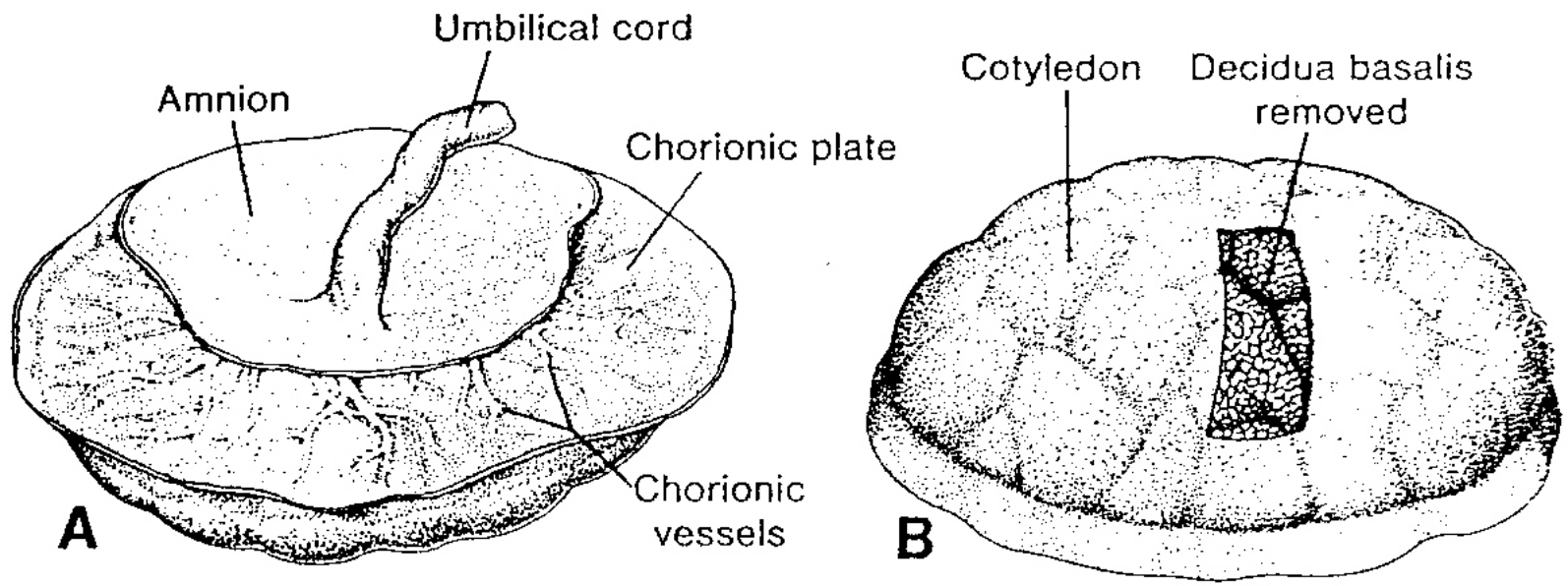
- Erosion of most of decidual basalis to increase size of intervillous spaces-decidual septa result

- Septation results in formation of cotyledons



Composite drawing of the placenta in the second half of pregnancy. The cotyledons are partially separated from each other by the decidual (maternal) septa. Note that most of the intervillous blood returns to the maternal circulation by way of the endometrial veins. A small portion enters neighboring cotyledons. The intervillous spaces are lined by syncytium.

Placenta in the second half of pregnancy.



Fetal and maternal surfaces of the placenta.

- Full size placenta achieved by 13weeks and increases in size with fetal growth.

- The fully developed placenta covers 15 to 30% of the decidua and weighs about one-sixth that of the fetus.

- Dimensions of full term placenta:
  - Weight 550-650gms
  - Greatest diameter 15-25cm
  - Greatest thickness -2.5 – 3.4 cm (Obimbo et al., 2016)

Placental Circulation

It is through the numerous branch villi that the main exchange of material between the mother and the fetus takes place. Circulations of the mother and fetus are separated by **placental membrane (barrier)**. Up to the 4th month the placental membrane is formed of:

1-Syncytiotrophoblast.

2-Cytotrophoblast.

3-Mesoderm

4-Endothelium of the fetal capillaries.

-From the 4th month on, the placental membrane becomes much thinner, thus increasing the rate of exchange. It is formed of:

1-Syncytiotrophoblast.

2-Endothelium of fetal capillaries.

Fetal Placental Circulation

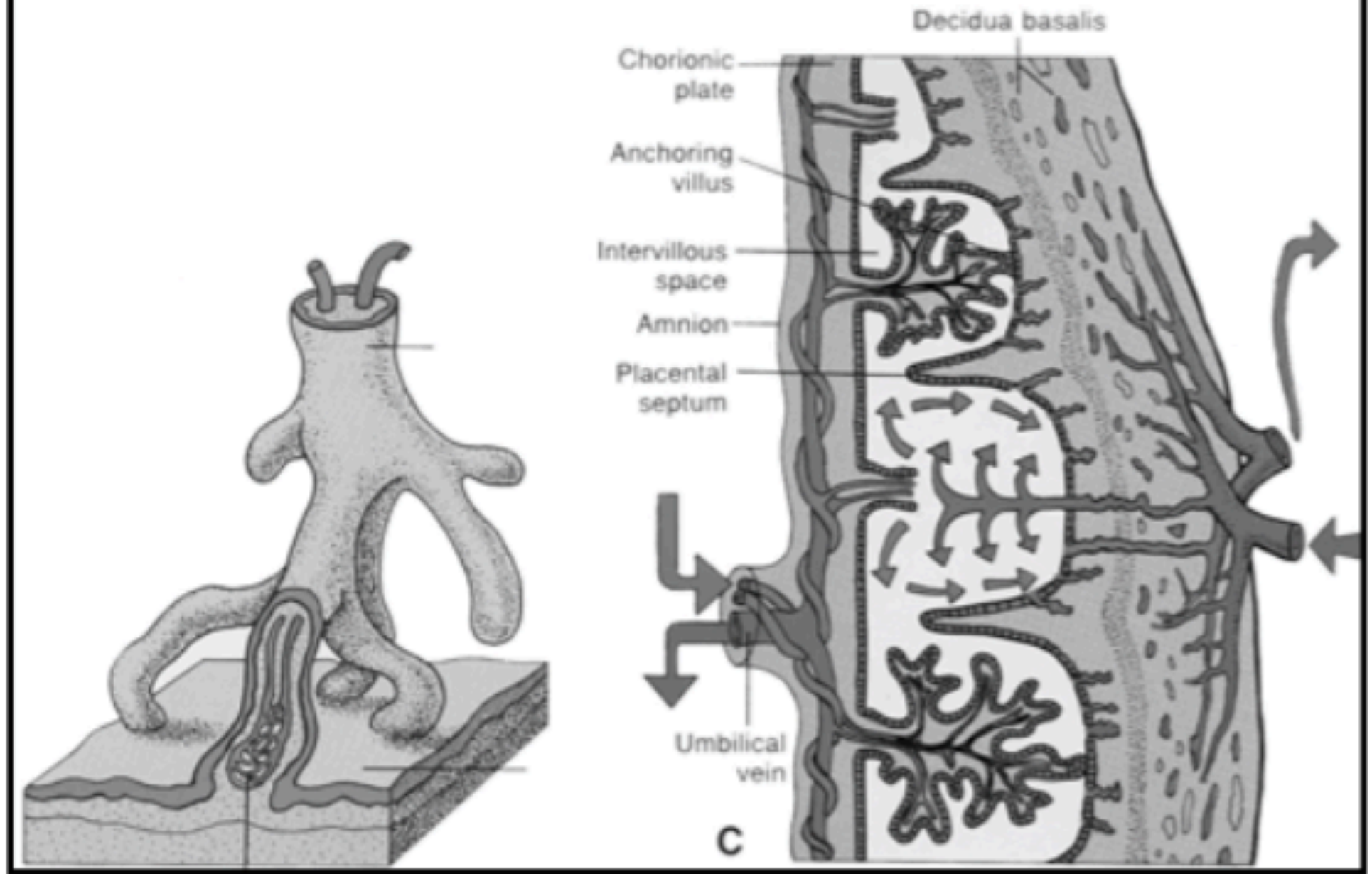
- Poorly oxygenated blood passes through umbilical arteries to the placenta
- Extensive **arterio-capillary-venous system in the chorionic villi**.
- Syncytiotrophoblasts show many microvilli that increase the surface area for exchange.

Maternal and fetal blood do not come in contact

Maternal Placental Circulation

- Numerous spiral arteries discharge blood into intervillous space in jets.
- Washing of villous structure with oxygenated blood
- As the pressure decreases, blood flows back from the chorionic plate toward the decidua, where it enters the endometrial veins.
- Intervillous spaces of the mature placenta contains 150 ml of blood which is replenished 4 times per minute.
- Reductions in uteroplacental circulation result in fetal hypoxia and fetal growth restriction/death.

Placental Anatomy



Functions of Placenta

The main functions of the placenta are:

1-**Transport** of gaseous and metabolic products between maternal and fetal blood.

2-**Metabolism**, e.g., synthesis of glycogen, cholesterol and fatty acids.

3-Production of **hormones** ,e.g., human chorionic trophic hormones, estrogens and progesterones.

1-Placental Transfer

Materials are transported across the placental membrane by one of the following mechanisms:

Simple diffusion – gases, water, fatty acids, urea, steroids

Facilitated diffusion - electrolytes

Active transport – amino acids

Pinocytosis – Igs, small proteins

In placental membrane breaks – check mechanism of Rh isoimmunization

2-Metabolism

The placenta synthesizes glycogen, cholesterol and fatty acids, which serve as sources of nutrients and energy for the fetus.

3-Endocrine Function

- Human Chorionic Gonadotropin – Corpus Luteum (declines after 8 weeks)
- Progesterone – High levels by the end of first trimester
- Estrogen – Synthesis involves enzymatic activity of fetal adrenal gland and liver
- Chorionic Somatomammotropin – Human Placental Lactogen – similar to GH (growth, lactation, lipid and carbohydrate metabolism)
- Placental Growth Hormone – similar to GH – Replaces materrnal GH by 15 wks – enhances blood glucose levels
- Chorionic Thyrotropin, Chorionic Corticotropin

Placental anomalies

A) Variations in shape and size

1-When villi persist on the entire surface of the chorionic sac, a thin layer of the placenta (membranous placenta) attaches to a large area of the uterus. This type of the placenta is called diffuse placenta or **placenta membranacea**.

2-When villi persist elsewhere, several variations in shape may result:

i-Placenta with two or three lobes; **placenta bipartita (bidiscoid) or placenta tripartita.**

ii-Placenta has two or three separate lobes; **placenta duplex or placenta triplex**.

iii-Placenta has small accessory lobe(s); **placenta succenturiata**.

iv-Failure of placenta to develop over a small area; **placenta fenestrata**.

v-Placenta with central depression; **placenta circumvallata**.

vi-**Horseshoe placenta**.

- Although there are variations in the size and shape of the placenta, most of them are of little physiological or clinical significance.

B) Abnormal insertion of the umbilical cord

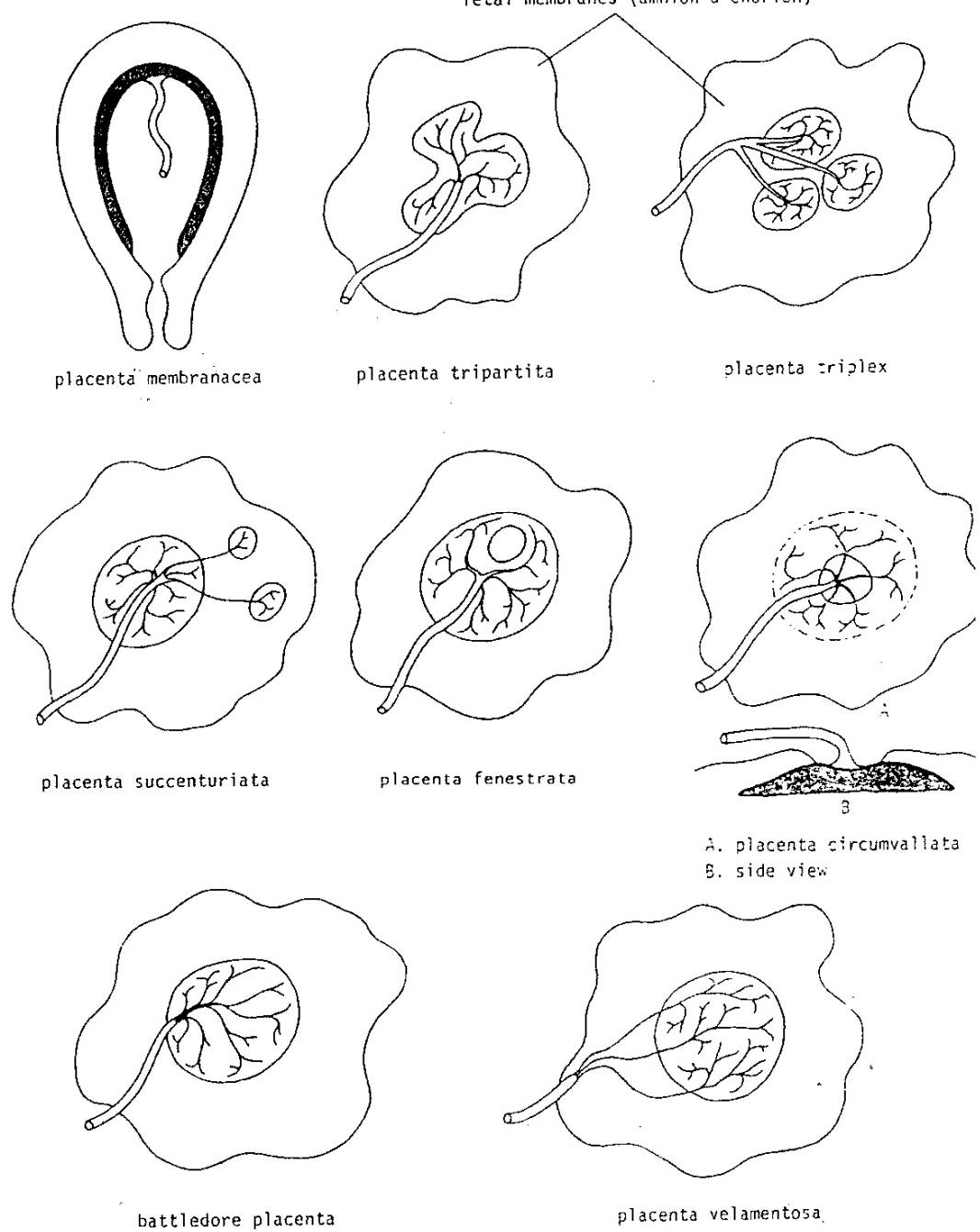
1-Marginal insertion of the cord**; battledore placenta**.

2-Umbilical cord attaches to membranes outside the placenta; **placenta velamentosa**.

C) Abnormal site of implantation of the blastocyst close to or overlying the internal os, the abnormality is called **placenta previa.** It has varieties:

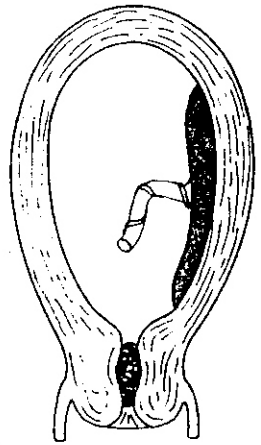
i-Implantation in the lateral uterine wall; **placenta previa lateralis.**

ii-Implantation approaching internal os; **placenta previa marginalis**.

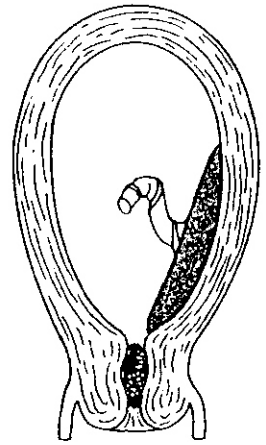


Abnormalities of the placenta.

TYPE I

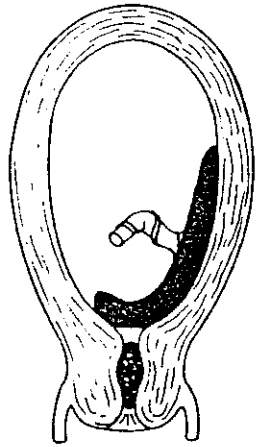


lateral placenta praevia



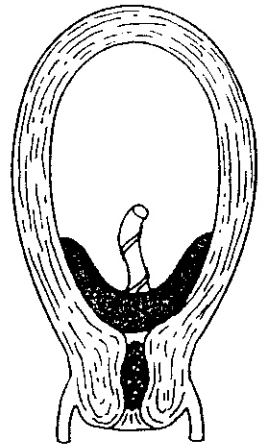
lateral placenta praevia

TYPE II



marginal placenta praevia

TYPE III



central placenta praevia

Different types of placenta previa.

iii-Implantation overlying internal os; **placenta previa centralis**.

Late pregnancy bleeding may result from placenta previa.

The fetus has to be delivered by Cesarean section when the placenta completely obstructs the internal os.

D) Abnormal adherence of the chorionic villi to the uterine wall

1-Chorionic villi adhere to myometrium; **placenta accreta (placenta increta).**

2-Chorionic villi penetrate the full thickness of the myometrium to the perimetrium (peritoneal covering); **placenta pancreta (placenta percreta)**.

After birth the placenta fails to separate from the uterine wall, and attempts to remove it may cause hemorrhage that is difficult to control. Most of these cases end with hysterectomy.

E) Abnormal proliferation of trophoblast may result in **vesicular moles** or **choriocarcinoma**. In choriocarcinoma the cells invade the decidua basalis, penetrate its blood vessels and lymphstics and may spread to lungs, bone marrow, liver and other organs. This tumour is sensitive to chemotherapy and cure is usually achieved.

F) Placental insufficiency: degenerative changes in the placenta that progressively reduce the oxygen supply and nourishment of the fetus.

G) Abruptio placentae:

premature detachment of the placenta during pregnancy rather than after delivery. Detachment may be complete or incomplete.

It carries risk of serious blood loss of the mother and risk of death of the fetus.

Placental stage of labour (3rd stage)

- Uterine contractions begin again shortly after partiurition.
- Retraction of the uterus reduces the area of placental attachment.
- The placenta and fetal membranes are expelled.
- The duration of the third stage of labour is **15-30 minutes**.

Recovery

- Myometrial contractions constrict spiral arteries preventing excessive bleeding.
- Duration of the fourth stage of labour is **2 hours**.

TIMELINE

Post Fertilization – embryonic day/week

d. 4-5	blastocyst reaches uterine lumen
d. 5-6.5	apposition, syncytiotrophoblast forms
d. 7	adhesion/implantation
d. 8	hCG detectable in mother's serum
d. 9	embryo completely implanted, lacunae in syncytiotrophoblast
d. 11-13	primary stem villi
d. 14	cytotrophoblasts partially occlude spiral arteries, maternal blood circulates (plasma only, no cells)
d. 16	secondary villi by invasion of extraembryonic mesoderm
d. 21	tertiary villi (fetal vessels)
8 weeks	end of embryonic period
12 weeks	maternal whole blood (cells and plasma) flow to placenta via converted spiral arteries

THANK YOU AND NICE DAY