Placenta and placental function

Professor

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Learning Objectives

- At the end of the lecture you will be able to:
- 1- Define the placenta
- 2- Know the role of placenta in pregnancy
- 3- Identify the placental Development
- 4- Identify the placental Function
- 5- Identify the mechanism of blood exchange

List of content

Definition

- The placenta is a vital organ with multiple functions, such as endocrine, immune, and physiological.
- The placenta is formed gradually during the first three months of pregnancy, while, after the fourth month, it grows parallel to the development of the uterus.
- Once completed, it resembles a spongy disc 20 cm in diameter and 3 cm thick.
- It is a temporary organ, whose genetic characteristics are identical to those of the developing child.
- The placenta interacts with the environment in which it is present and vice versa.

Role in pregnancy:

- Proper development of the placenta is essential for a successful pregnancy.
- There are several layers of tissue that make up this delicate organ that need to develop normally for proper function during gestation.
- Without proper function, there can be devastating consequences to the pregnancy.

Development

- The placenta is a fetal organ made up of its parenchyma, chorion, amnion, and umbilical cord.
- The fetal structures form from the zygote and therefore separate the fetus from the endometrium.
- The fetal tissues form from the chorionic sac - which includes the amnion, chorion, yolk sac, and allantois.
- These tissues get delivered after birth.
- The maternal part comes from the endometrium and is called the decidua.
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Cont.

- There are three parts to the decidua

1. - the decidua basalis (deep at the implantation site),
2. the decidua capsularis (covers the implantation site),
3. and the decidua parietalis (everything else). [1]

- After fertilization, the fertilized ovum evolves into a morula, which will develop into the embryo and fetal placenta.
- The inner cell mass develops into the embryoblast,
- The outer cell mass is the trophoblast.

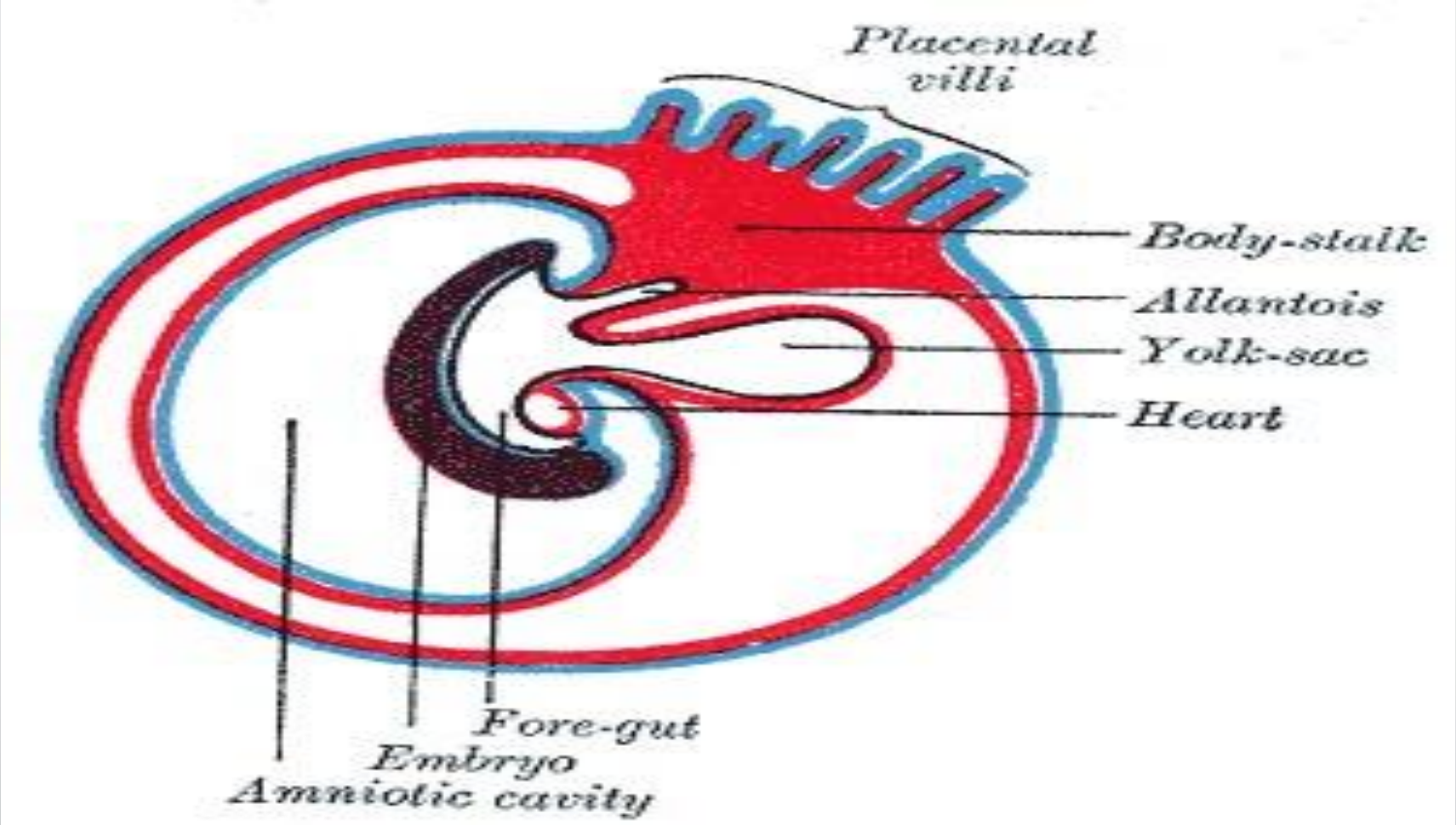


Figure 1: Development of the Fetal membrane and the Placenta, Diagram showing the expansion of amnion and delimitation of the umbilicus, Heart, Fore-gut, Embryo, Amniotic cavity, Placental villi. Contributed by Gray's Anatomy Plates

- The morula then takes in fluid and forms a blastocyst with the trophoblast surrounding the inner cell mass and fluid.
- The blastocyst implants into the uterus approximately six days after fertilization.
- The contact of the trophoblast with the endometrium causes the development of the syncytiotrophoblast, which secretes human chorionic gonadotrophic hormone (hCG) and the cytotrophoblast which secretes enzymes that break down the bond between endometrial cells so the syncytiotrophoblast can invade the endometrial wall.
- Both the cytotrophoblast and the syncytiotrophoblast are part of the chorion, which develops into the placenta along with the extraembryonic mesoderm.[2-4]
- The chorion forms the placenta and consists of the syncytiotrophoblast, cytotrophoblast, and extraembryonic mesoderm.

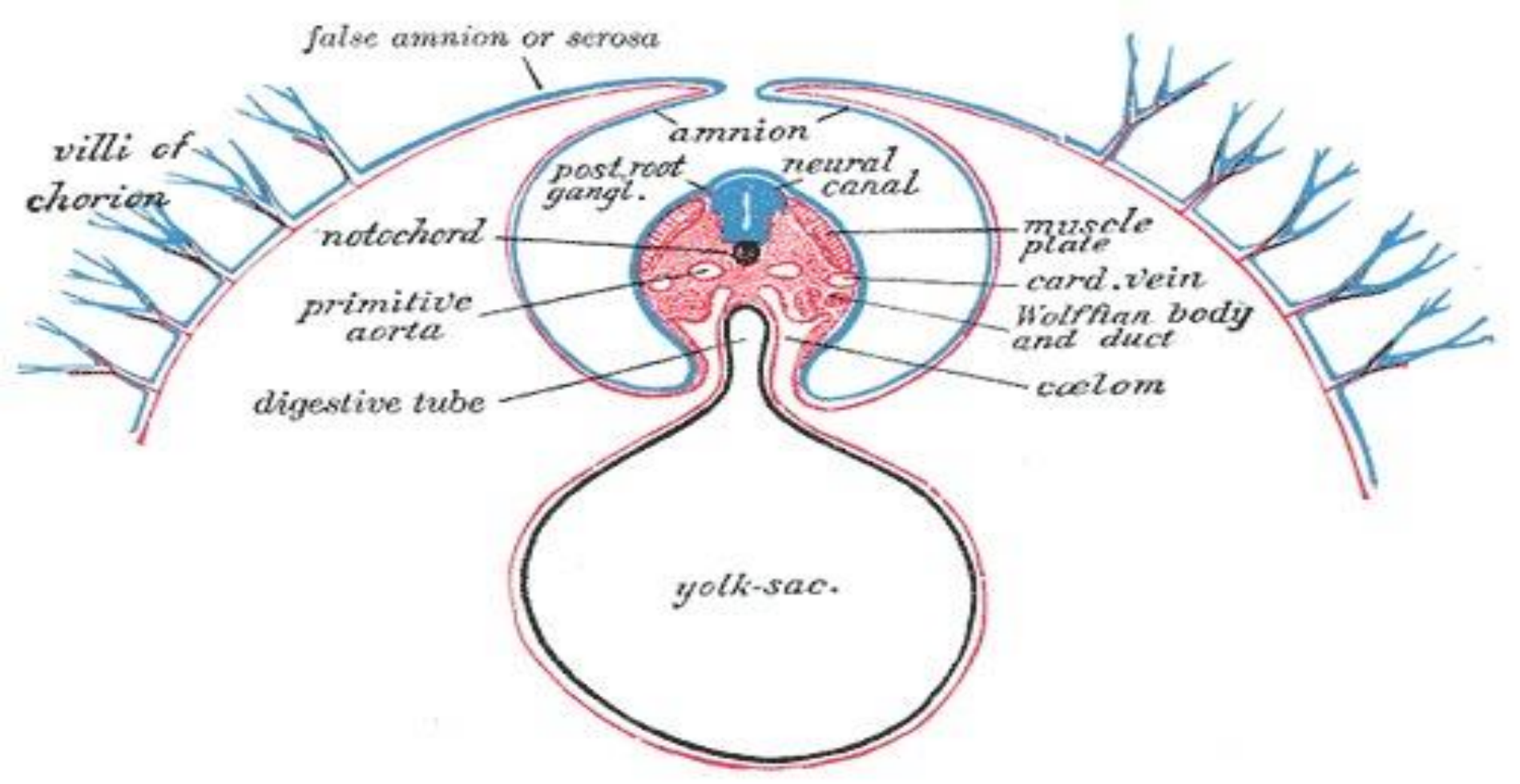
- The cytotrophoblast grows into the syncytiotrophoblast as finger-like projections, which are called the primary chorionic villi.
- The extraembryonic mesoderm splits into somatic and splanchnic mesoderm, and the somatic mesoderm grows into the primary villi creating the secondary villi.
- The mesenchyme gives rise to blood cells and vessels, which designates tertiary villi when formed.
- Capillary beds grow from the villi, which connect to the embryo heart.
- Maternal blood flowing through the embryonic capillaries provide oxygen and nutrients to the fetus.
- The villi continue to grow and branch into the villus chorion, which is the fetal placenta.[5]

- As development continues, cells from the cytotrophoblast continue to extend through the syncytiotrophoblast to eventually form a cytotrophoblastic shell.
- As progesterone increases, the decidua connective tissue develops into "decidua cells," which help protect the uterus from an invasion of the syncytiotrophoblast.
- As the sac continues to grow, the decidua capsularis villi degenerate and eventually disappear as they fuse with the decidua parietalis.
- The amniotic sac enlarges faster than the chorionic sac, which causes them eventually to come into contact and fuse into the amniochorionic membrane.
- The amniochorionic membrane then fuses to the decidua capsularis and, ultimately, the decidua parietalis for stability.
- The amniochorionic membrane ruptures during labor.
- The amniochorionic membrane with the fetal vessels makes up the chorionic plate.

Cont.

- Parts of the decidua basalis grow into the chorionic plate dividing it into separated septa called cotyledons, in which each contains stem villi.[6]
- The fetomaternal junction provides stability for the chorion. The chorionic villi that attach to the decidua basalis are an anchor for the fetal chorionic sac to the endometrium.
- Endometrial vessels, called spiral arteries, make their way through openings in the cytotrophoblastic shell and reside inside the villi where they release maternal blood to bath the chorionic villi in each cotyledon; this allows for maternal blood to provide oxygen and nutrients to the fetus across the placental membrane.
- Endometrial veins then drain the blood.
- Although the fetal vessels are bathed in maternal blood, there is normally no mixing between maternal and fetal red blood cells.[7]

- **The placental membrane** is where the mother and fetus exchange gases, nutrients, etc. The membrane forms by the syncytiotrophoblast, cytotrophoblast, embryonic connective tissue (Wharton's jelly), and the endothelium of fetal blood vessels.
- The umbilical cord serves to attach the fetus to the placenta and consists of two umbilical arteries and one umbilical vein.



Development of the Fetal membrane and the Placenta, Diagram of a transverse section, showing the mode of formation of the amnion in the chick. The amniotic folds have nearly united in the middle line, Ectoderm is blue is the mesoderm; red is the entoderm and notochord is black. Contributed by Gray's Anatomy Plates

Function

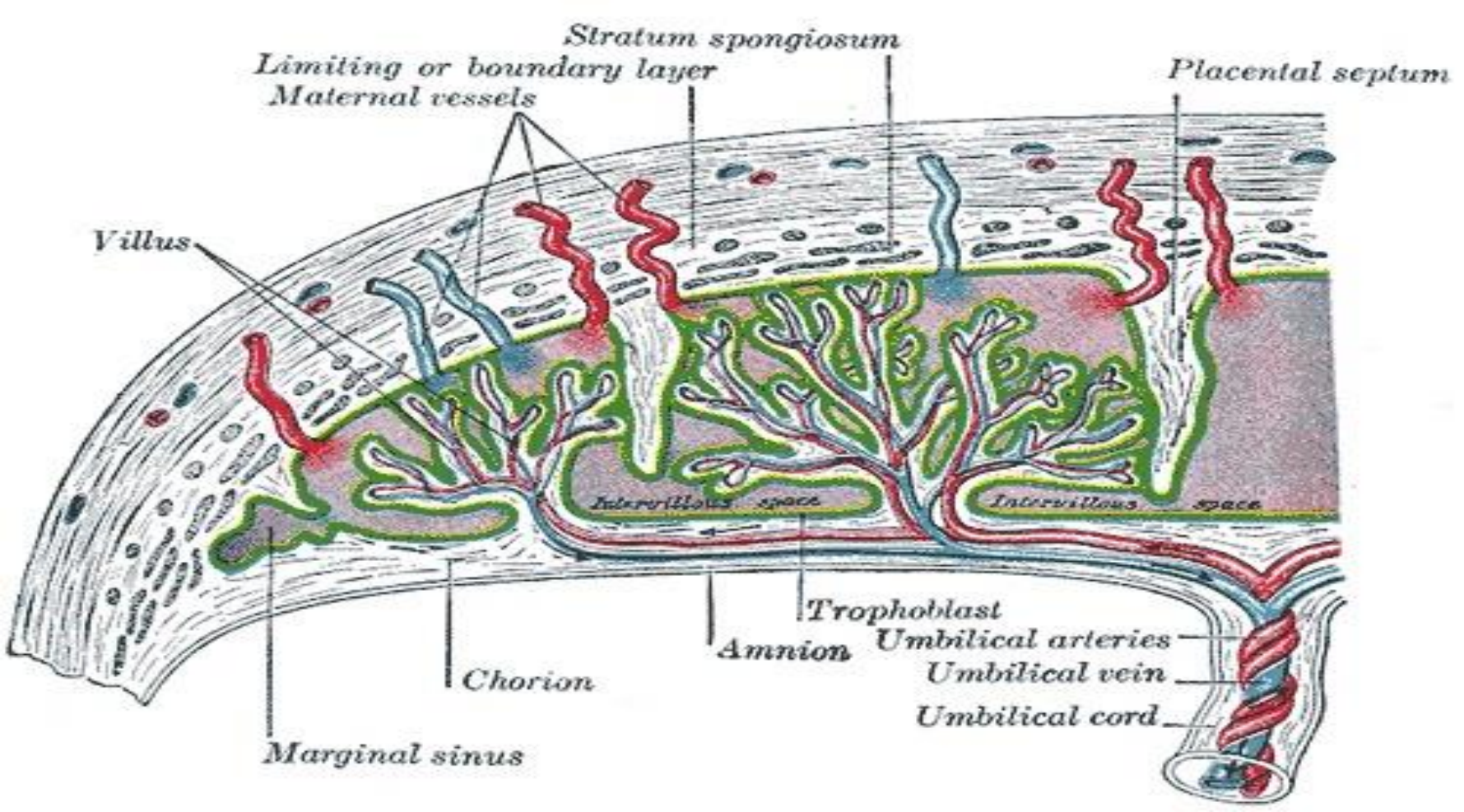
- The placenta is the means of communication between mom and fetus.
- The placental membrane is where the exchange of substances happens between mother and fetus.
- This exchange is essential for the transfer of gases, electrolytes, hormones, maternal antibodies, fetal waste, and nutrition such as water, amino acids, glucose, vitamins, and free fatty acids.
- Fetal waste includes urea, uric acid, and bilirubin. Alpha-fetoprotein and other proteins also get exchanged.
- These transfers are beneficial to the fetus, but many harmful substances can pass through the placental membrane such as certain drugs, live vaccines, carbon monoxide, anti-Rh antibodies, and several infectious agents ("ToRCHes" infections).[8-9]
- Solvent drag is the bulk flow of water, which brings in nutrients across the placental membrane into each cotyledon to be absorbed. The higher the pressure, the more nutrients that will be absorbed.[10]

Cont.

- Solutes and gases are absorbed by simple diffusion depending on their molecular makeup and properties.
- Oxygen and carbon dioxide are highly permeable across the placental tissues due to their lipophilicity.
- Their exchange is perfusion limited, which can cause fetal growth restriction if there is tissue hypoxia.[11]
- The placenta also uses channels for ion transport down their electrochemical gradient, facilitated diffusion for glucose using carrier proteins, and active transport for several solutes.[12]

Mechanism

- Fetal circulation flows from the fetus to the two umbilical arteries (deoxygenated), then to chorionic arteries in the cotyledons, through the capillary beds to exchange gases with maternal blood, then back to the fetus via a single umbilical vein (oxygenated).



Scheme of Placental circulation, Marginal sinus, Chorion, Amnion, Trophoblast, Umbilical Arteries and Veins in the Cord. Contributed by Gray's Anatomy Plates

The figure shows a human placenta. Contributed by Bruno Bordoni, PhD.

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Thank You for listening . . =)