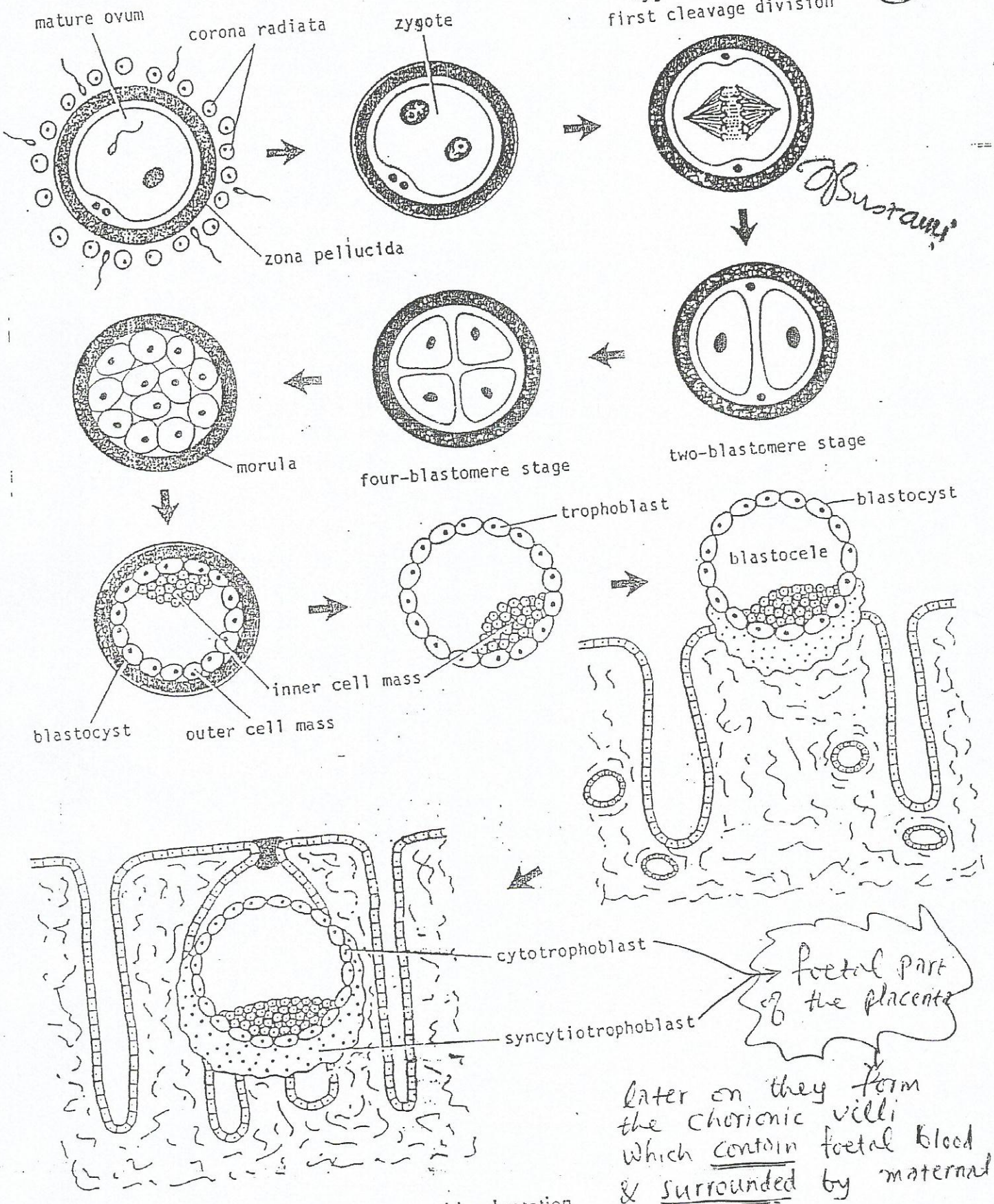


Stages of fertilization, cleavage, and implantation.

later on they form the chorionic villi which contain foetal blood & surrounded by maternal blood

D Bustami (2)

The Placenta

By the beginning of the fourth month, the placenta has two components.

(a) A foetal part formed by the chorion frondosum
(b) A maternal part formed by the decidua basalis

The decidua is the name given to the endometrium after the blastocyst is completely embedded in it. After implantation the secretory phase of the endometrium undergoes further changes: (1) The capillaries of the endometrium become congested and dilated to form intercommunicating sinusoids (2) The walls of these maternal sinusoids are eroded and broken down by the trophoblast (3) the trophoblastic lacunae become confluent with each other and with the maternal blood sinusoids (4) when the walls of the maternal arterioles and venules have become eroded by the trophoblast a definite circulation of blood is established between trophoblastic lacunae (foetal) and (maternal) sinusoids. (Look at page 1 and related figures).

The decidua is divided into the following three parts:
(1) D. basalis (2) D. capsularis (3) D. parietalis.

(1) Decidua basalis it is the part which lies between the blastocyst and the wall of the uterus.
This part of the decidua is the most important part and will develop to form the maternal part of the placenta

(2) Decidua capsularis is a thin layer of endometrium which covers the blastocyst and forms a thin capsule for it.

(3) Decidua parietalis this is the decidua which lines the remaining part of the uterine cavity.

As the embryo grows, the decidua capsularis and decidua parietalis come in opposition and fuse with each other and in this way :-

(a) the cavity of the uterus becomes obliterated

(b) the only part of the decidua which remains functioning is the decidua basalis and it developes to form the maternal part of the placenta.

Further Development of the Trophoblast 1st → 2nd Week (3)

A. Syncytiotrophoblast

–is the outer multinucleated zone of the trophoblast; no mitosis occurs in this zone.

–arises from the cytotrophoblast.

–continues invasion of the endometrial stroma, thereby eroding **endometrial blood vessels** and **endometrial glands**.

1. Isolated spaces (**lacunae**) form within the syncytiotrophoblast, predominantly at the **embryonic pole,** and become filled with nutritive **maternal blood** and **glandular secretions**. **Endometrial stromal cells (decidual cells)** at the site of implantation become filled with glycogen and lipids and also supply nutrients to the embryoblast.

   a. Isolated lacunae fuse to form a **lacunar network**.

   b. Maternal blood flows in and out of the lacunar network, thus establishing early **uteroplacental circulation**.

2. Although a primitive circulation is established between the **uterus** and future **placenta**, the embryoblast receives its nutrition via **diffusion only** at this time.

3. As implantation proceeds, there is **progressive involvement of maternal blood vessels:** endometrial capillaries at week 2 after fertilization, endometrial arterioles at week 3, and endometrial spiral arteries at week 8.

B. Cytotrophoblast

–is mitotically active.

1. New cytotrophoblastic cells migrate into the syncytiotrophoblast, thereby fueling its growth.

2. New cytotrophoblastic cells produce local mounds (**primary chorionic villi**) that bulge into the surrounding syncytiotrophoblast.

III. Development of Extraembryonic Mesoderm

A. A new layer develops consisting of loosely arranged cells, which is derived from the epiblast.

B. This layer fills the space between the exocoelomic membrane and the cytotrophoblast.

C. Large spaces develop in the extraembryonic mesoderm and coalesce to form the **extraembryonic coelom**.

D. The extraembryonic coelom divides the extraembryonic mesoderm into the **extraembryonic somatic mesoderm** and **extraembryonic visceral mesoderm**.

   1. Extraembryonic somatic mesoderm lines the **trophoblast,** forms the **connecting stalk,** and covers the **amnion**.

   2. Extraembryonic visceral mesoderm covers the **yolk sac**.

E. Extraembryonic somatic mesoderm, cytotrophoblast, and syncytiotrophoblast constitute the **chorion**.

F. The extraembryonic coelom is now called the **chorionic cavity**.

G. The embryoblast is suspended by the **connecting stalk** within the chorionic cavity.

Clinical Considerations

A. Human chorionic gonadotropin (hCG)

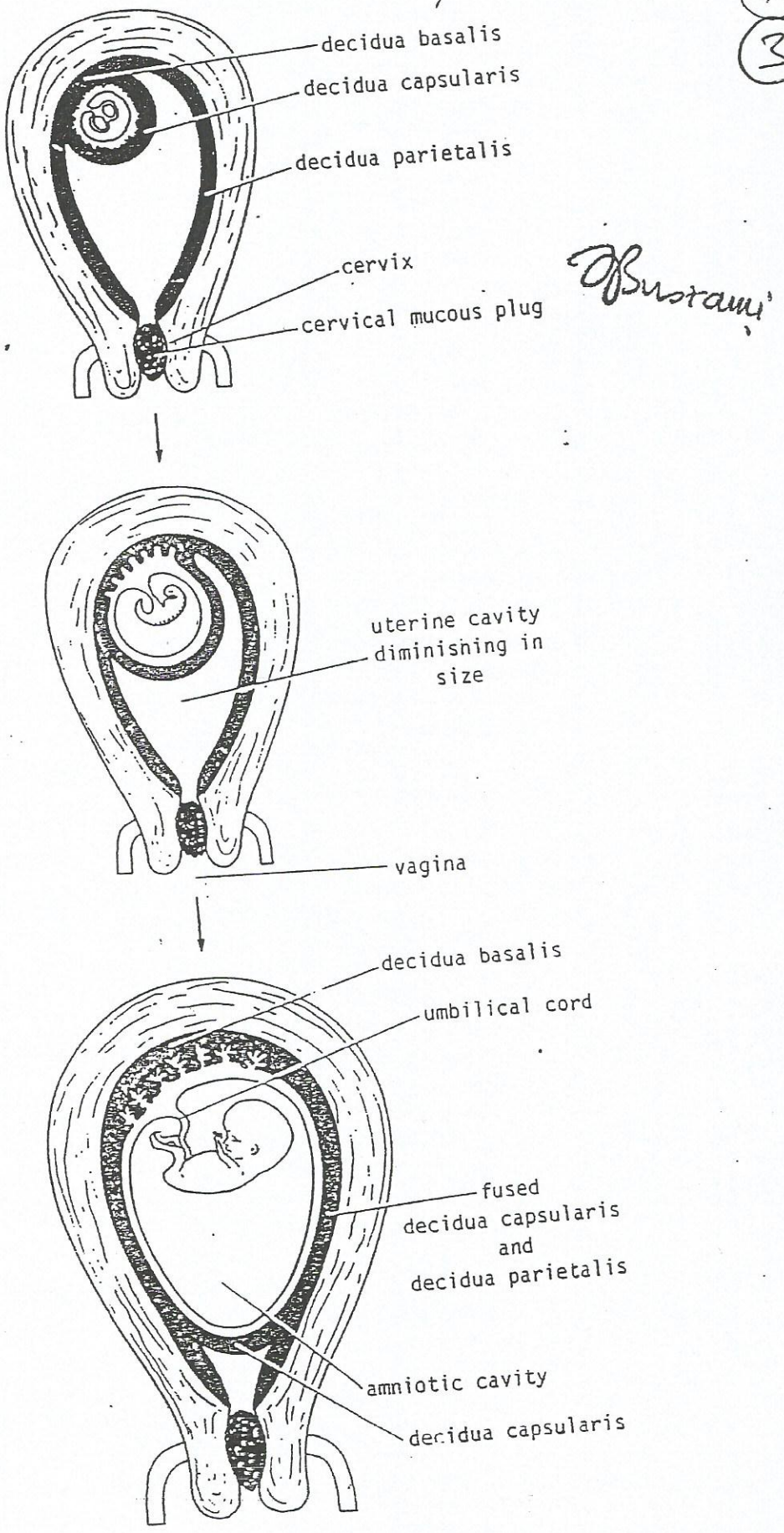
–is a 57,000 MW glycoprotein with two subunits (alpha and beta) produced by the **syncytiotrophoblast**.

–enters **maternal blood circulation**.

–prevents degeneration of the **corpus luteum**.

–stimulates production of **progesterone,** not only in the corpus luteum, but also in the **chorion** itself. Progesterone is important in sustaining the **placenta**.

–can be assayed in maternal blood at day 8 after fertilization and in maternal urine at day 10; this is the basis of early diagnosis of pregnancy.


decidua basalis
decidua capsularis
decidua parietalis
cervix
cervical mucous plug
uterine cavity diminishing in size
vagina
decidua basalis
umbilical cord
fused decidua capsularis and decidua parietalis
amniotic cavity
decidua capsularis

4

The Chorion

The chorion is the name given to the trophoblast after the extraembryonic mesoderm is formed on its inner surface. As pregnancy advances and in order to obtain more surface area, small finger-like processes called the chorionic villi start to develop from the outer surface of the chorion. The chorionic villi are formed in three stages : Primary, secondary and tertiary (see page).

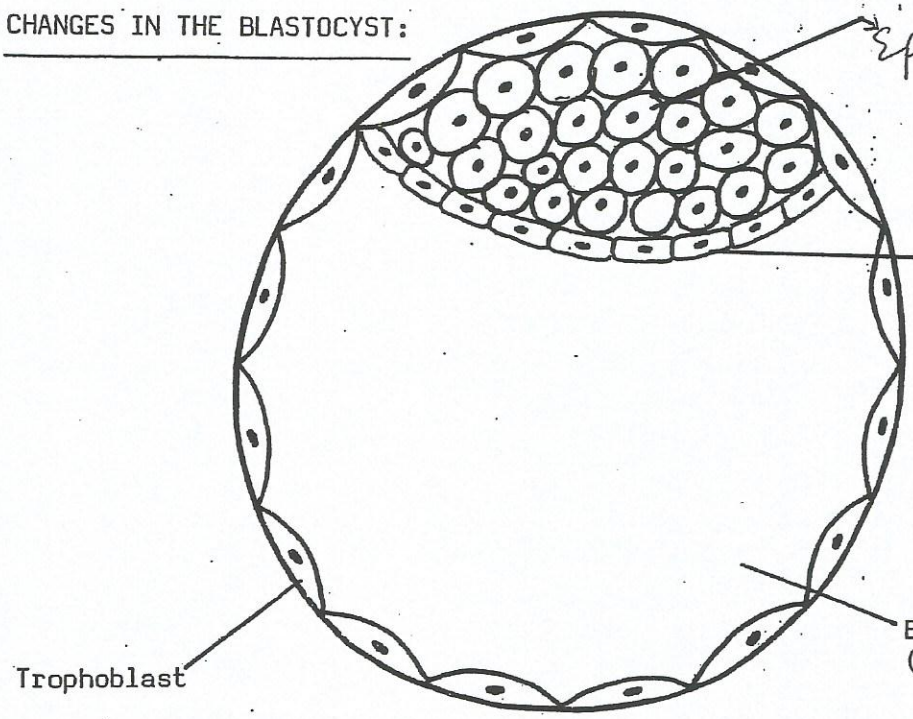
In the early weeks of development the chorionic villi cover the whole surface of the chorionic vesicle (blastocyst). As pregnancy advances the villi increase over the embryonic pole of the chorionic vesicle, forming the Chorion frondosum (bushy - like) and degenerate elsewhere forming the chorion laeve. The chorion frondosum is the only functioning part of the chorion, it LIES OVER the decidua basalis and will develop to form the foetal part of the placenta.

N.B.

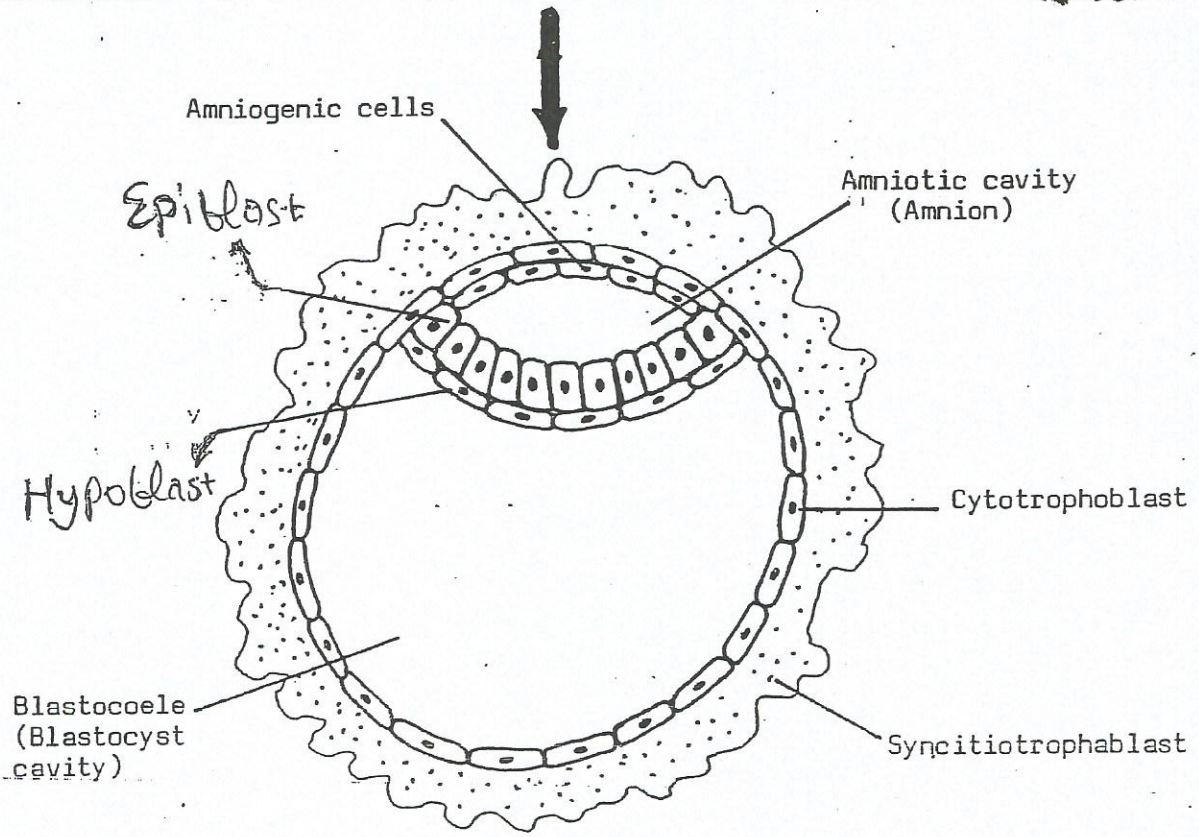
(1) With the development of the chorionic villi, the "primitive blood lake" in which the blastocyst is floating is converted into many small intervillous space The maternal blood passes out of the eroded vessels of the endometrium to fill the intervillous spaces & between the chorionic villi) while the foetal blood passes in and out of the chorionic villi through the afferent and efferent capillary loops found inside the cores of these villi. The foetal and maternal blood do not mix with each other, because they are separated from each other by the placental barrier which is formed of four layers: (1) the endothelial lining of the capillaries in the chorionic villi (2) the connective tissue in the core of these villi (3) a layer of cytotrophoblast (4) a layer of syncytiotrophoblast covering the cytotrophoblast. In late pregnancy the villi lose two of their components, these are the connective tissue core of the villi and the layer of cyto-trophoblast, thus the placental barrier becomes thinner and this makes the exchange of materials

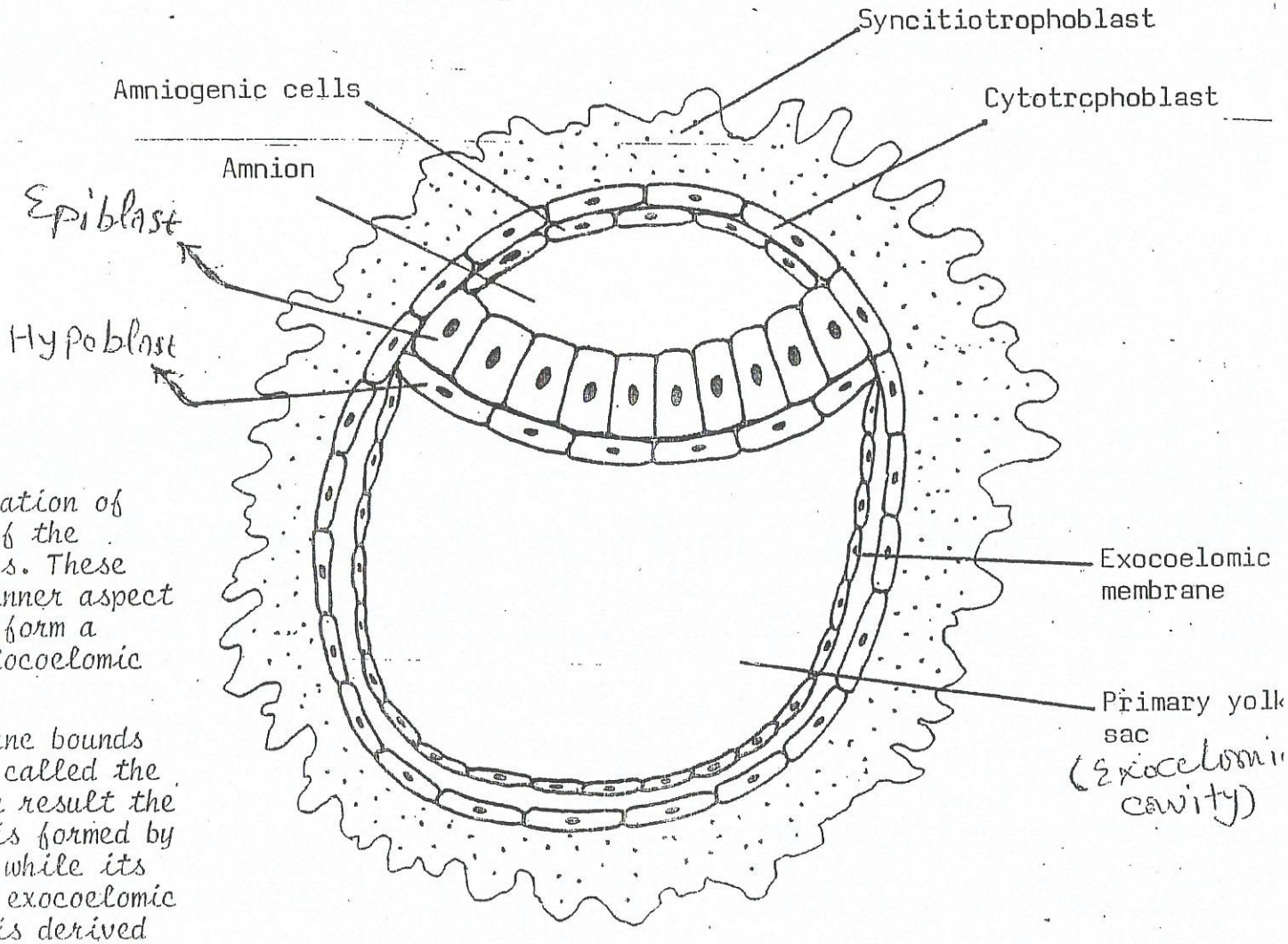
(4) B

CHANGES IN THE BLASTOCYST:

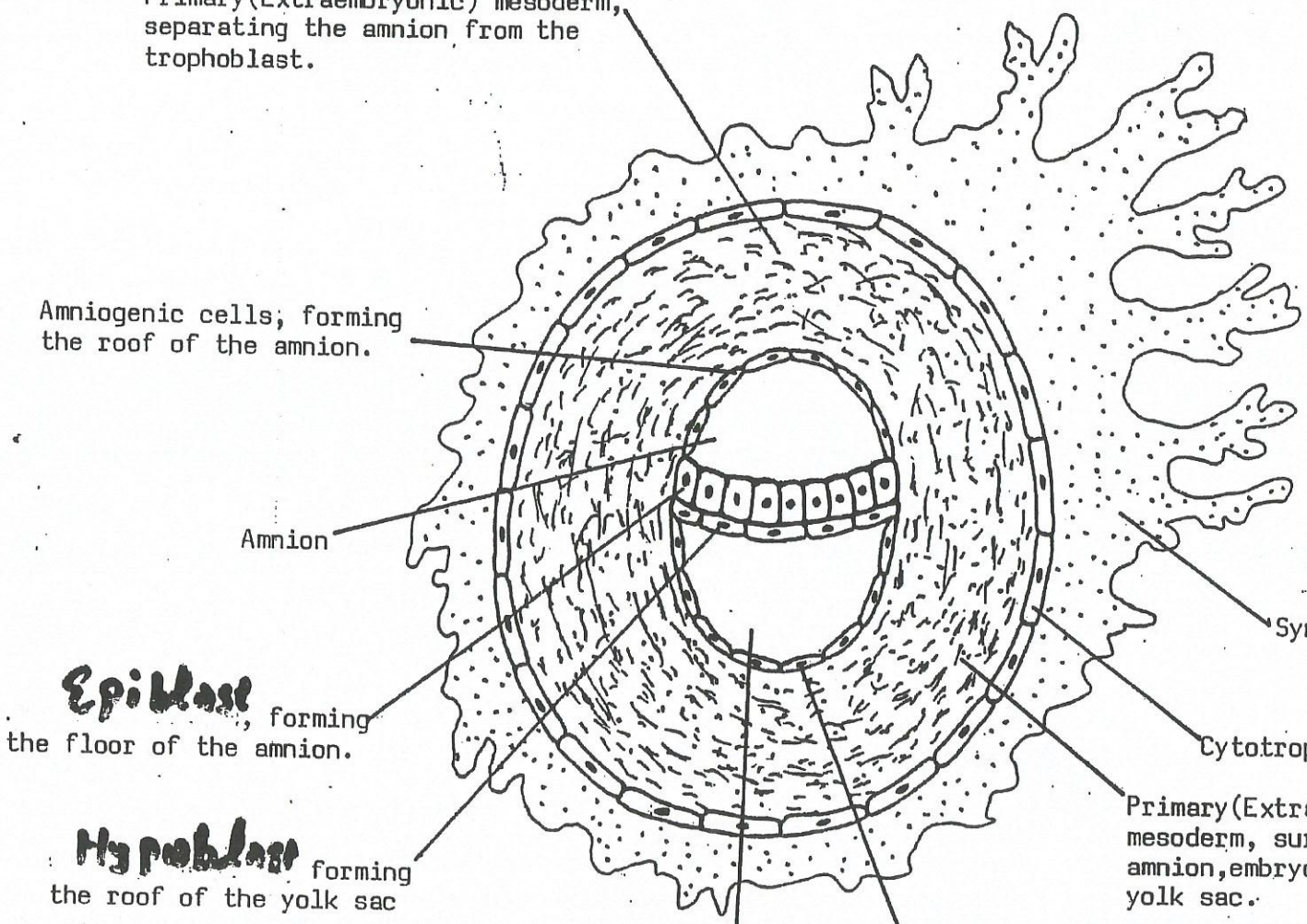


- *The cells of the inner cell mass towards the blastocyst cavity (blastocoele), chan into a layer of flat cells called the* [redacted]
- *The remainder of the cells of the inner cell mass constitute the* [redacted]

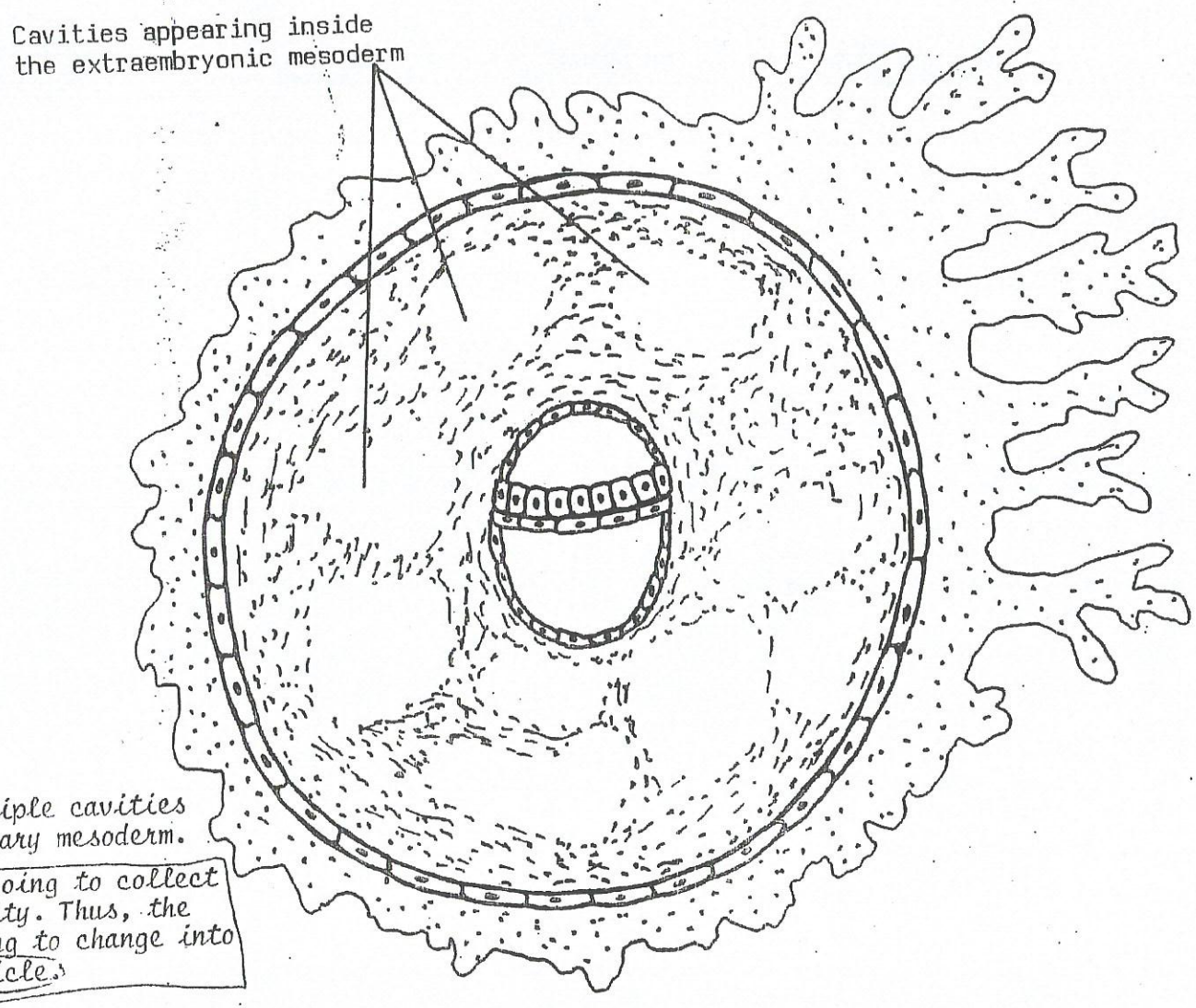




- At this stage proliferation of cells at the margins of the hypoblast occurs. These cells migrate on the inner aspect of the trophoblast to form a membrane called the exocoelomic membrane.
- The exocoelomic membrane bounds a new cavity which is called the primary yolk sac. As a result the roof of the yolk sac is formed by the primary entoderm; while its wall is formed by the exocoelomic membrane. The latter is derived from the hypoblast.

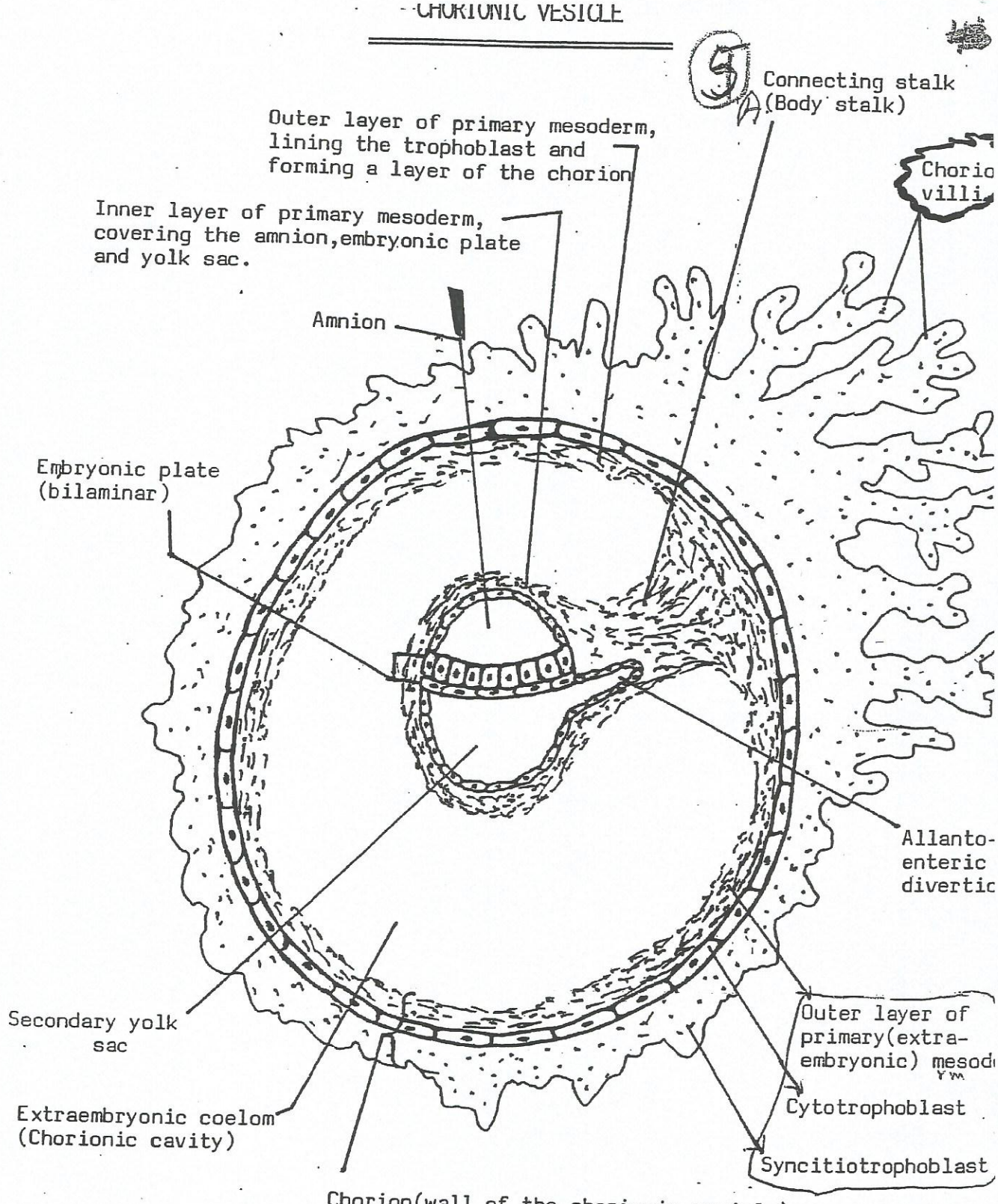


* At this stage the primary mesoderm has increased greatly and migrated to separate the amnion from the overlying trophoblast.



- At this stage multiple cavities appear in the primary mesoderm.
- The cavities are going to collect into a single cavity. Thus, the blastocyst is going to change into the chorionic vesicle.

CHORIONIC VESICLE



Chorionic vesicle

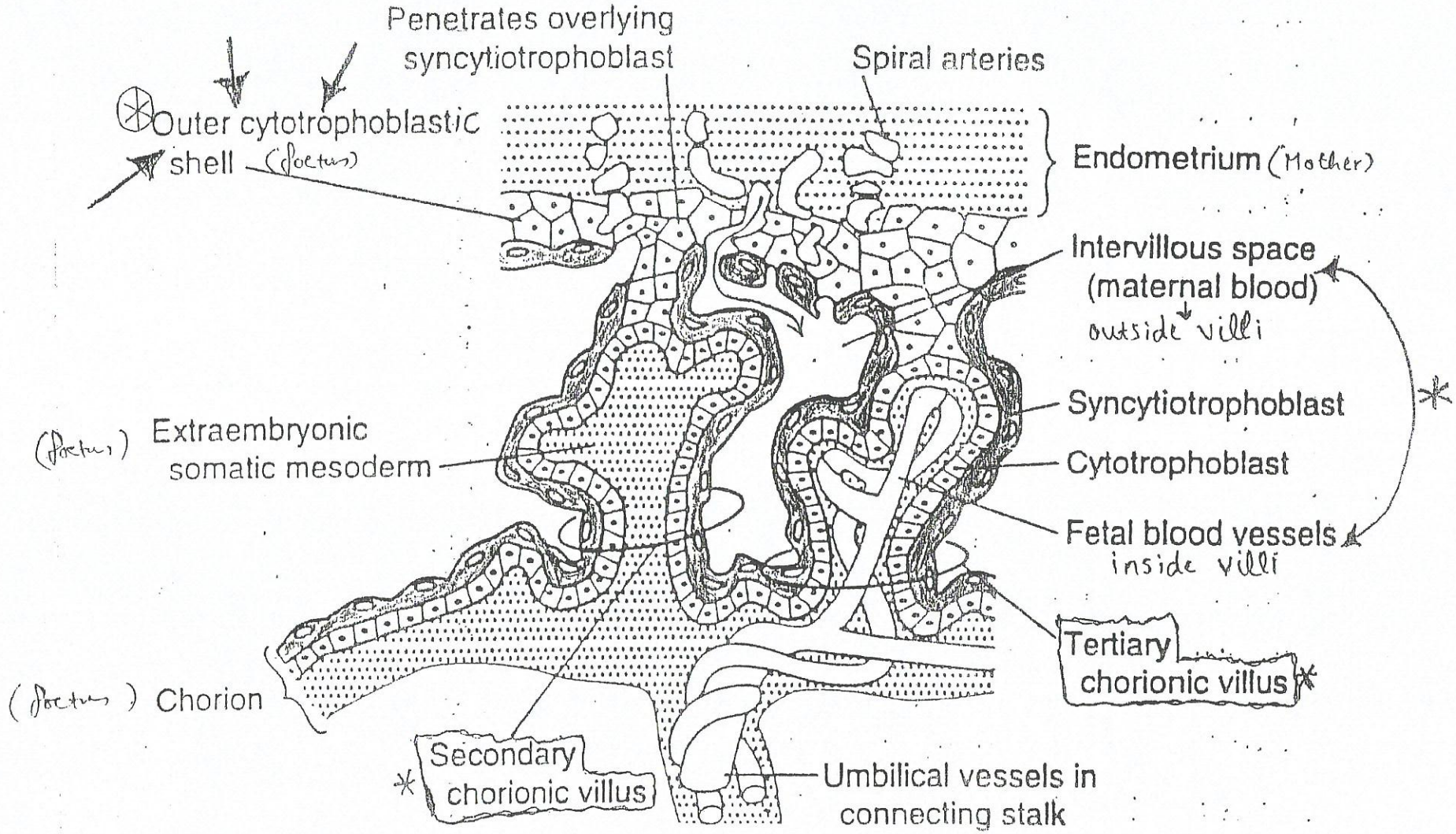


Figure 4-3. Schematic representation of the further development of the trophoblast, demonstrating a secondar chorionic villus, a tertiary chorionic villus, and the outer cytotrophoblast shell.

I. Formation of the Placenta (Figure 6-1)

–The placenta is formed as the **endometrium** of the uterus is **invaded** by the developing embryo and as the trophoblast forms the **villous chorion**.
–Villous chorion formation goes through three stages: primary chorionic villi, secondary chorionic villi, and tertiary chorionic villi.

II. Placental Components: Decidua Basalis and Villous Chorion (Figure 6-2)

A. Maternal component

1. This consists structurally of the **decidua basalis,** which is derived from the endometrium of the uterus located between the blastocyst and the myometrium.
2. The decidua basalis and **decidua parietalis** (which includes all portions of the endometrium other than the site of implantation) are shed as part of the **afterbirth**.
3. The **decidua capsularis,** the portion of endometrium that covers the blastocyst and separates it from the uterine cavity, becomes attenuated and degenerates at week 22 of development because of a reduced blood supply.
4. Functionally, the human placenta is of the **hemochorial type,** so that maternal blood may be considered a component of the placenta.
5. The term *decidua* means "falling off," "shed," or "sloughed off."

B. Fetal component

–consists of **tertiary chorionic villi** derived from both the trophoblast and extraembryonic mesoderm, which collectively become known as the **villous chorion**.

1. The villous chorion develops most prolifically at the site of the decidua basalis.
2. The villous chorion is in contrast to an area of no villus development known as the **smooth chorion** (which is related to the decidua capsularis).

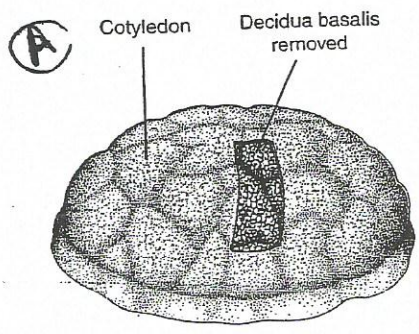
Appearance of the Placenta in Afterbirth

A. Maternal surface of placenta

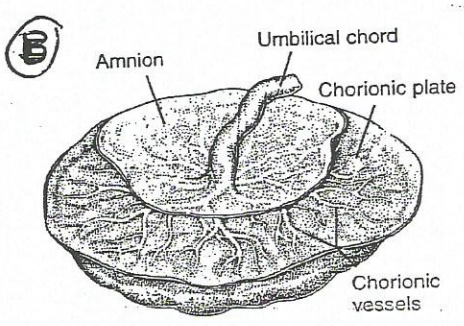
–is characterized by 15 to 20 compartments called **cotyledons,** which are separated by **decidual (placental) septa**.
–is dark red in color.
–oozes blood due to torn maternal blood vessels.

B. Fetal surface of placenta

–is characterized by the well-vascularized **chorionic plate** containing the **chorionic blood vessels**.
–has a smooth and shiny appearance because of the amnion.



maternal surface of the placenta



fetal surface of the placenta

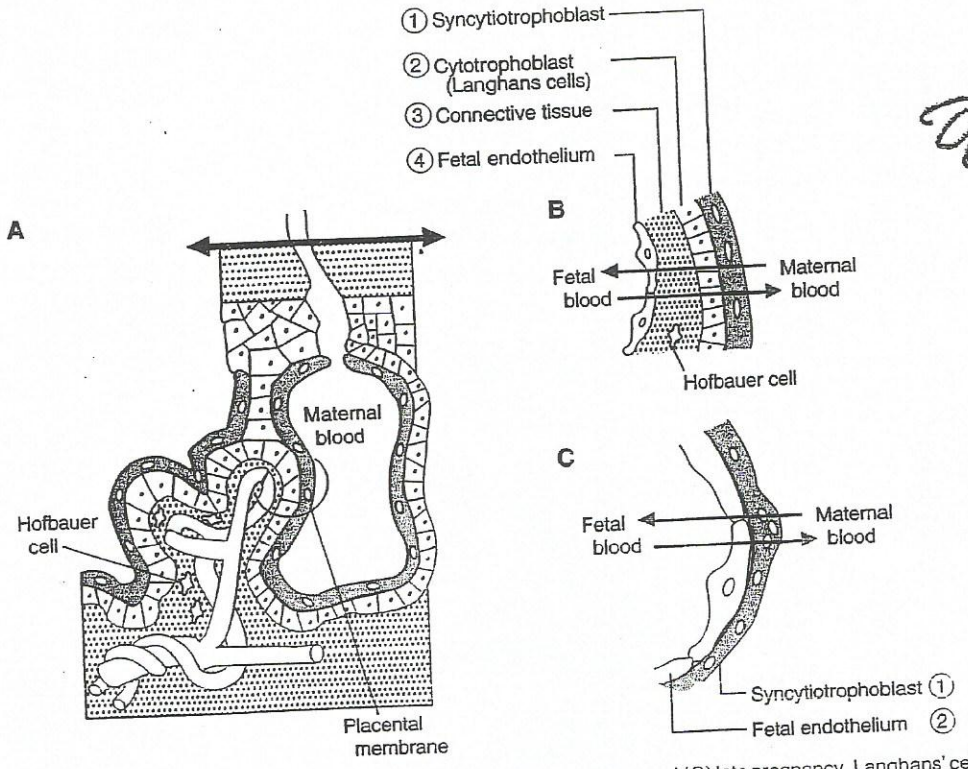


Figure 6-3. Diagrams of the placental membrane at (*A, B*) early pregnancy and (*C*) late pregnancy. Langhans' cells are cytotrophoblastic cells that serve as stem cells for the synctiotrophoblast.

1. The placenta has four layers in early pregnancy: syncytiotrophoblast, cytotrophoblast (**Langhans cells**), connective tissue, and endothelium of fetal capillaries. **Hofbauer cells,** large elliptical cells found in the connective tissue, are most numerous in early pregnancy; they have characteristics similar to those of macrophages.
2. The placenta has two layers in late pregnancy: syncytiotrophoblast and endothelium of fetal capillaries.

Note ⇒ the placental barrier (membrane) in early pregnancy is formed of 4 layers which are reduced to 2 layers in late pregnancy

(i) The placenta now becomes subdivided by a number of septa, that grow into the intervillous space from the maternal side (Fig. 6.17). Each subdivision of the placenta is called a *cotyledon*. It contains one anchoring villus and its branches. If the placenta is viewed from the maternal side, the bases of the septa are seen as grooves (Fig. 6.18), while the cotyledons appear as convex areas bounded by the grooves. The cotyledons generally number 15 to 20, but they may be as few as 10, or as many as 38.

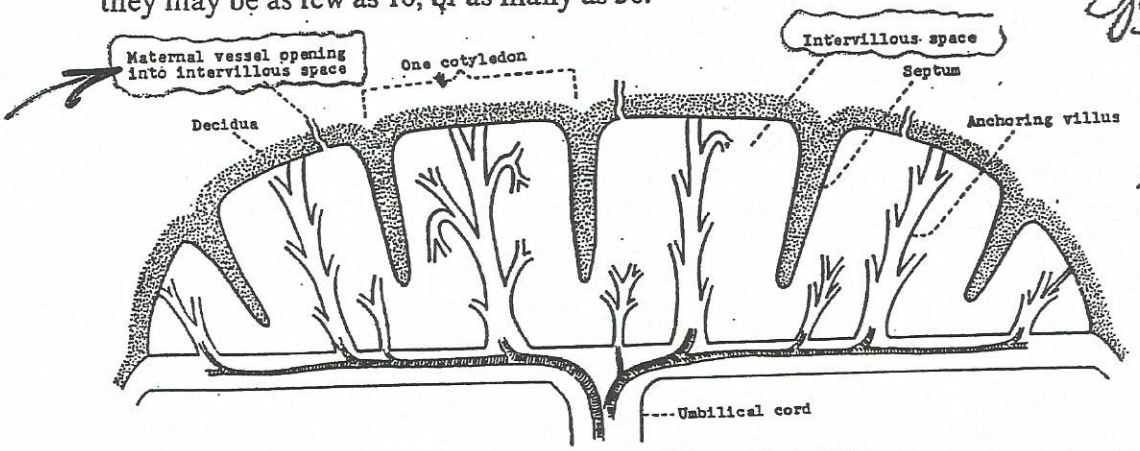
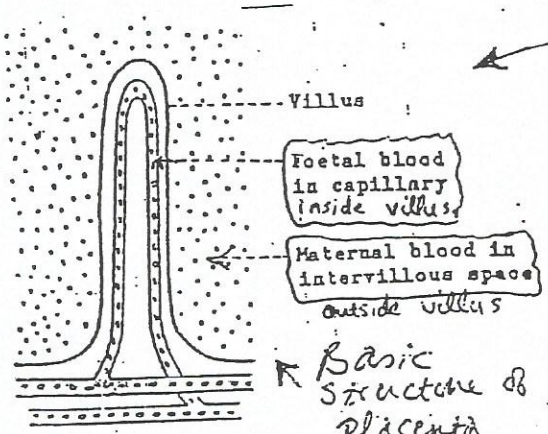


Fig. 6.17 Structure of fully formed placenta.



Basic Structure of placenta

Basic structure of placenta

Foetal blood inside villi is separated from maternal blood – present within the intervillous spaces – by the wall of the villi i.e there is NO mixing between maternal and foetal blood inside the placenta

NORMAL SITE OF IMPLANTATION OF THE OVUM

The uterus can be divided into an upper part, consisting of the fundus and the greater part of the body, and a lower part, consisting of the lower part of the body and the cervix. These are called the *upper uterine segment*, and the *lower uterine segment*, respectively. It is the upper uterine segment that enlarges during pregnancy. The placenta is normally attached only to the upper uterine segment, generally on the posterior wall (Fig. 6.21).

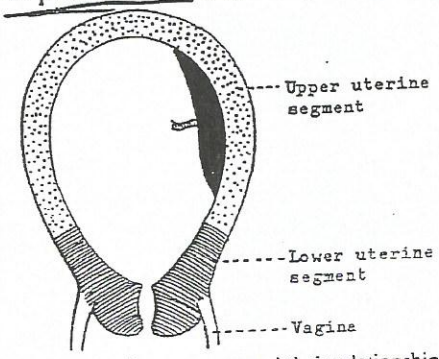


Fig. 6.21 Upper and lower uterine segments and their relationship to the placenta.

ABNORMAL SITES OF IMPLANTATION OF THE OVUM

(a) *Abnormal implantation within the uterus*

The attachment of the placenta may extend partially, or completely, into the lower uterine segment. This condition is called *placenta praevia*. It causes difficulty during child-birth and may cause severe bleeding. Various degrees of placenta praevia may be recognised:

(i) *First degree*: The attachment of the placenta extends into the lower uterin segment, but does not reach the internal os (Fig. 6.22A).

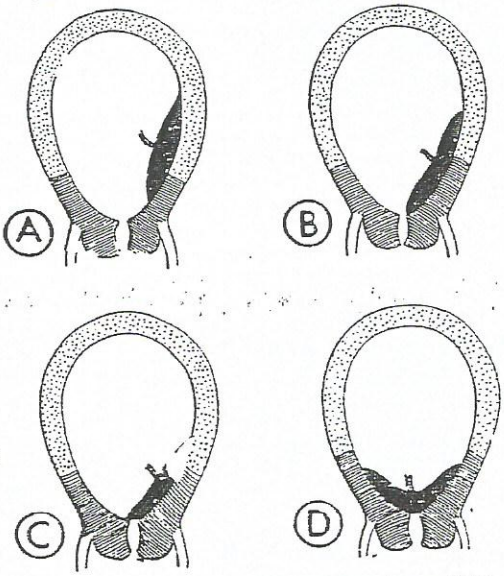


Fig. 6.22 Types of placenta praevia. (A) First degree (B) Second degree (C) Third degree (D) Fourth degree.

(ii) *Second degree:* The margin of the placenta reaches the internal os, but does not cover it (Fig. 6.22B).

(iii) *Third degree:* The edge of the placenta covers the internal os, but as the os dilates during child-birth, the placenta no longer occludes it (Fig. 6.22C).

(iv) *Fourth degree:* The placenta completely covers the internal os, and occludes it even after it has dilated (Fig. 6.22D).

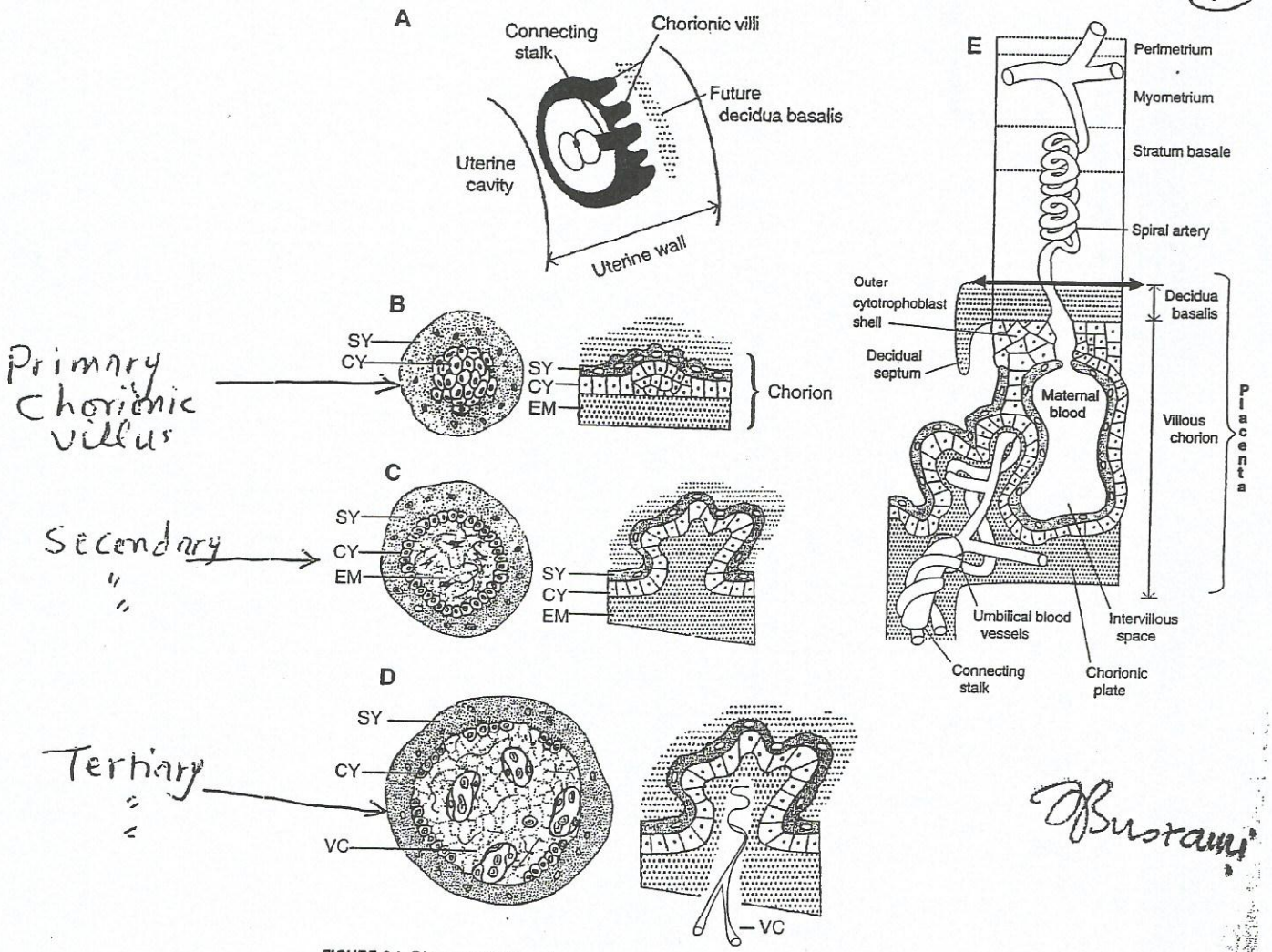


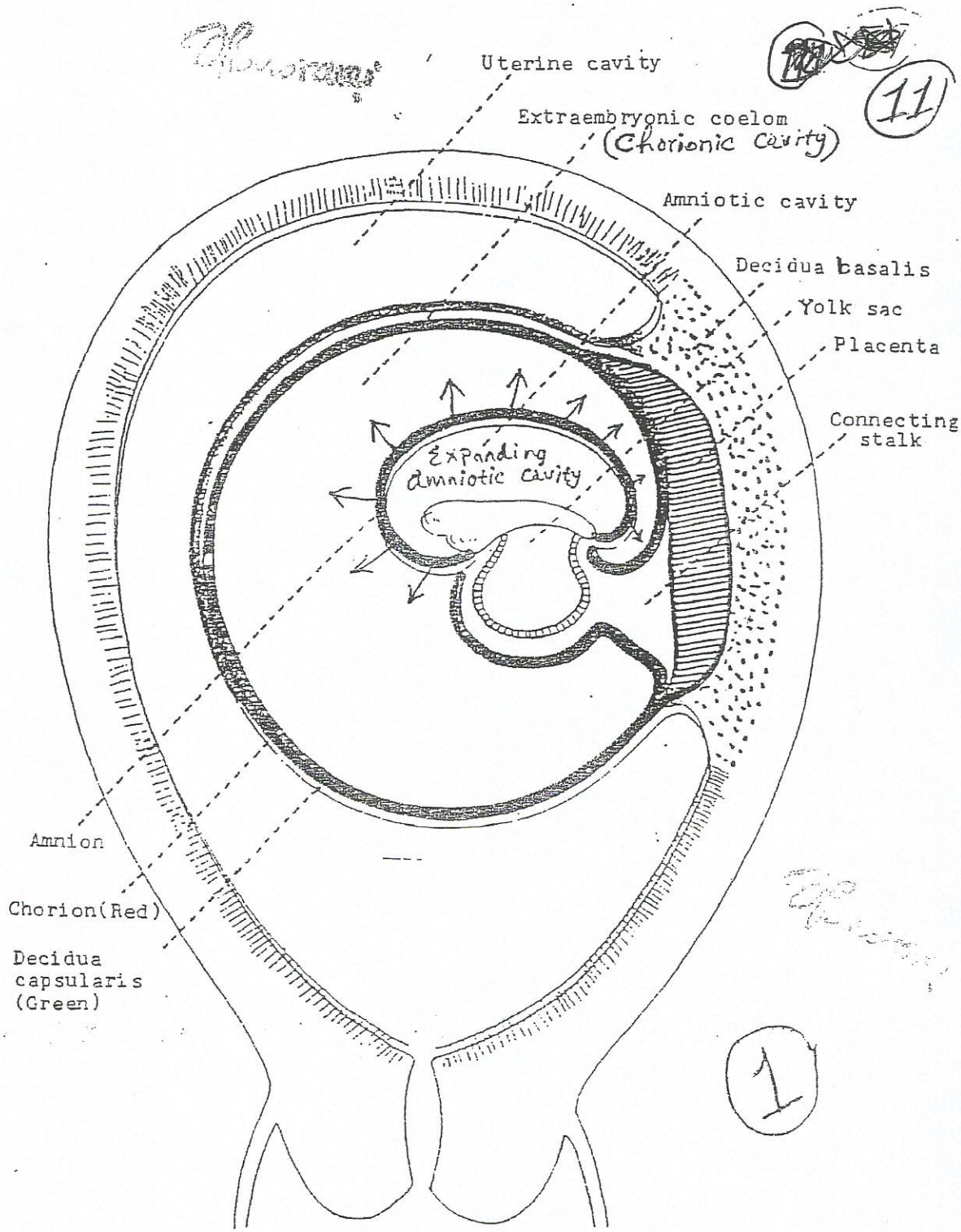
FIGURE 6.1. Diagram of the various stages of villous chorion formation as it relates to placental development. **(A)** A week 2 embryo completely embedded in the wall of the uterus. **(B)** Primary chorionic villus during week 2. A primary villus consists of a core of cytotrophoblastic cells surrounding by syncytiotrophoblast. **(C)** Secondary chorionic villus during the start of week 3. A secondary villus consists of a core of extraembryonic mesoderm surrounded by cytotrophoblastic cells and syncytiotrophoblast. **(D)** Tertiary chorionic villus at the end of week 3. A tertiary villus consists of a core of villous (fetal) capillaries surrounded by cytotrophoblastic cells and syncytiotrophoblast. **(E)** The villous chorion (consisting of tertiary chorionic villi) and decidua basalis are the two components of the definitive placenta. Note that the cytotrophoblast penetrates the syncytiotrophoblast to make contact with the decidua basalis and form the outer cytotrophoblast shell. The thick, *double-headed arrow* indicates the plane of separation when the placenta is shed during the afterbirth. (Note: The stratum basale is not part of the placenta.) SY = syncytiotrophoblast; CY = cytotrophoblast; EM = extraembryonic mesoderm; VC = villous capillaries.

Remember → Chorion is formed of { syncitiotrophoblast / cytotrophoblast (2) / Extraembryonic (3) Somatic mesoderm

A primary chorionic villus is formed of 1+2

A secondary chorionic villus is formed of 1+2+3

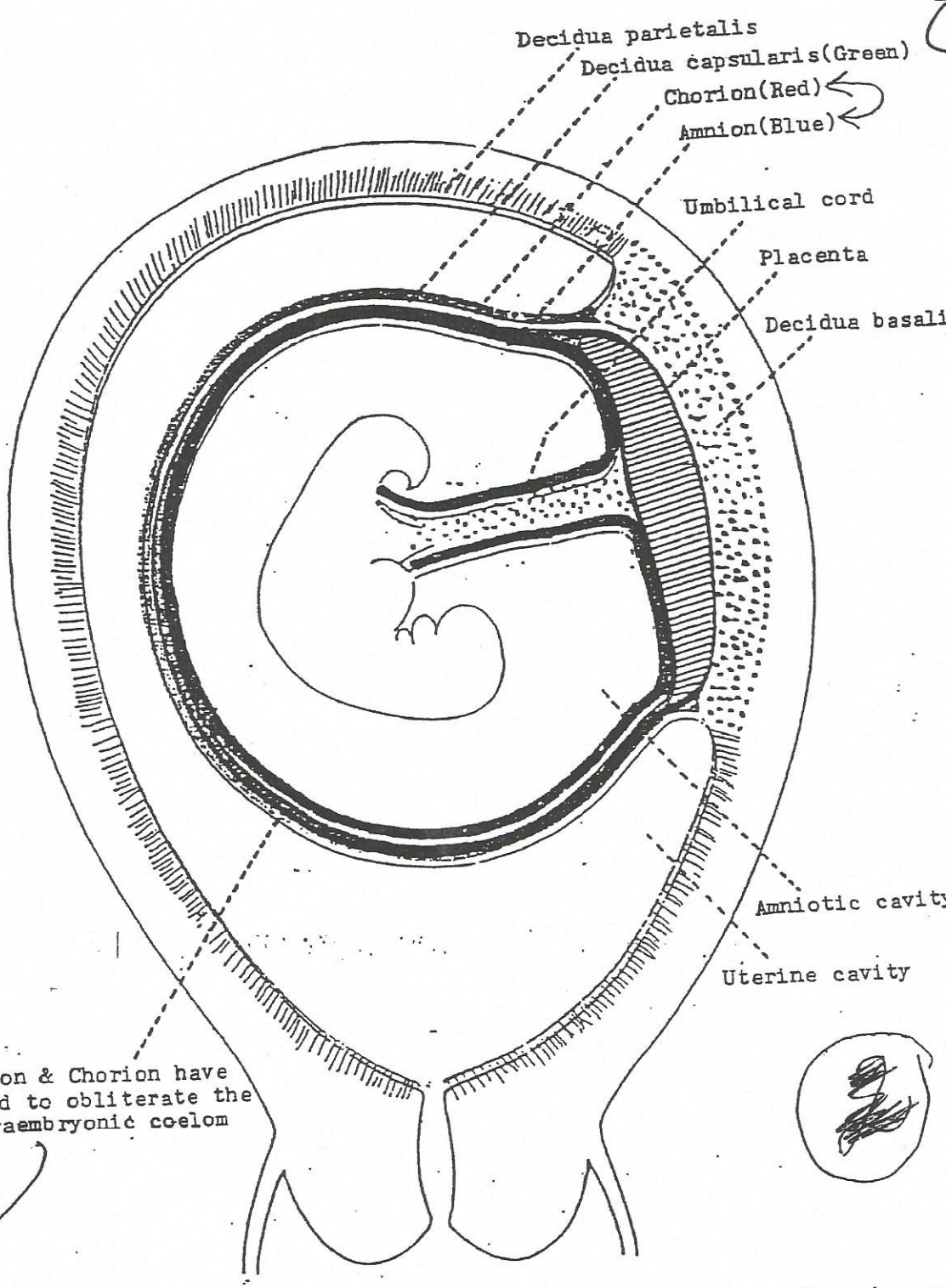
A tertiary chorionic villus is formed of 1+2+3+ blood vessels



Relationship of amniotic cavity, extra-embryonic coelom and uterine cavity. description see text. (1) Notice that the amniotic cavity is expanding at the expense of the extraembryonic coelom (Chorionic cavity)

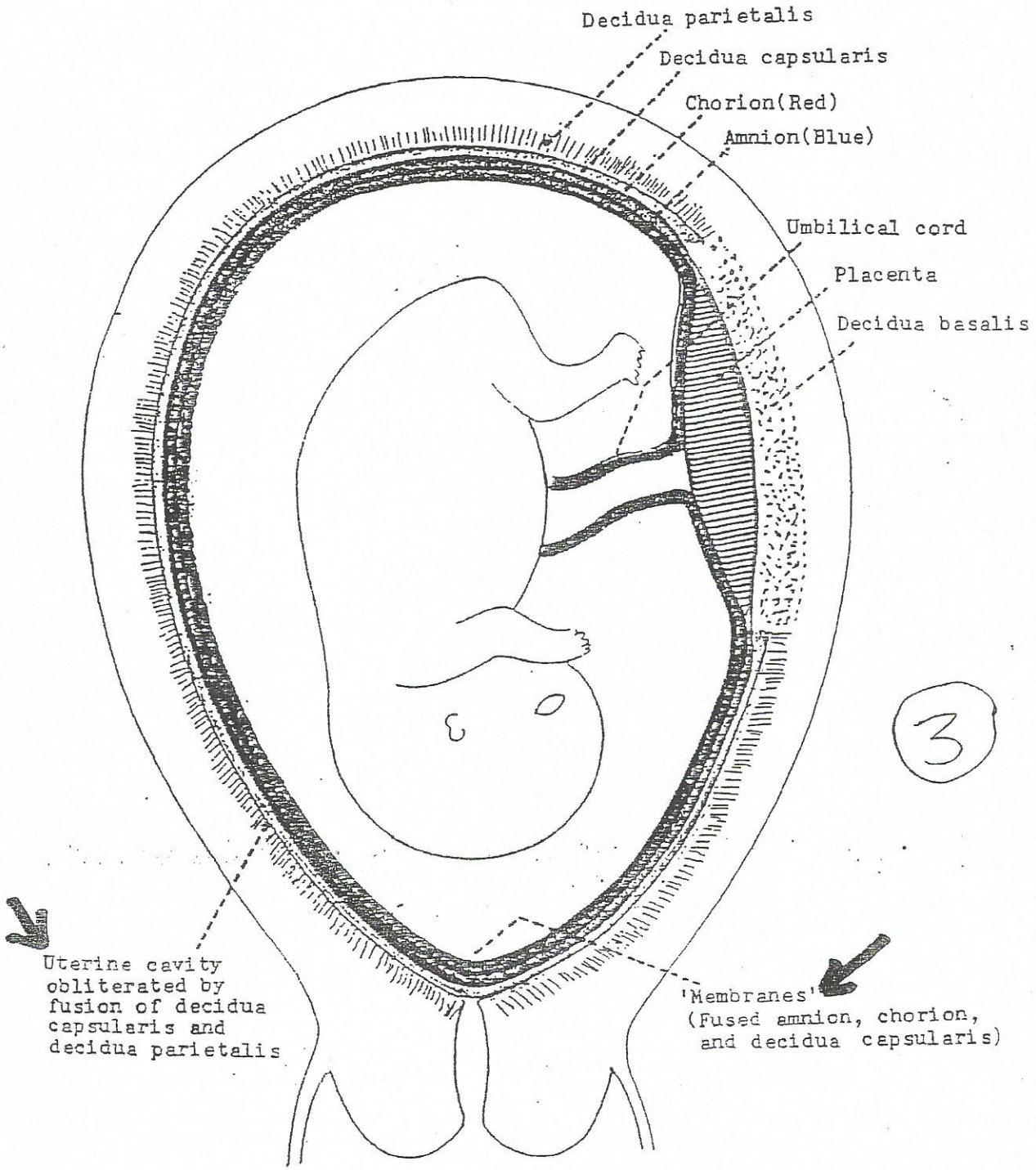
Obstetrics

12



Relationship of amniotic cavity, extra-embryonic coelom and uterine cavity.

→ Remember that the (2) fused amnion and Smooth Chorion form the amniochorionic membrane (bag of waters) which dilate the cervical canal during labour



Amniotic cavity after obliteration of extraembryonic coelom and uterine cavity.

(3)

VIII. TWINNING (FIGURE 6.6)

A. **Dizygotic (fraternal) twins result** from the fertilization of two different secondary oocytes by two different sperm. The resulting two zygotes form two blastocysts, each of which implants separately into the endometrium of the uterus. Hence, these twins are no more genetically alike than are siblings born at different times. Dizygotic twins and 35% of monozygotic twins have **two placentas, two amniotic sacs, and two chorions (i.e., a diamniotic–dichorionic membrane).**

B. **Monozygotic (identical) twins** result from the fertilization of one secondary oocyte by one sperm. The resulting zygote forms a blastocyst in which the inner cell mass (embryoblast)

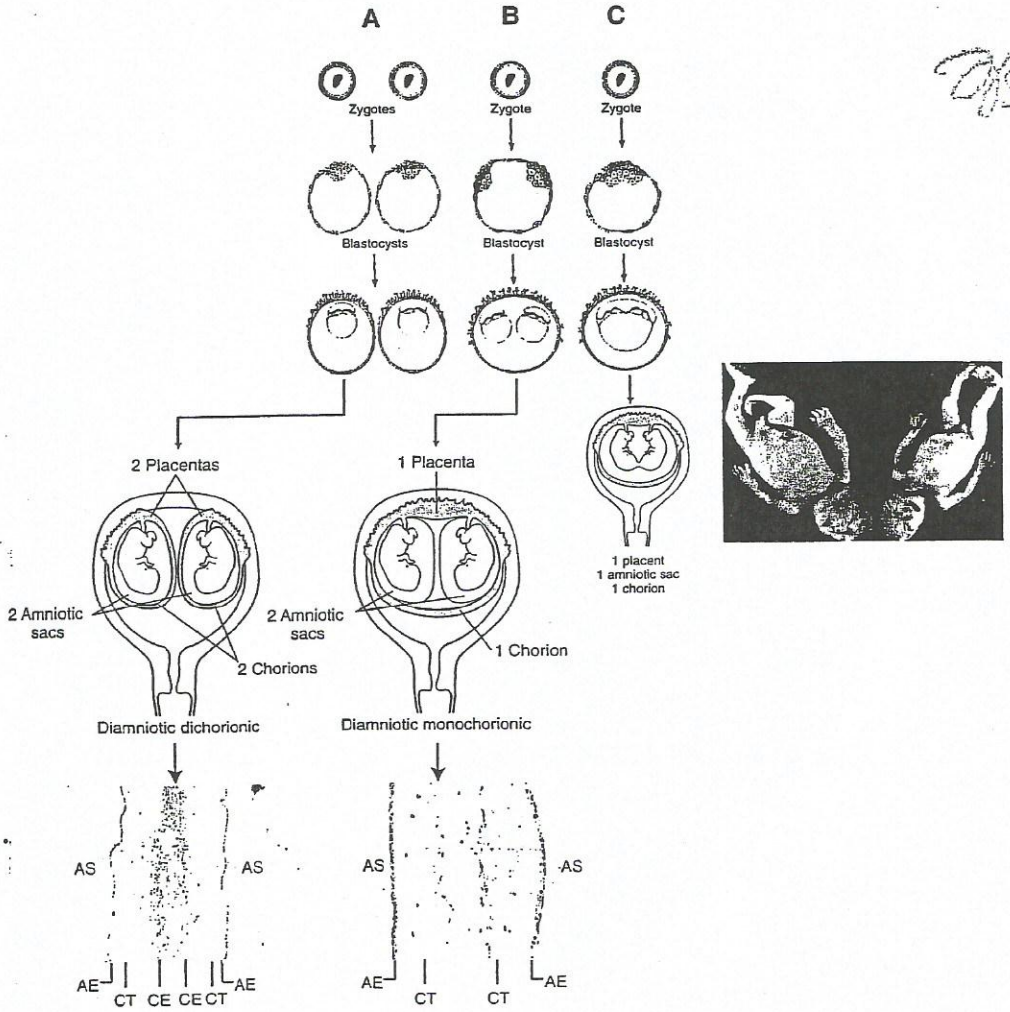


FIGURE 6.6. Diagram of twinning. **(A)** Dizygotic twins. Note that dizygotic twins and 35% of monozygotic twins have **two placentas, two amniotic sacs, and two chorions** (diamniotic–dichorionic membrane; remember "222"). Light micrograph shows the histological arrangement of the placental components in dizygotic twins and 35% of monozygotic twins (*boxed area*). Note the two amniotic sacs (AS), two layers of simple cuboidal epithelium of the amnion (AE), a two chorions consisting of connective tissue (CT), and chorionic epithelium (CE). The gross appearance of a diamniotic–dichorionic membrane is opaque, with some remnants of blood vessels. **(B)** Monozygotic twins. In 65% of cases, monozygotic (identical) twins have **one placenta, two amniotic sacs, and one chorion** (diamniotic–monochorionic membrane; remember "121"). Light micrograph shows the histological arrangement of the placental components in 65% of monozygotic (identical) twins (*boxed area*). Note the two amniotic sacs (AS), two layers of simple cuboidal epithelium of the amnion (AE), and surrounding connective tissue (CT). Also note the absence of the intervening cellular chorionic layer as seen in panel A. The gross appearance of a diamniotic–monochorionic membrane is transparent. **(C)** Conjoined twins. Twins conjoined at the head (i.e., craniopagus) with lower limb deformities (*arrows*) are shown.

splits into two. Hence, these twins are genetically identical. In 65% of cases, monozygotic (identical) twins have **one placenta, two amniotic sacs, and one chorion (i.e., a diamniotic–monochorionic membrane).**

C. **Conjoined (Siamese) twins** form exactly like monozygotic twins, except that the inner cell mass (embryoblast) does not completely split. Hence, two embryos form, but they are joined