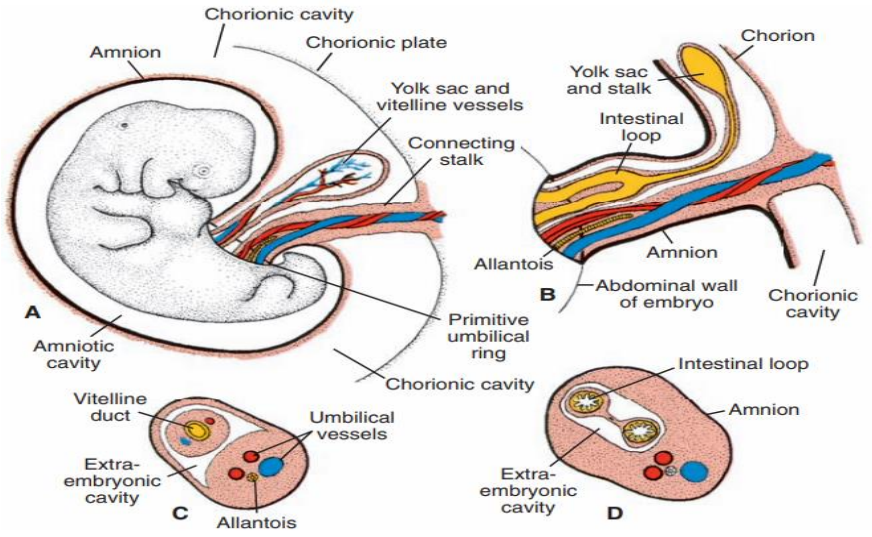
Lecture 9

Amnion and Umbilical Cord

The oval line of reflection between the amnion and embryonic ectoderm (amnio-ectodermal junction) is the primitive umbilical ring. At the fifth week of development, the following structures pass through the ring: **(a) the connecting stalk, containing the allantois and the umbilical vessels, consisting of two arteries and one vein; (b) the yolk stalk (vitelline duct), accompanied by the vitelline vessels; and (c) the canal connecting the intraembryonic and extraembryonic cavities**. The yolk sac proper occupies a space in the chorionic cavity, that is, the space between the amnion and chorionic plate.



During further development, the amniotic cavity enlarges rapidly at the expense of the chorionic cavity, and the amnion begins to envelop the connecting and yolk sac stalks, crowding them together and giving rise to the primitive umbilical cord. Distally the cord contains the yolk sac stalk and umbilical vessels. More proximally it contains some intestinal loops and the remnant of the allantois. The yolk sac, found in the chorionic cavity, is connected to the umbilical cord by its stalk. At the end of the third month, the amnion has expanded so that it comes in contact with the

chorion, obliterating the chorionic cavity. The yolk sac then usually shrinks and is gradually obliterated. The abdominal cavity is temporarily too small for the rapidly developing intestinal loops and some of them are pushed into the extraembryonic space in the umbilical cord. These extruding intestinal loops form a physiological umbilical hernia. At approximately the end of the third month, the loops are withdrawn into the body of the embryo and the cavity in the cord is obliterated. When the allantois and the vitelline duct and its vessels are also obliterated, all that remains in the cord are the umbilical vessels surrounded by the jelly of Wharton.

This tissue, which is rich in proteoglycans, functions as a protective layer for the blood vessels. The walls of the arteries are muscular and contain many elastic fibers, which contribute to a rapid constriction and contraction of the umbilical vessels after the cord is tied off.

Placental changes at the end of pregnancy

At the end of pregnancy, a number of changes that occur in the placenta may indicate reduced exchange between the two circulations.

1. Increase in fibrous tissue.
2. Thickening in the basement membrane of capillaries.
3. Obliterative changes in small villi capillaries.
4. Deposition of fibrinoid on the surface of villi.

Amniotic fluid

The amniotic cavity is filled with a clear, watery fluid that is produced in part by amniotic cells but is derived primarily from maternal blood. The amount of fluid increases from approximately 30 ml at 10 weeks of gestation to 450 ml at 20 weeks to 800 to 1000 ml at 37 weeks. During the early months of pregnancy, the embryo is suspended by its umbilical cord in this fluid, which serves as a protective cushion.

The function of the fluid

- absorbs jolts.
- prevents adherence of the embryo to the amnion.
- allows for fetal movements

The volume of amniotic fluid is replaced every 3 hours. From the beginning of the fifth month, the fetus swallows its own amniotic fluid and it is estimated that it drinks about 400 ml a day, about half of the total amount. Fetal urine is added daily to the amniotic fluid in the fifth month, but this urine is mostly water, since the placenta is functioning as an exchange for metabolic wastes. During childbirth, the amnio-chorionic membrane forms a hydrostatic wedge that helps to dilate the cervical canal.

Amniotic fluid abnormalities

Hydramnios or polyhydramnios is the term used to describe an excess of amniotic fluid (1500–2000 ml), whereas **oligohydramnios** refers to a decreased amount (less than 400 ml). Both conditions are associated with an increase in the incidence of birth defects.

Primary causes of hydramnios include:

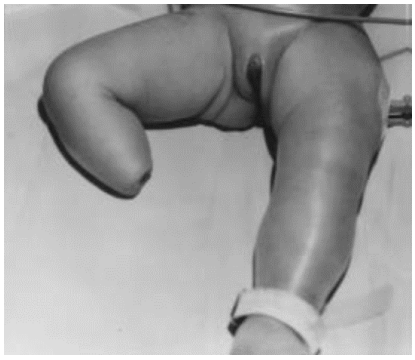
- idiopathic causes
- maternal diabetes
- congenital malformations, including central nervous system disorders (e.g., anencephaly) and gastrointestinal defects (atresia, e.g., esophageal) that prevent the infant from swallowing the fluid.

Oligohydramnios is a rare occurrence that may result from renal agenesis. Premature rupture of the amnion, the most common cause of preterm labor,

occurs in 10% of pregnancies. Furthermore, clubfoot and lung hypoplasia may be caused by oligohydramnios following amnion rupture. Causes of rupture are largely unknown, but in some cases **trauma** plays a role.

Amniotic bands

Occasionally**, tears in the amnion result in amniotic bands** that may encircle part of the fetus, particularly the limbs and digits. Amputations, ring constrictions, and other abnormalities, including craniofacial deformations, may result. Origin of the bands is probably from infection or toxic insults that involve either the fetus, fetal membranes, or both. Bands then form from the amnion, like scar tissue, constricting fetal structures.



Umbilical cord abnormalities

At birth, the umbilical cord is approximately 2 cm in diameter and 50 to 60 cm long. It is tortuous, causing false knots. An extremely long cord may encircle the neck of the fetus, usually without increased risk, whereas a short one may cause difficulties during delivery by pulling the placenta from its attachment in the uterus.

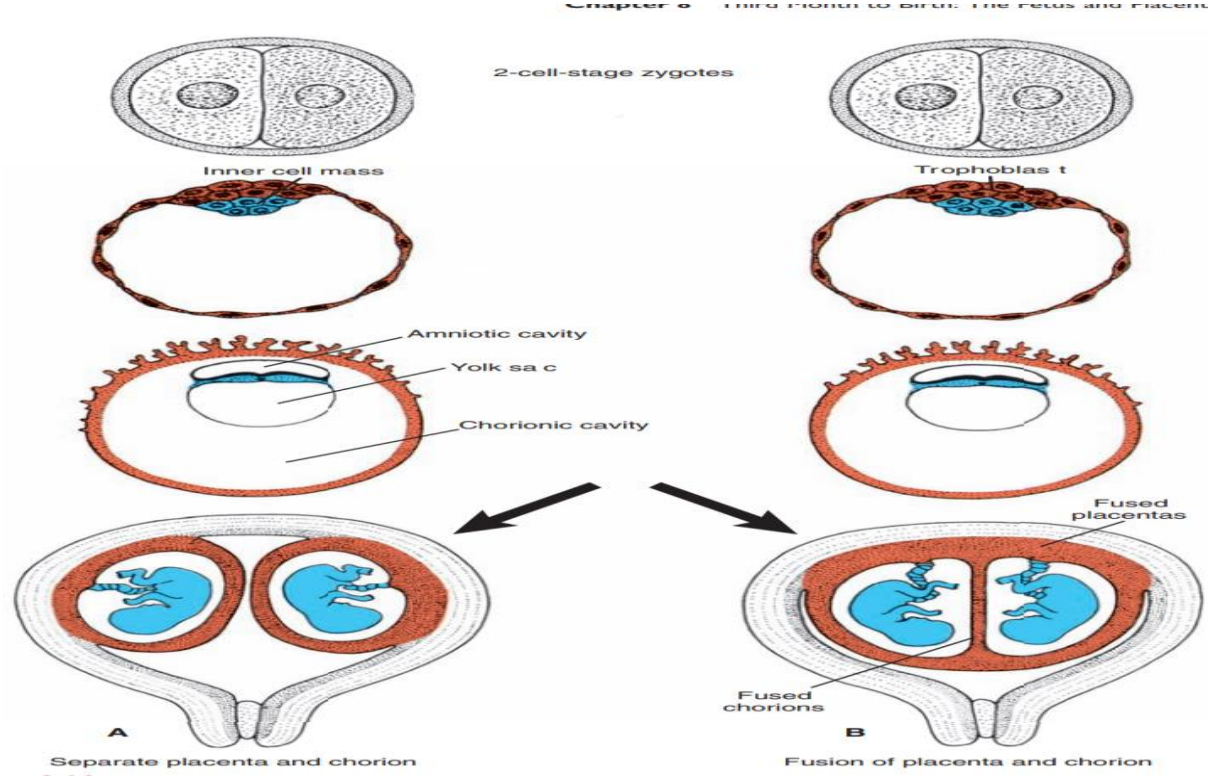
Normally there are two arteries and one vein in the umbilical cord. In 1 in 200 newborns, however, only one artery is present, and these babies have approximately a 20% chance of having cardiac and other vascular defects. The missing artery either fails to form (agenesis) or degenerates early in development.

Fetal membrane in twin

The frequency of twin has increased substantially due to increase age of women at the time of their infant birth and the use of fertility treatment such as assisted reproductive technologies.

Dizygotic twin

Approximately 90% of twins are dizygotic, or fraternal, increases with maternal age (more than 35 years). They result from simultaneous shedding of two oocytes and fertilization by different spermatozoa. Since the two zygotes have totally different genetic constitutions, the twins have no more resemblance than any other brothers or sisters. They may or may not be of different sex. The zygotes implant individually in the uterus, and usually each develops its own placenta, amnion, and chorionic sac. Sometimes, however, the two placentas are so close together that they fuse. Similarly, the walls of the chorionic sacs may also come into close apposition and fuse. Occasionally, each dizygotic twin possesses red blood cells of two different types **(erythrocyte mosaicism),** indicating that fusion of the two placentas was so intimate that red cells were exchanged.

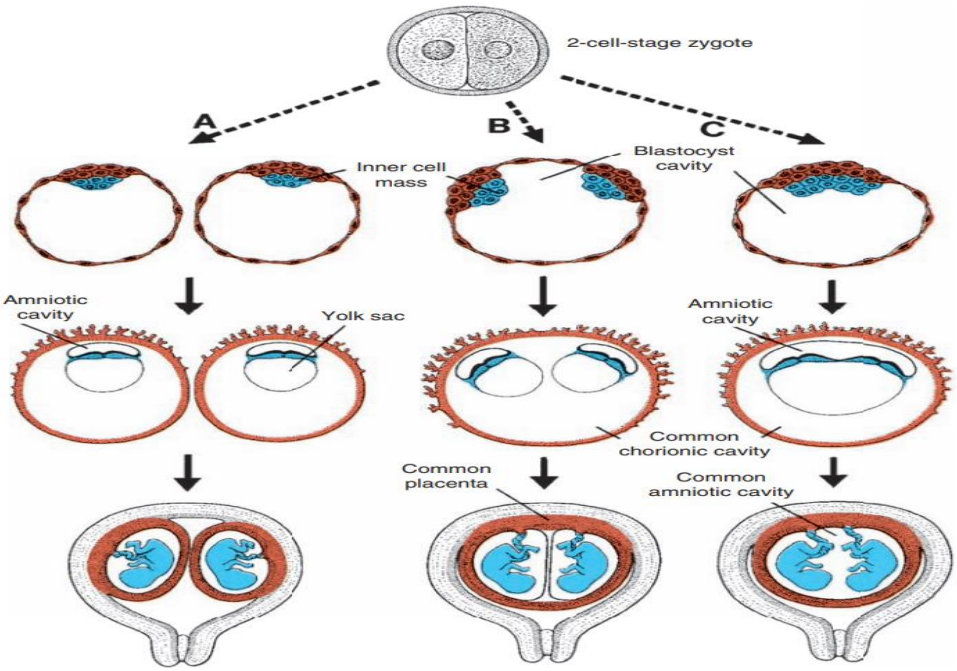


Monozygotic twin

The second type of twins, which develops from a single fertilized ovum, is monozygotic, or identical, twins. They result from splitting of the zygote at various stages of development.

The earliest separation is believed to occur at the two-cell stage, in which case two separate zygotes develop. The blastocysts implant separately, and each embryo has its own placenta and chorionic sac. The two can be recognized as partners of a monozygotic pair by their strong resemblance in blood groups, fingerprints, sex, and external appearance, such as eye and hair color. Splitting of the zygote usually occurs at the early blastocyst stage. The inner cell mass splits into two separate groups of cells within the same blastocyst cavity. The two embryos have a common placenta and a common chorionic cavity, but separate amniotic cavities.

In rare cases the separation occurs at the bilaminar germ disc stage, just before the appearance of the primitive streak. This method of splitting results in formation of two partners with a single placenta and a common chorionic and amniotic sac. Although the twins have a common placenta, blood supply is usually well balanced.



Complication of twin pregnancy

1. high incidence of perinatal mortality and morbidity.
2. Preterm labor.
3. Low birth weight.
4. Many twins die before birth and some studies indicate that only 29% of women pregnant with twins actually give birth to two infants. The term **vanishing twin** refers to the death of one fetus.

5. Another problem leading to increased mortality among twins is the twin transfusion syndrome, which occurs in 5 to 15% of monochorionic monozygotic pregnancies. In this condition, placental vascular anastomoses, which occur in a balanced arrangement in most monochorionic placentas, are formed so that one twin receives most of the blood flow and flow to the other is compromised. As a result, one twin is larger than the other. The outcome is poor, with the death of both twins occurring in 60 to 100% of cases.

Figure 8.21 Monozygotic twins with twin transfusion

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