Fetal Development

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Objectives;

At the end of the lecture ,students will be able to;

1-Define fertilization

2-Classify the stages of fetal development

3- Demonstrate fetal circulation

Stages of prenatal or fetal development

- Germinal period or Preembryonic stage (0-2 weeks)

–fertilization through the second week(Zygote till Implantation)

- Embryonic period (3-8 weeks)

– Nervous, circulatory & respiratory systems formed

- Fetal period (9 weeks – birth)

– Organs & systems are refined

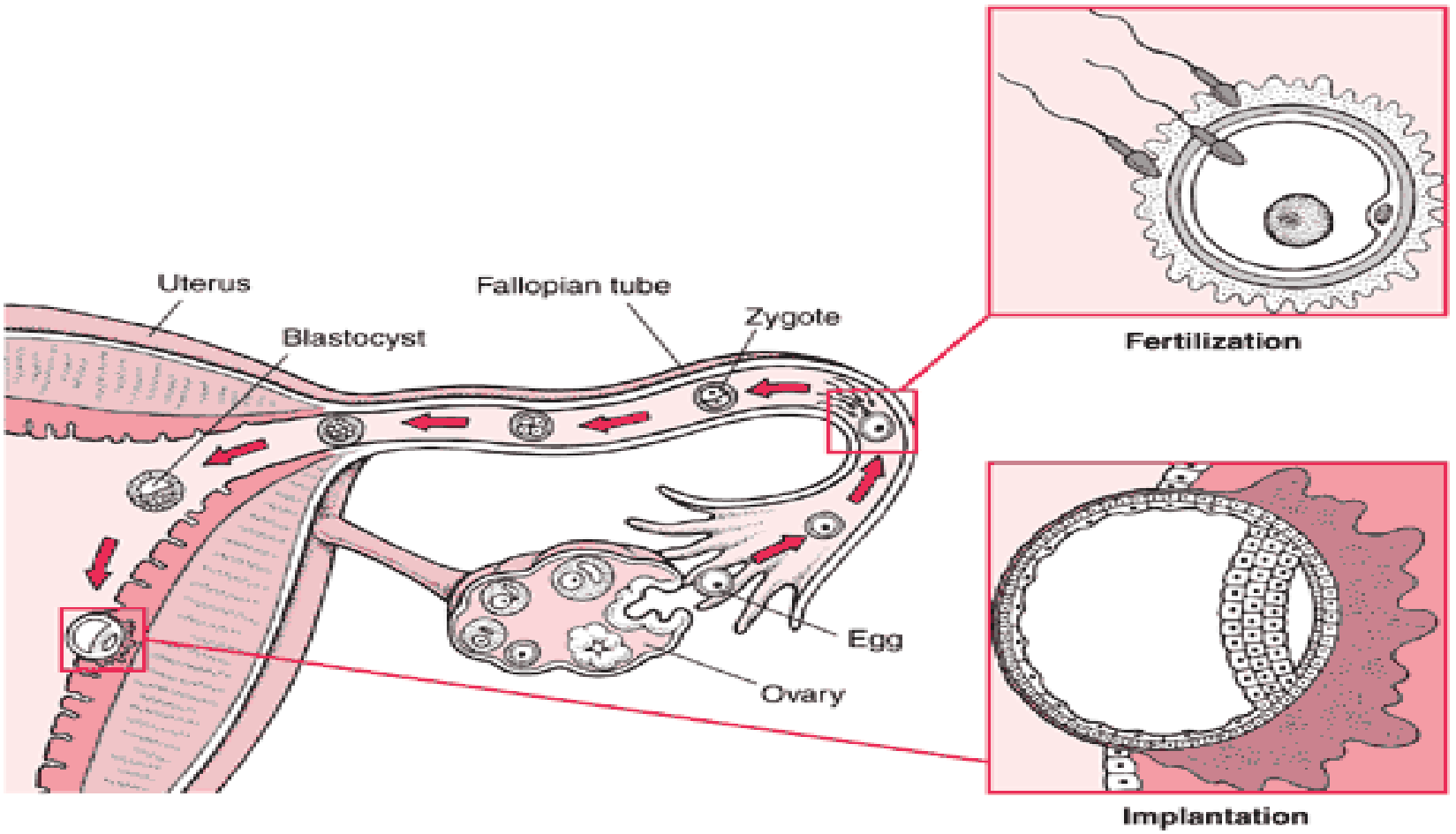
Fertilization:

This occurs in the ampulla part of the tube ,

the procession of events that begins when a spermatozoon *makes contact* with a secondary oocyte, and ends with the intermingling of maternal and paternal chromosomes at metaphase of the first mitotic division resulting in a single cell called *a zygot .*

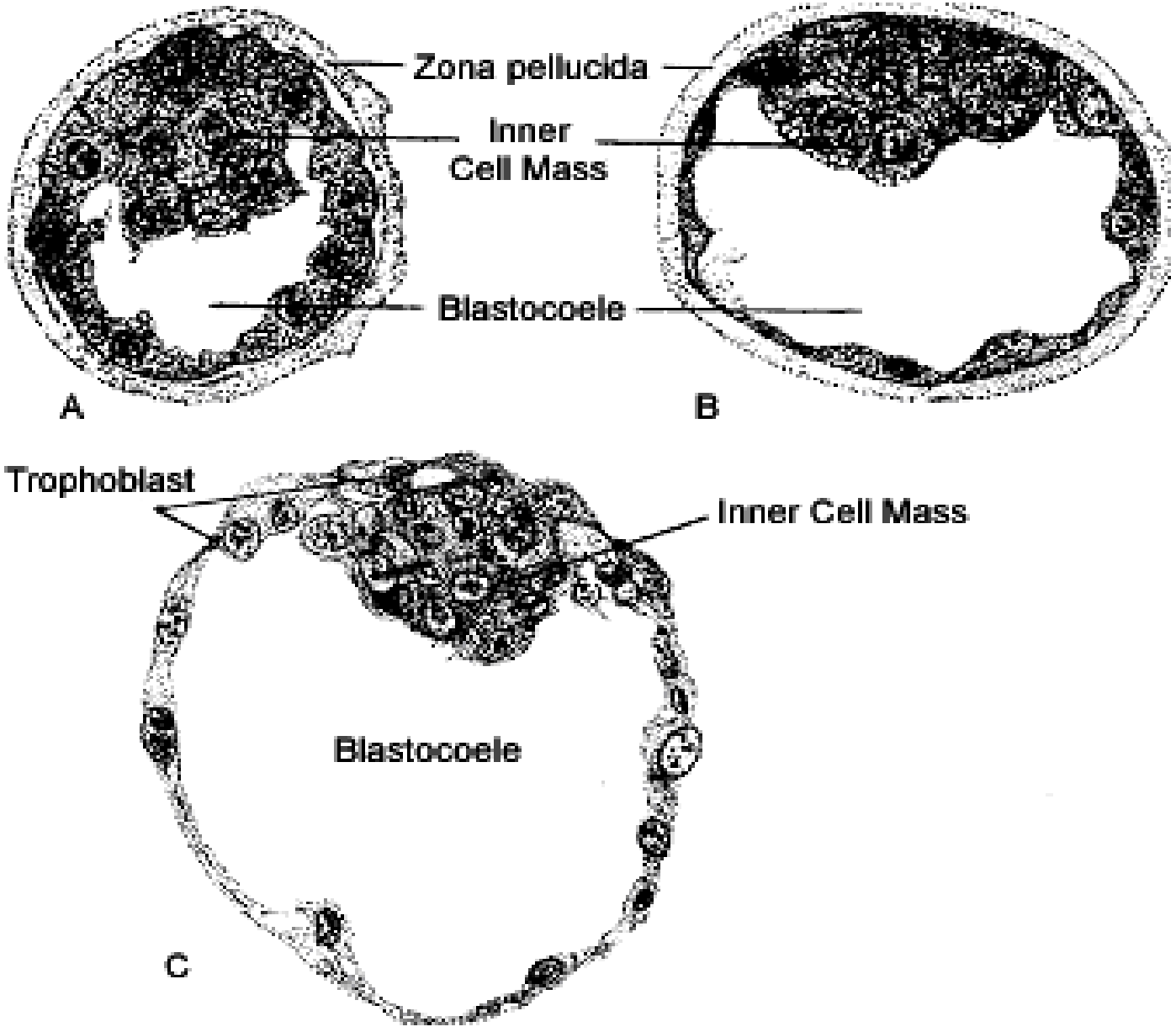
The zygot start to divide and form the morula

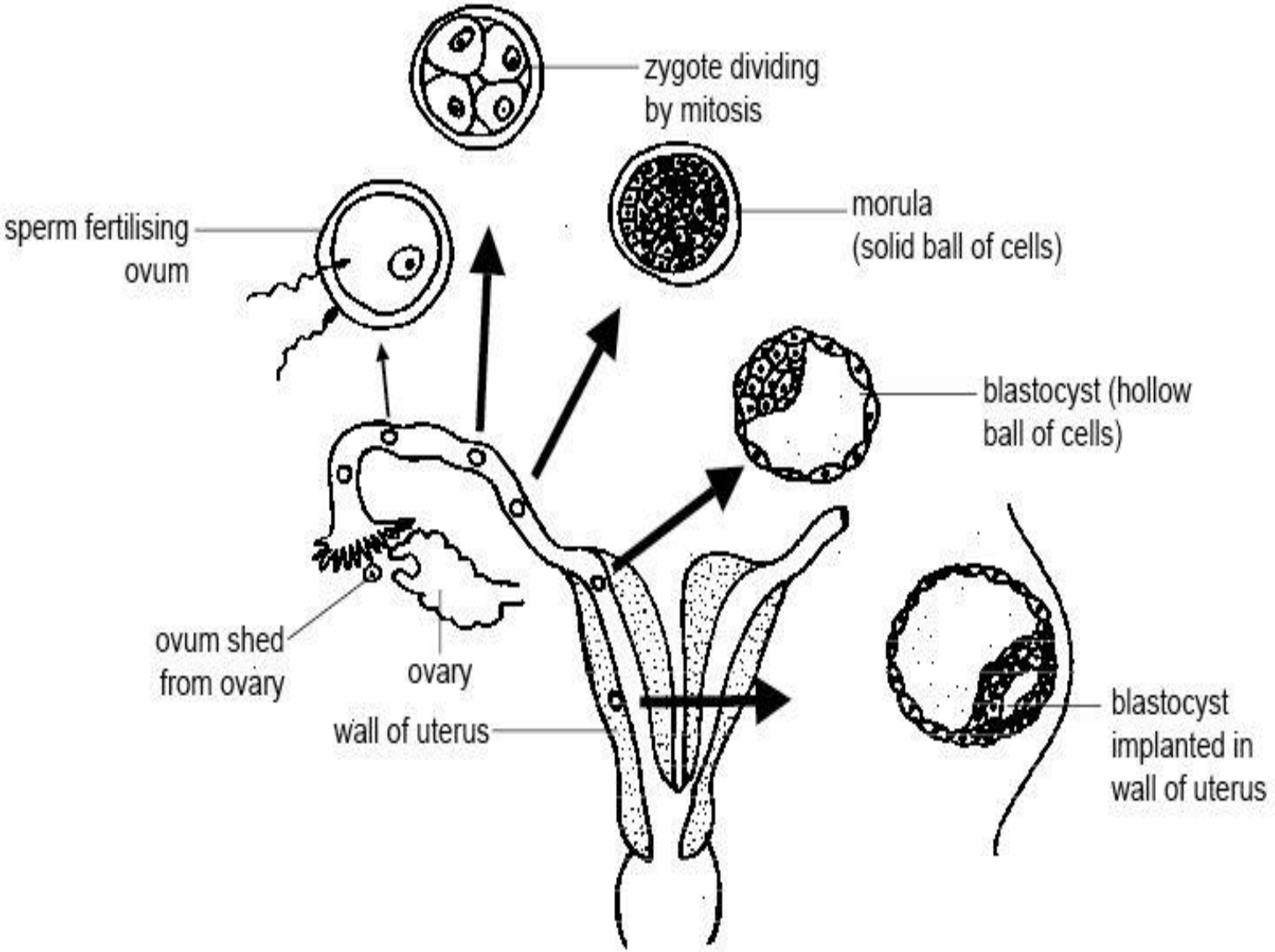
a ball of 16 cells called a morula, which divides into cells that form fetal structures

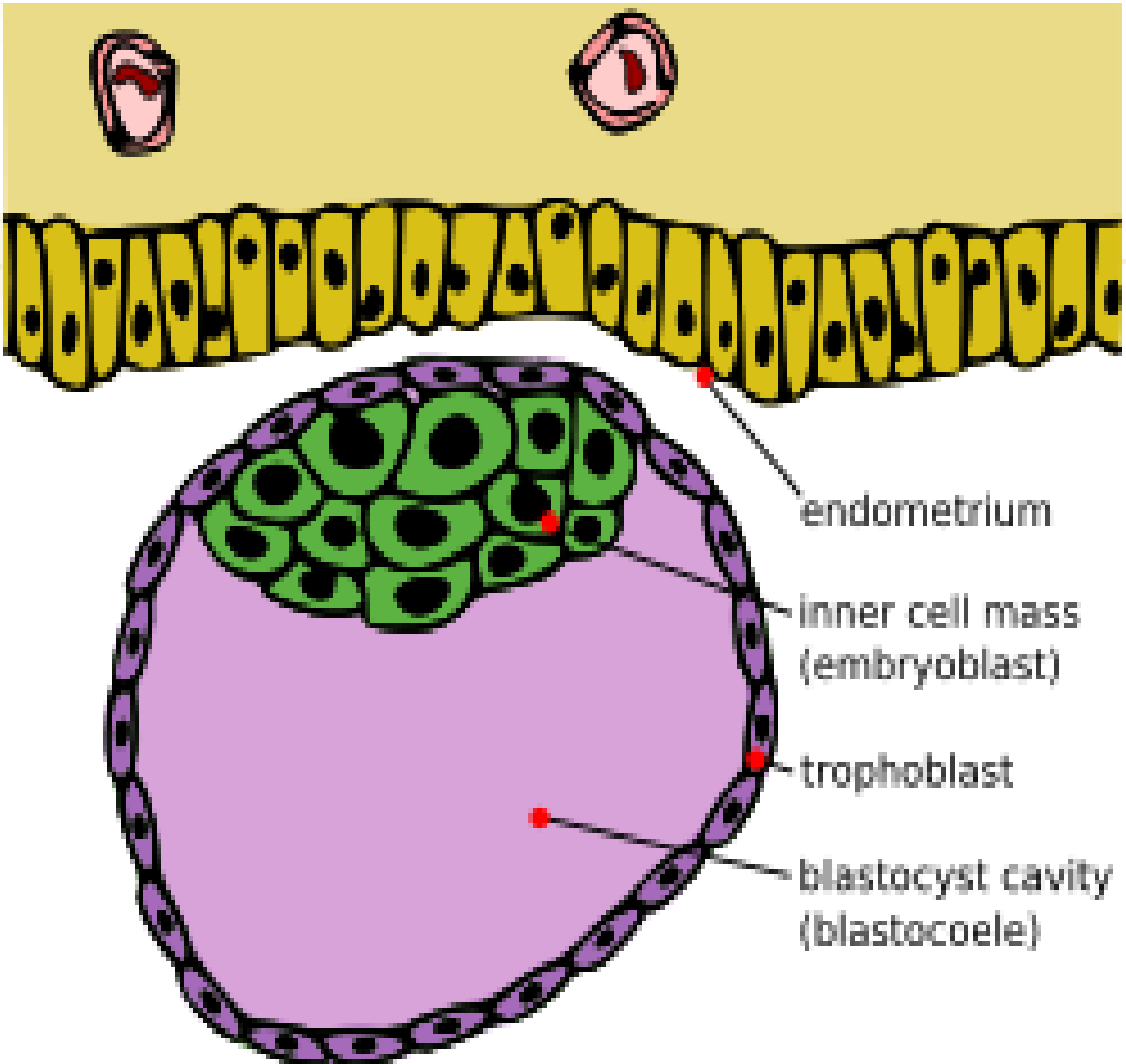

Uterus
Blastocyst
Fallopian tube
Zygote
Egg
Ovary
Fertilization
Implantation

When the morula enters the uterus, fluid starts to accumulate between its blastomeres. The fluid-filled spaces run together, forming a relatively large fluid-filled cavity. At the point when the cavity becomes recognizable, the organism is called a *blastocyst* .The outer cells of the blastocyst, especially those around the blastocyst cavity, assume a flattened shape. The flattened cells of the exterior blastocyst are the *trophoblast*. They become the embryo's contribution to the placenta and other supporting structures. On one side of the blastocyst is a group of cells that project inside into the blastocyst cavity; this is the *inner cell mass*, or *embryoblast*, and its progeny form the body of the new offspring.

FORMATION OF THE BLASTOCYST




zygote dividing by mitosis
morula (solid ball of cells)
sperm fertilising ovum
blastocyst (hollow ball of cells)
ovum shed from ovary
ovary
wall of uterus
blastocyst implanted in wall of uterus


endometrium
inner cell mass
(embryoblast)
trophoblast
blastocyst cavity
(blastocoele)

Implantation:

The uterus at the time of implantation is in the secretory phase, and the blastocyst implants in the endometrium along the anterior or posterior wall about the sixth day.

(*between the 7th to 10th day*)

The trophoblast differentiate to an inner, actively proliferating layer cytotrophoblast and an

outer layer, the syncytiotrophoblast, which erodes maternal tissues .

The syncytiotrophoblast produces human chorionic

gonadotropin (HCG) .

the first hormonal evidence of implantation (the appearance of hCG) occurred on 8, 9, or 10 days after ovulation; the earliest was 6 days and the latest 12 days

By day 9, lacunae develop in the syncytiotrophoblast. Subsequently, maternal sinusoids are eroded by the syncytiotrophoblast, maternal blood enters the lacunar network, and by the end of the second week, a primitive uteroplacental
circulation begins .
The placenta is formed in the second week after ovulation

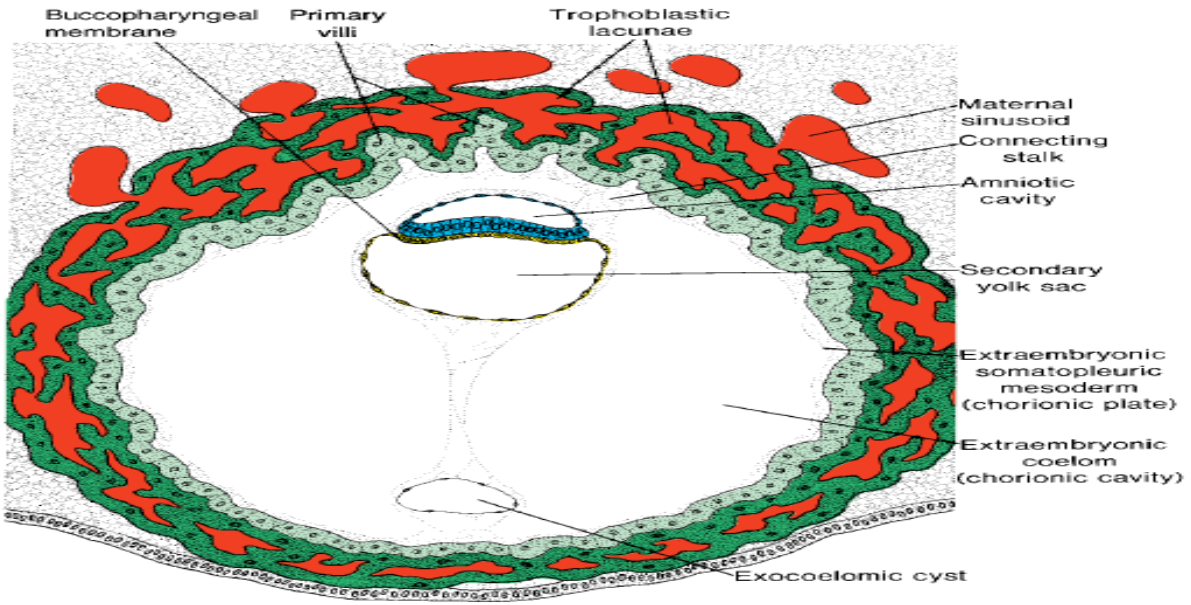


Figure 3.6 A 13-day human blastocyst. Trophoblastic lacunae are present at the embryonic as well as the abembryonic pole, and the uteroplacental circulation has begun. Note the primary villi and the extraembryonic coelom or **chorionic cavity.** The secondary yolk sac is entirely lined with endoderm.

Third week embryo:

1-The inner cell mass or embryoblast forms the bilaminar germ disk

The most characteristic event occurring during the third week of gestation is gastrulation, the process that establishes all three germ layers (ectoderm, mesoderm, and endoderm) in the embryo.

2-formation of yolk sac which is important for exchange of metabolites between the mother and the embryo at time where there is no placenta the life span is short its full development is at 32 day and start degeneration by the end of 16th week .

Fourth week embryo:

1-At this stage organogenesis start .

2-The first organ appear is the primitive heart and cardiac activity at 22 day.

3-Development of nervous system .

4-The respiratory system appear as segmentation of the forgut and the lung buds are evident at the end of 4^{th} week

Fifth week:

The embryo begin to look more as a human and genital ridges may be seen by this time and complete formation of the urinary system and paired limbs buds are evident .

Sex differentiation usually occurs bet 8-12 weeks .

During the important period(Embryonic period) drugs and infections that can cross the placenta as rubella virus can have effect on fetal development and lead to fetal abnormalities .

Fetal circulation:

Throughout the fetal stage of development, the maternal blood supplies the fetus with O_2 and nutrients and carries away its wastes.

These substances diffuse between the maternal and fetal blood through the placental membrane.

They are carried to and from the fetal body by the umbilical blood vessels

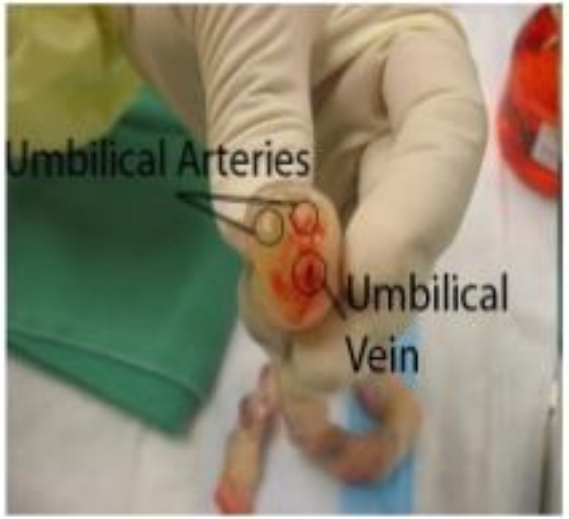
The concentration of hemoglobin in fetal blood is about 50 % greater than in maternal blood.

Fetal hemoglobin is slightly different chemically and has a greater affinity for O_2 than maternal hemoglobin.

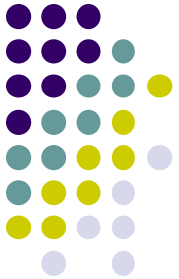
At a particular oxygen partial pressure, fetal hemoglobin can carry 20-30% more O_2 than maternal hemoglobin

Anatomy and Physiology
Fetal Circulation

- Umbilical cord
  - 2 umbilical arteries: return de-oxygenated blood, fecal waste, CO_2 to placenta
  - 1umbilical vein: brings oxygenated blood and nutrients to the fetus



In the fetal circulatory system, the umbilical vein transports blood rich in O_2 and nutrients from the placenta to the fetus



The umbilical vein enters the body through the umbilical ring and travels along the anterior abdominal wall to the liver.

About 1/2 the blood it carries passes into the liver.

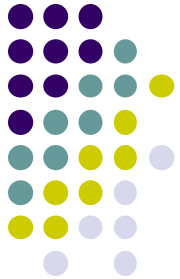
The other 1/2 of the blood enters a vessel called the ductus venosus which bypasses the liver.

The ductus venosus travels a short distance and joins the inferior vena cava. There, the oxygenated blood from the placenta is mixed with the deoxygenated blood from the lower parts of the body.

This mixture continues through the vena cava to the right atrium. In the adult heart, blood flows from the right atrium to the right ventricle then through the pulmonary arteries to the lungs.

In the fetus however, the lungs are nonfunctional and the blood largely bypasses them

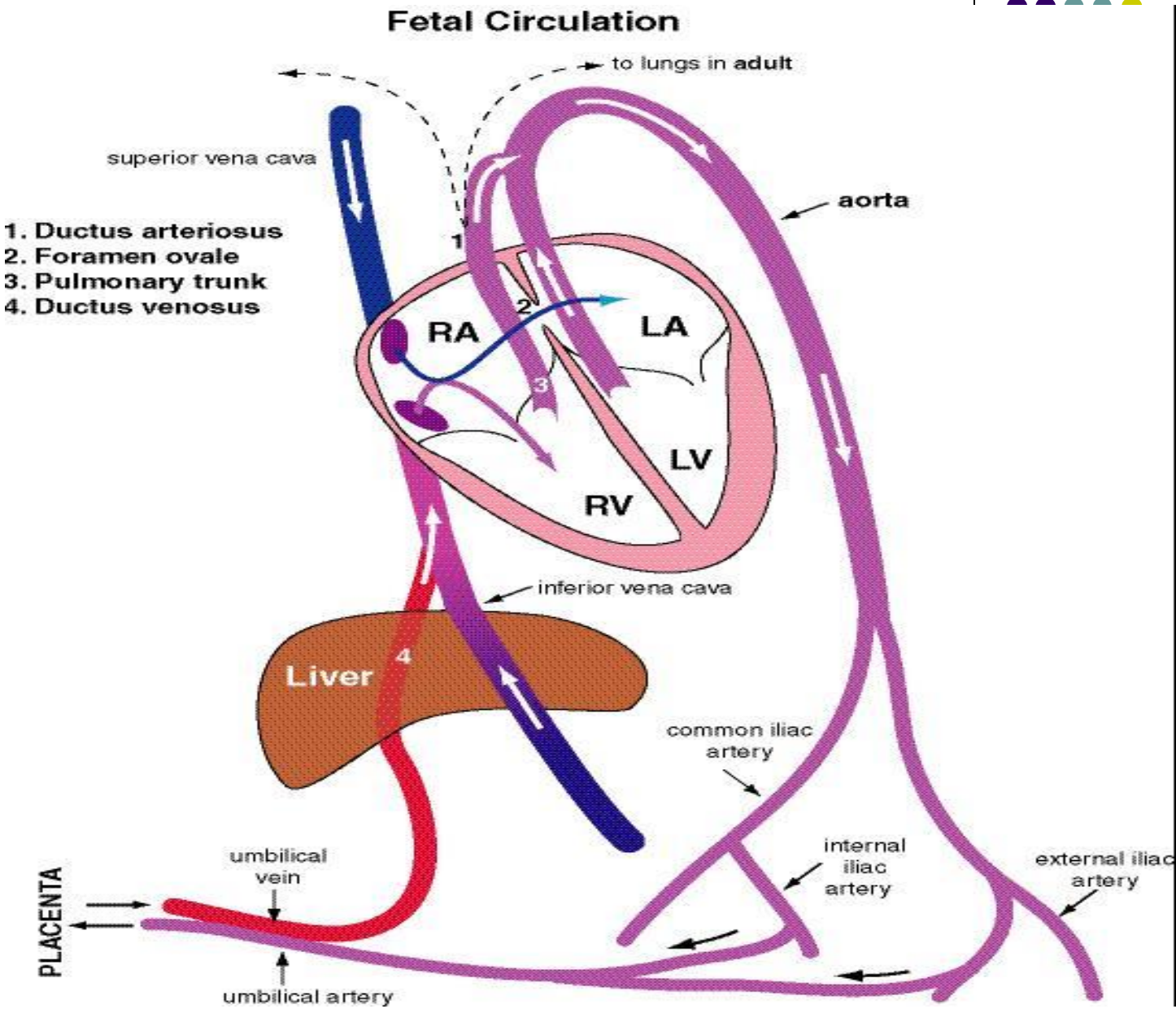
As the blood from the inferior vena cava enters the right atrium, a large proportion of it is shunted directly into the left atrium through an opening called the foramen ovale



- **Only a small volume of blood enters the pulmonary circuit, because the lungs are collapsed, and their blood vessels have a high resistance to flow. Enough blood reaches the lung tissue to sustain them . Most of the blood in the pulmonary trunk bypasses the lungs by entering a fetal vessel called the ductus arteriosus which connects the pulmonary trunk to the descending portion of the aortic arch.**

The blood carried by the descending aorta is partially oxygenated and partially deoxygenated. Some of it is carries into the branches of the aorta that lead to various parts of the lower regions of the body.

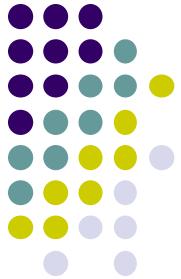
The rest passes into the umbilical arteries, which branch from the internal iliac arteries and lead to the placenta. There the blood is reoxygenated


Fetal Circulation
to lungs in adult
superior vena cava
aorta
1. Ductus arteriosus
2. Foramen ovale
3. Pulmonary trunk
4. Ductus venosus
1
2
3
RA
LA
LV
RV
inferior vena cava
Liver
4
common iliac artery
internal iliac artery
external iliac artery
umbilical vein
umbilical artery
PLACENTA

Circulatory Changes at Birth

At birth, placental blood flow ceases and lung respiration begins. The sudden drop in right atrial pressure, close the foramen ovale. The ductus arteriosus begins to close almost immediately, Other embryonic circulatory vessels are slowly obliterated and remain in the adult only as fibrous remnants.

Problem with persistence of fetal circulation



Patent (open) ductus arteriosus and patent foramen ovale each characterize about 8% of congenital heart defects.

Both cause a mixing of oxygen-rich and oxygen-poor blood; blood reaching tissues not fully oxygenated. Can cause cyanosis.

Surgical correction now available, ideally completed around age two.

Many of these defects go undetected until child is at least school age.

Conclusion

- Oxygenated blood enters the **umbilical vein** from the placenta
- Enters **ductus venosus**
- Passes through **inferior venacava**
- Enters the **right atrium**
- Enters the **foramen ovale**
- Goes to the **left atrium**
- Passes through **left ventricle**
- Flows to **ascending aorta** to supply nourishment to the brain and upper extremities

Contd….

- Enters **superior vena cava**
- Goes to **right atrium**
- Enters the **right ventricle**
- Enters **pulmonary artery** with some blood going to the lungs to supply oxygen and nourishment
- Flows to **ductus arteriosus**
- Enters **descending aorta** (some blood going to the lower extremeties)
- Enters **hypogastric arteries**
- Goes back to the **placenta**

End