Fertilisation

- Human ovum is 0.2mm in diameter
- Before ovulation it undergoes maturation , first casting off the 1st polar body forming the secondary oocyte
- Similar process occurs in the spermatozoa
- After maturation , the ovum and spermatozoa are called female and male gametes

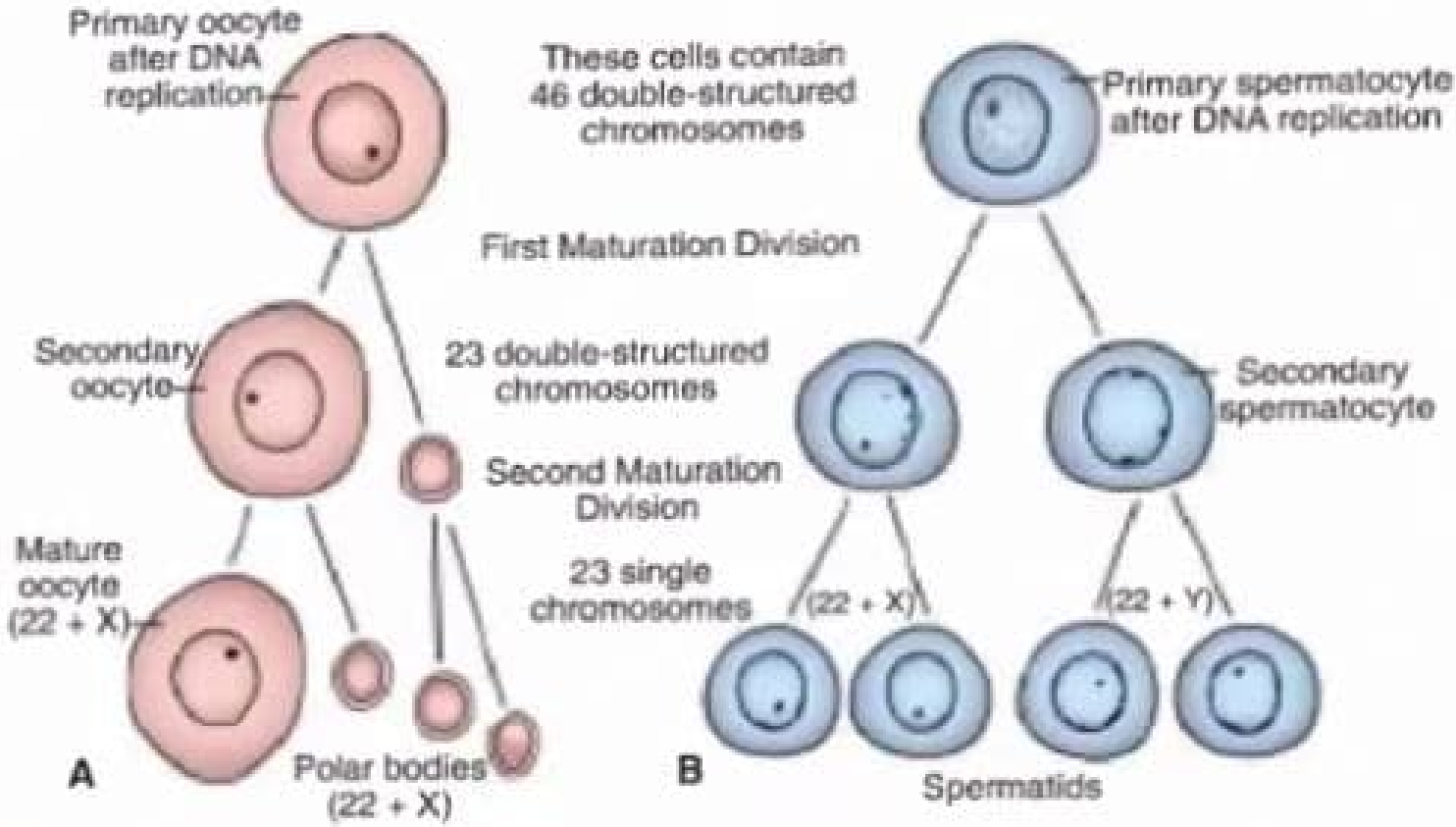

FIGURE 2.5 Events occurring during the first and second maturation divisions. **A.** The primitive female germ cell (primary oocyte) produces only one mature gamete, the mature oocyte. **B.** The primitive male germ cell (primary spermatocyte) produces four spermatids, all of which develop into spermatozoa.

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- Sperms travel at a distance of one inch per hour
- Once released into the peritoneal cavity, the oocyte is quickly picked up by the fimbria of fallopian tube
- Union of gametes occur in the ampullary portion of fallopian tube

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- Spermatozoa cannot fertilise the oocyte immediately on arrival in the female genital tract
- It should undergo 1. capacitation
  2. acrosome reaction

Capacitation –

- Conditioning in female genital tract that lasts for approximately 7 hours.
- The glycoprotein coat and seminal plasma proteins are removed from the plasma membranes that overlies the acrosomal region of spermatozoa

Phases of fertilisation

- Phase 1- penetration of corona radiata
- Phase 2- penetration of zona pellucida
- Phase 3-fusion of oocyte and sperm cell membrane

Acrosomal reaction

- Occurs after binding to zona pellucida
- It is induced by zona proteins
- This results in release of enzymes needed to penetrate the zona pellucida- including acrosin and trypsin like substances

As soon as the spermatozoon has entered the oocyte, the egg responds in 3 ways

1. Cortical and zona reaction

   oocyte membrane becomes impenetrable to other sperms-vitelline block

2. Resumption of second meiotic division leading to formation of definitive oocyte and second polar body

3. Metabolic activation of egg

Main results of fertilisation

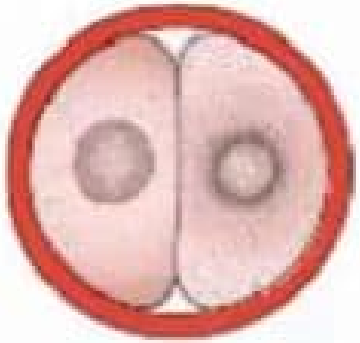
1. Restoration of diploid number of chromosomes
2. Determination of sex of the new individual. Chromosomal sex is determined at fertilisation
3. Initiation of cleavage

Without fertilisation the oocyte usually degenerates 24 hours after ovulation

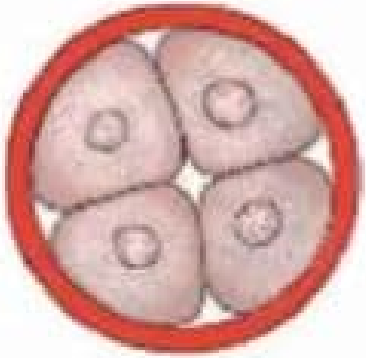
Early development of embryo

- Once fertilised ovum reaches the uterus , walls of uterus hypertrophy and considerable increase in blood supply occur to meet the needs of enlarging uterus, developing fetus and placenta
- After fertilisation, ovum becomes a zygote- a diploid cell with 46 chromosomes

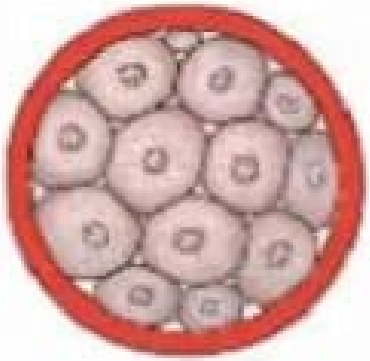
- 1st division results in formation of 2 blastomeres
- In 2 cell zygote ,the blastomeres and polar body are free in the perivitelline fluid and surrounded by a thick zona pellucida
- Zygote undergoes free cleavage for 3 days while still in the fallopian tube



Two-cell stage



Four-cell stage

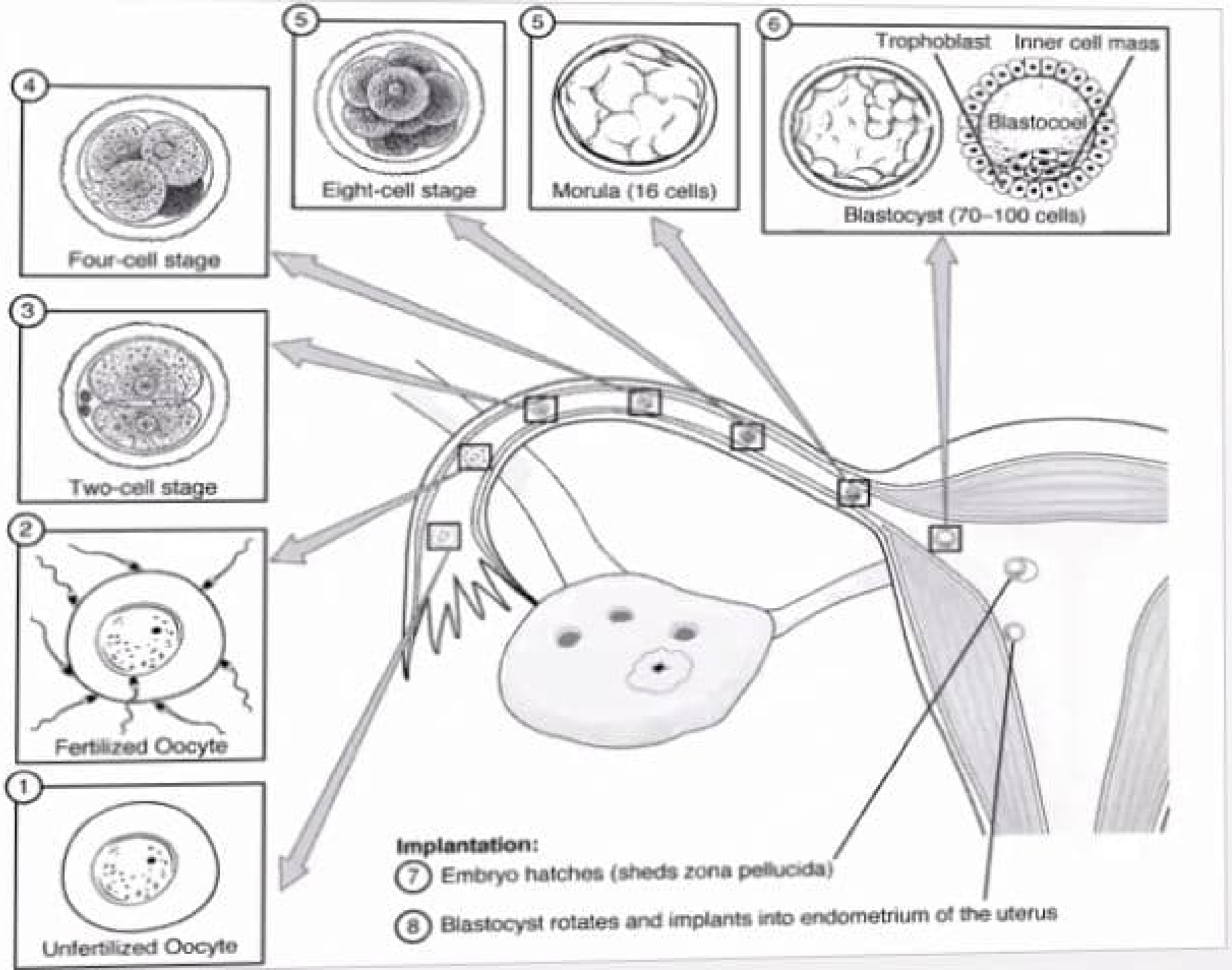


Morula

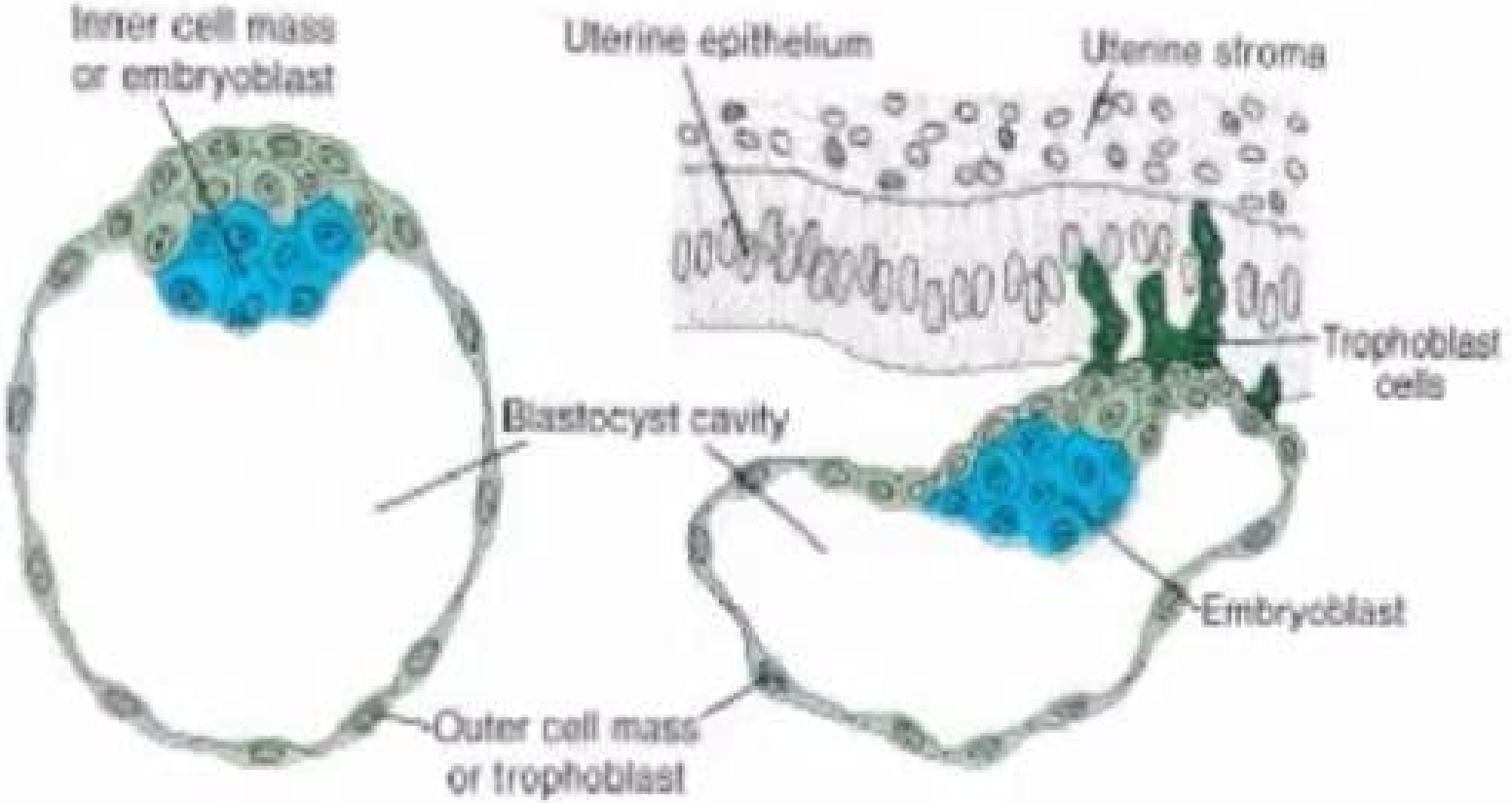
Development of the zygote from the two—cell stage to the late morula stage. The two—cell stage is reached approximately 30 hours after fertilization; the four—cell stage is reached at approximately 40 hours; the 12 to 16 cell stage is reached at approximately 3 days; and the late morula stage is reached at approximately 4 days. During this period, blastomeres are surrounded by the zona pellucida, which disappears at the end of the fourth day.

I

- As the blastomeres continue to divide, a solid mulberry like ball of cells , the morula is produced. (16 cell stage)
- Morula enters the uterine cavity about 3 days after fertilisation
- Gradual accumulation of fluid between the cells of morula results in formation of early blastocyst


4
Four-cell stage
5
Eight-cell stage
5
Morula (16 cells)
6
Trophoblast
Inner cell mass
Blastocoel
Blastocyst (70–100 cells)
3
Two-cell stage
2
Fertilized Oocyte
1
Unfertilized Oocyte
Implantation:
7 Embryo hatches (sheds zona pellucida)
8 Blastocyst rotates and implants into endometrium of the uterus

- Blastocyst consists of a compact mass of cells on one pole – the inner cell mass forming the embryo and outer cell mass destined to form the trophoblasts
- At 107 cell blastocyst stage ,the blastocyst is released from zona pellucida as a result of secretion of proteases from secretory phase endometrial glands



A.Schematic representation of a human blastocyst recovered from the uterine cavity at approximately 4.5 days. Blue, inner cell mass or embryoblast; green, trophoblast. B. Schematic representation of a blastocyst at the sixth day of development showing trophoblast cells at the embryonic pole of the blastocyst penetrating the uterine mucosa. The human blastocyst begins to penetrate the uterine mucosa by the sixth dayof development

Blastocyst implantation

- Implantation of embryo into the uterine wall is a common feature of mammals
- In women it takes place 6-7 days after fertilisation
- The process is divided in three phases

1. apposition - initial adhesion of blastocyst to uterine wall
2. adhesion – increased physical contact between blastocyst and uterine endometrium
3. invasion – penetration and invasion of trophoblast to endometrium, inner third of myometrium and uterine vasculature

Trophoblast

- Formation of human placenta begins with the trophectoderm which first differentiates at the morula stage
- It gives rise to a layer of cells encircling the blastocyst

Functions

1. helps in implantation
2. provides channels by which developing embryo provides nourishments
3. acts as an endocrine organ for maternal physiological adaptations and maintenance of pregnancy

Trophoblast differentiation

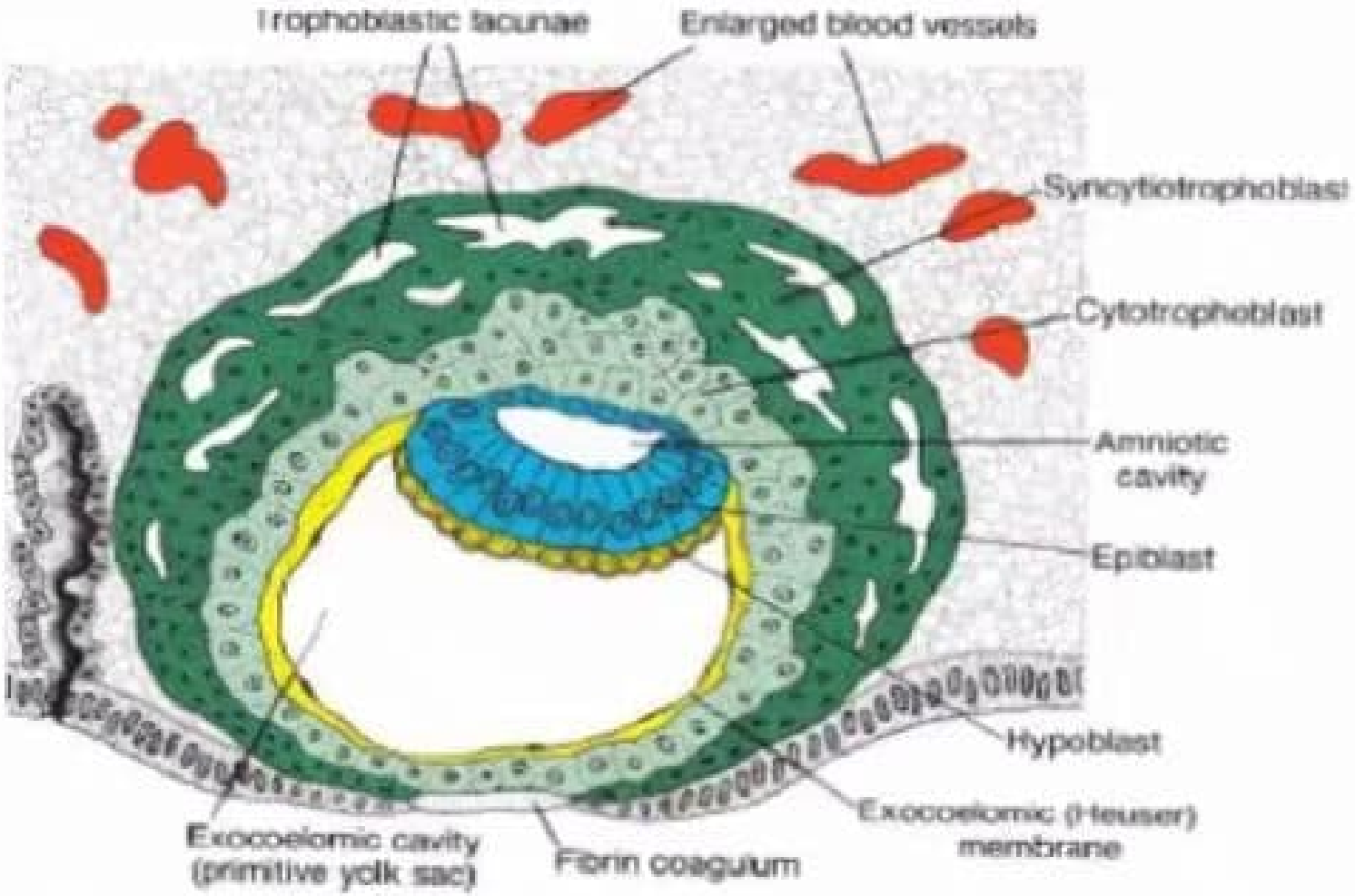
- By 8th day post fertilisation ,after initial implantation, the trophoblast differentiates into an outer multinucleated syncytium – primitive syncytiotrophoblast, and an inner layer of primitive mononuclear cells - cytotrophoblast

Cytotrophoblast

- They are germinal cells for the syncytium
- Primary secretory component within the placenta
- Has a well demarcated cell border and a single nucleus

Syncytiotrophoblast

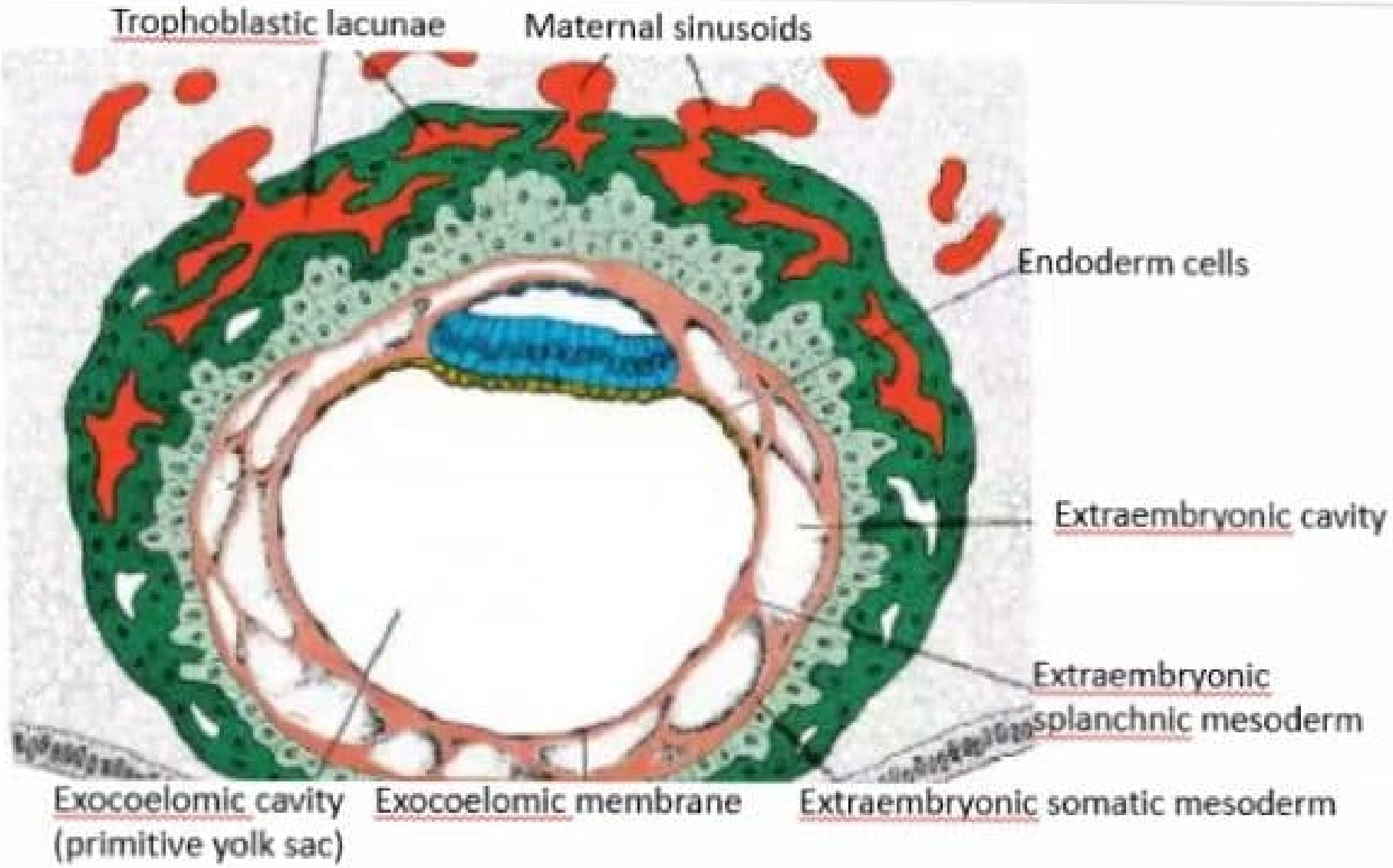
- Has no individual cells
- Has an amorphous cytoplasm without cell borders , nuclei that are multiple and diverse in shape and size and a continuous syncytial lining
- This aids transport across syncytiotrophoblast



A 9—day human blastocyst. The syncytiotrophoblast shows a large number of lacunae. Flat cells form the exocoelomic membrane. The bilaminar disc consists of a layer of columnar epiblast cells and a layer of cuboidal hypoblast cells. The original surface defect is closed by a fibrin coagulum.

- The remaining cells of the inner cell mass become columnar and forms the ectoderm
- Space appears between the ectoderm and trophoblast . This is the amniotic cavity. The roof of the cavity is lined by amniogenic cells and floor is formed by ectoderm
- Flattened cells from the endoderm spread and line the inside of blastocyst cavity. This cavity is the primary yolk sac

- Cells of trophoblast give origin to a mass of cells called extraembryonic mesoderm. These cells come to lie between the trophoblast and flattened endodermal cells lining the yolksac. These cells also separate wall of amniotic cavity from trophoblast

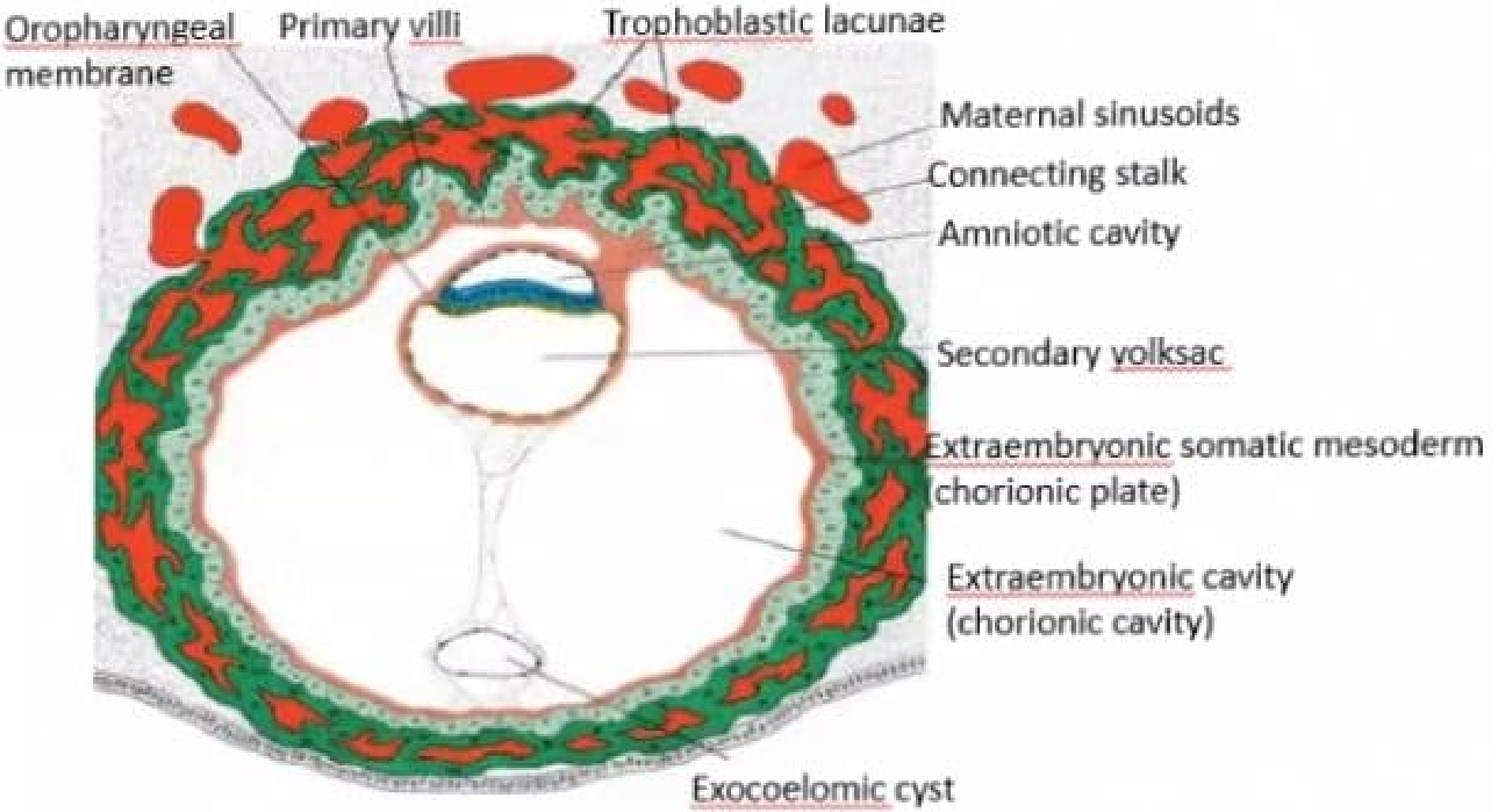


Human blastocyst of approximately 12 days. The trophoblastic lacunae at the embryonic pole are in open connection with maternal sinusoids in the endometrial stroma. Extraembryonic mesoderm proliferates and fills the space between the exocoelomic membrane and the inner aspect of the trophoblast

- Cells of trophoblast give origin to a mass of cells called extraembryonic mesoderm. These cells come to lie between the trophoblast and flattened endodermal cells lining the yolksac. These cells also separate wall of amniotic cavity from trophoblast

- The part lining the inside of trophoblast and outside the amniotic cavity is the parietal or somatopleuric extraembryonic mesoderm
- Part lining outside the yolksac is the visceral or splanchnopleuric mesoderm

- Extraembryonic coelom does not extend to that part of extraembryonic mesoderm that attaches the wall of amniotic cavity to trophoblast. This mesoderm forms the structure of connecting stalk.

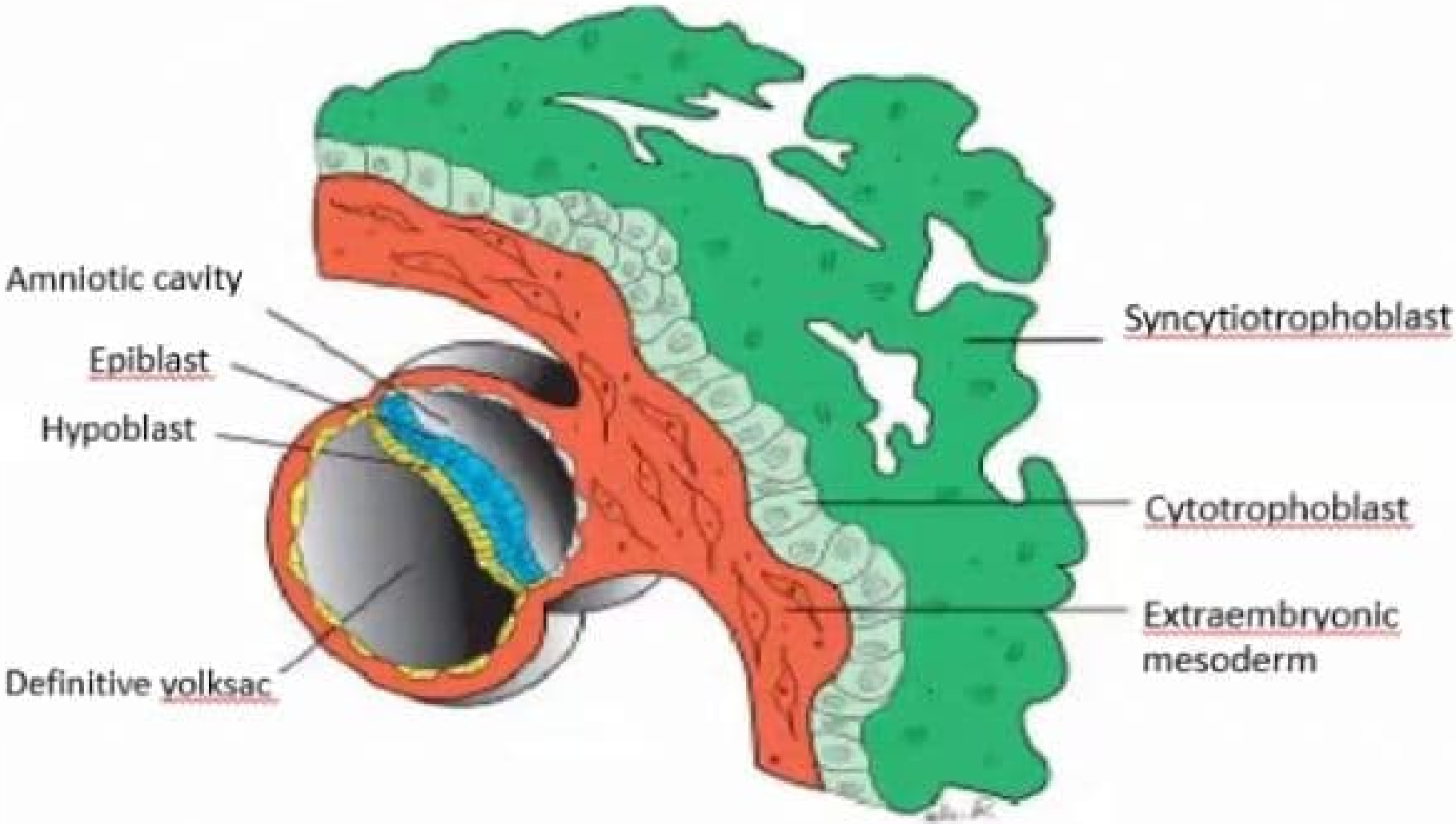


A 13—day human blastocyst. Trophoblastic lacunae are present at the embryonic as well as the abembryonic pole, and the uteroplacental circulation has begun. Note the primary villi and the extraembryonic coelom or chorionic cavity. The secondary yolk sac is entirely lined with endoderm.

Formation of amnion and chorion

- Chorion is formed by the parietal extraembryonic mesoderm and the overlying trophoblast
- Amnion is constituted by the amniogenic cells forming the wall of amniotic cavity derived from trophoblast

- With the appearance of extraembryonic mesoderm and extraembryonic coelom , the yolksac becomes smaller and is called the secondary yolksac.
- At this stage , the embryo is a circular disc of 2 layers- the upper layer towards the amniotic cavity is the ectoderm (columnar cells) and the lower layer towards the yolksac is the endoderm (cubical cells)



Implantation site at the end of the second week.