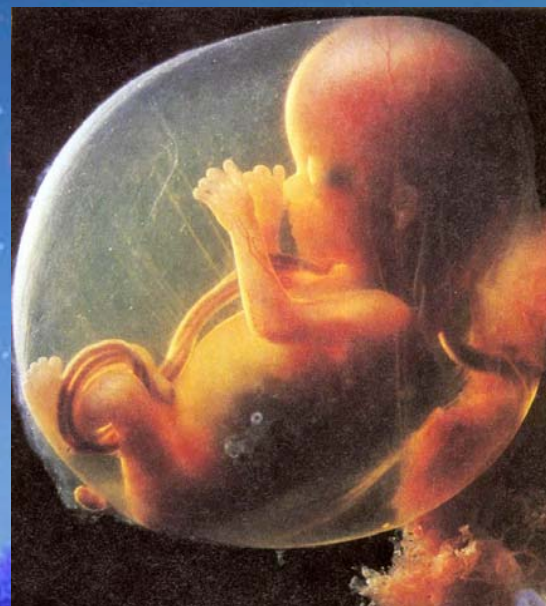
HUMAN EMBRYOLOGY

Department of Histology and Embryology
Jilin University

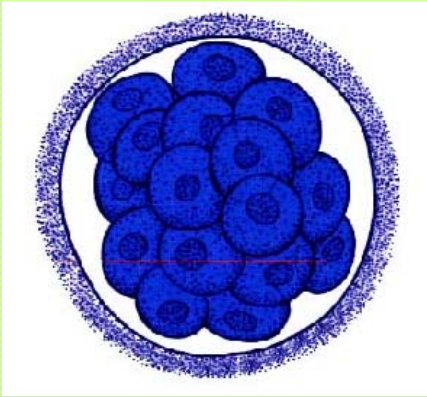


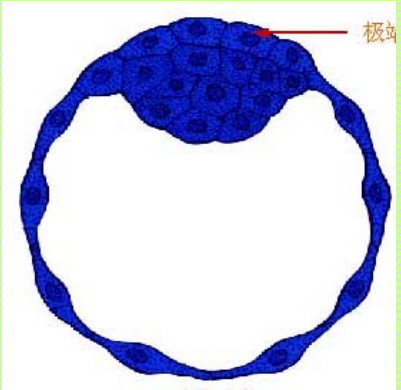
Chapter 2
General Embryology

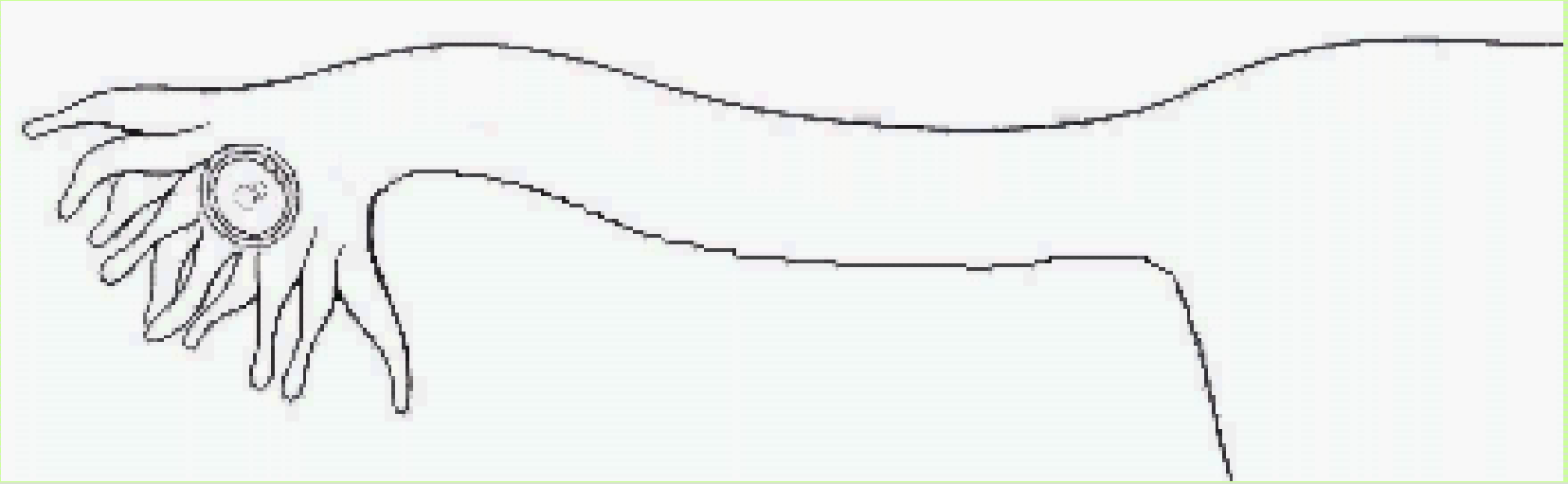
Second week:
Implantation & bilaminar germ Disc

Review: 1st-4th day of development

- human zygote → morula → blastocyst → moving towards uterine cavity →Zona pellucida disappears

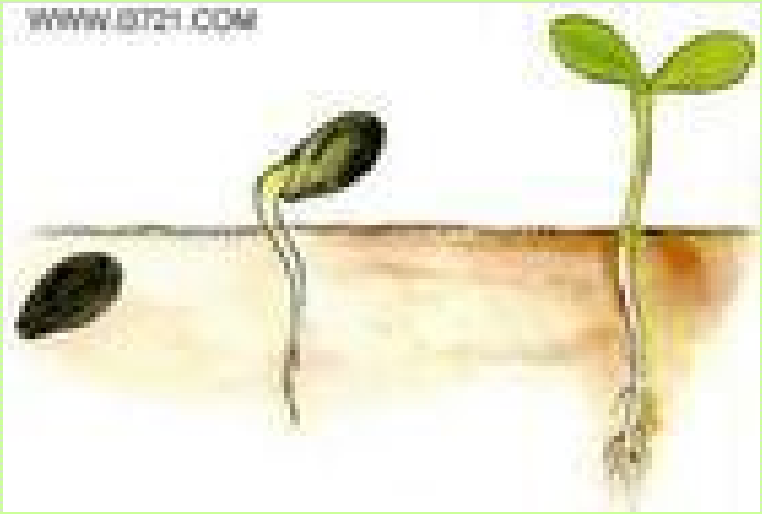






5. Implantation/imbed

- **process in which blastocyst is embedded in endometrium of the uterus**
- **time: begin on 5th –6th day; finish on 11th –12th day**
- **place: fundus and body of uterus**



Seed —— blastocyst

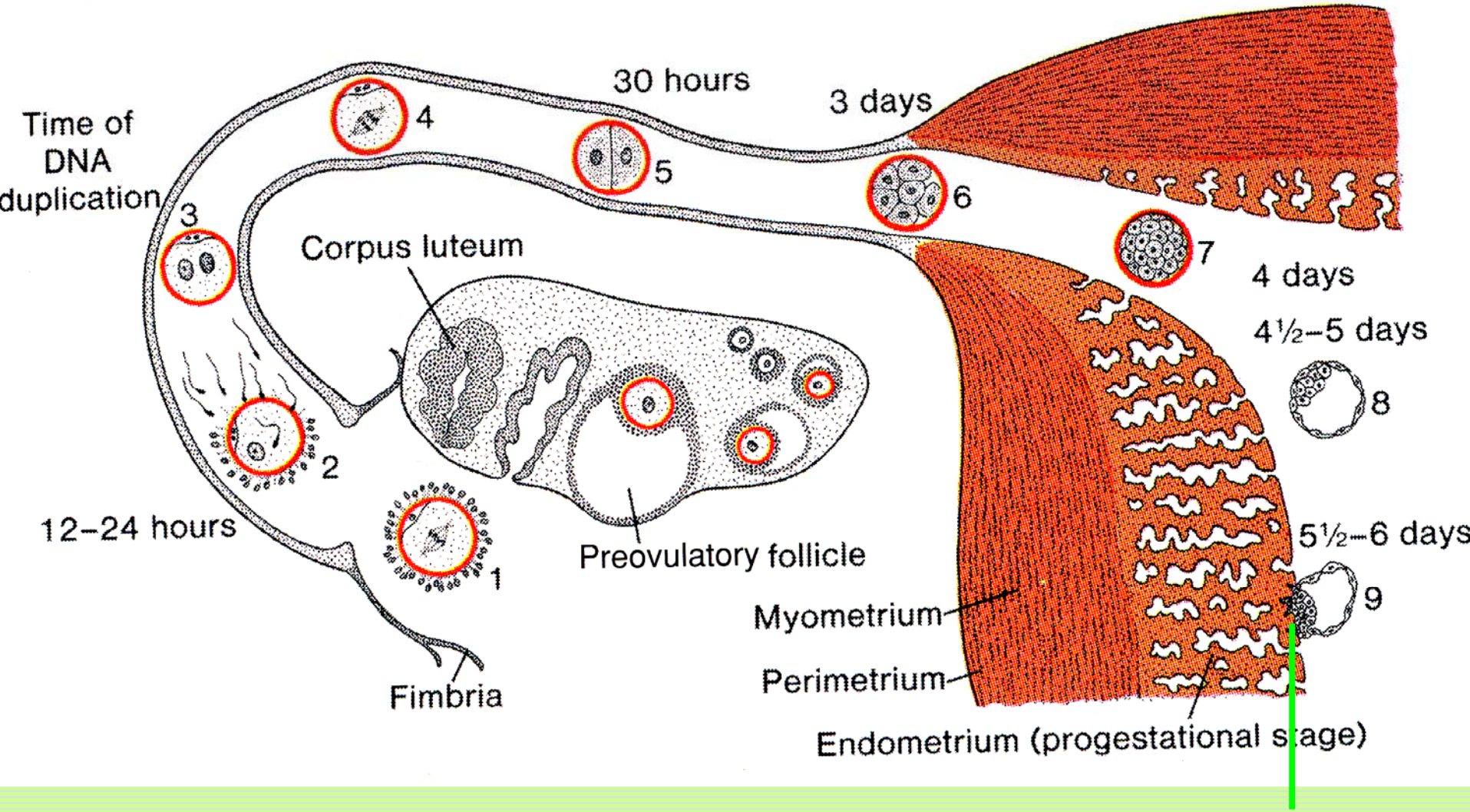
Soil —— endometrium

Root —— placenta

Bud —— embryo/fetus

plant —— infant

From ovulation to fertilization, morula, blastocyst and beginning of implantation



Animation of implantation

5.1 Process of implantation

Day 6

- **Polar trophoblastic cells penetrate endometrium.**
- **The endometrium is eroded by proteinase.**
- **Blastocyst begins to be immersed into the defect and be embedded into the endoemtrium.**

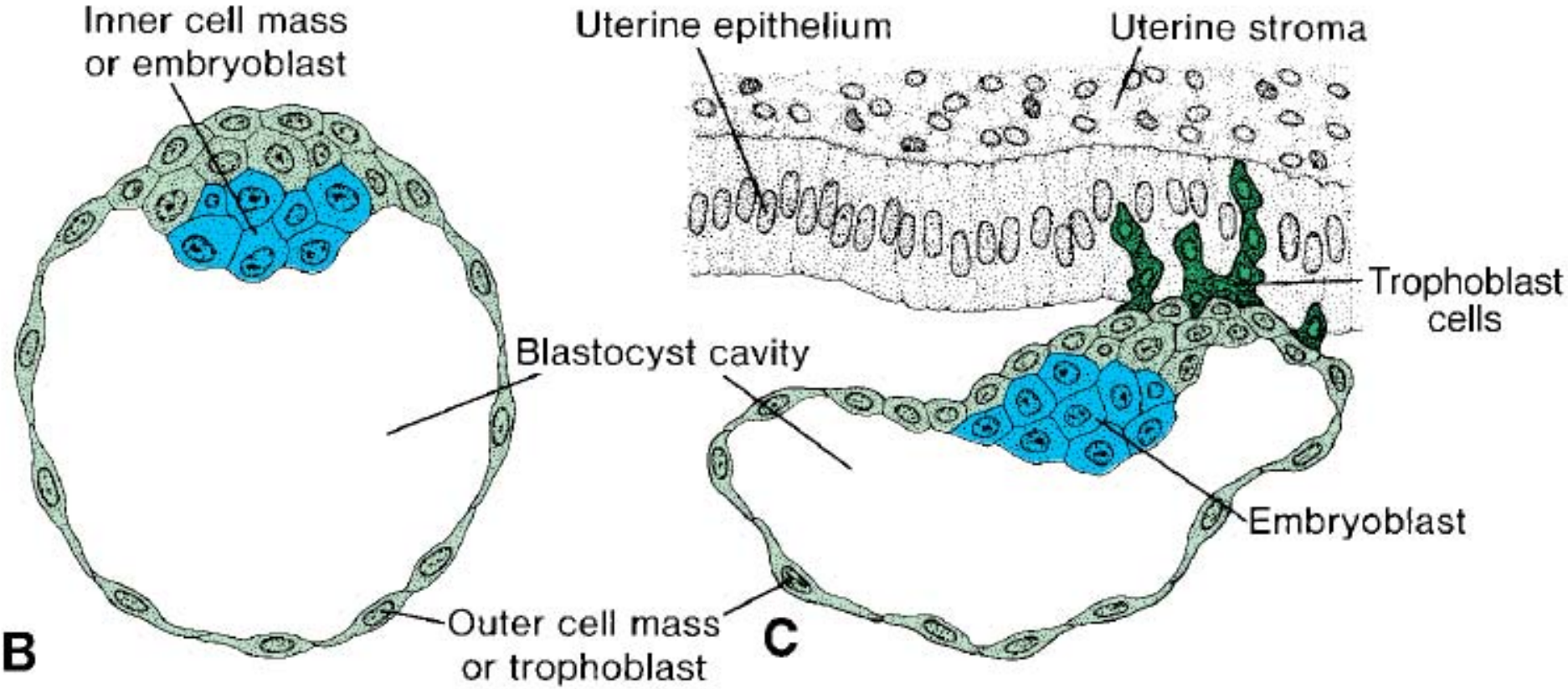
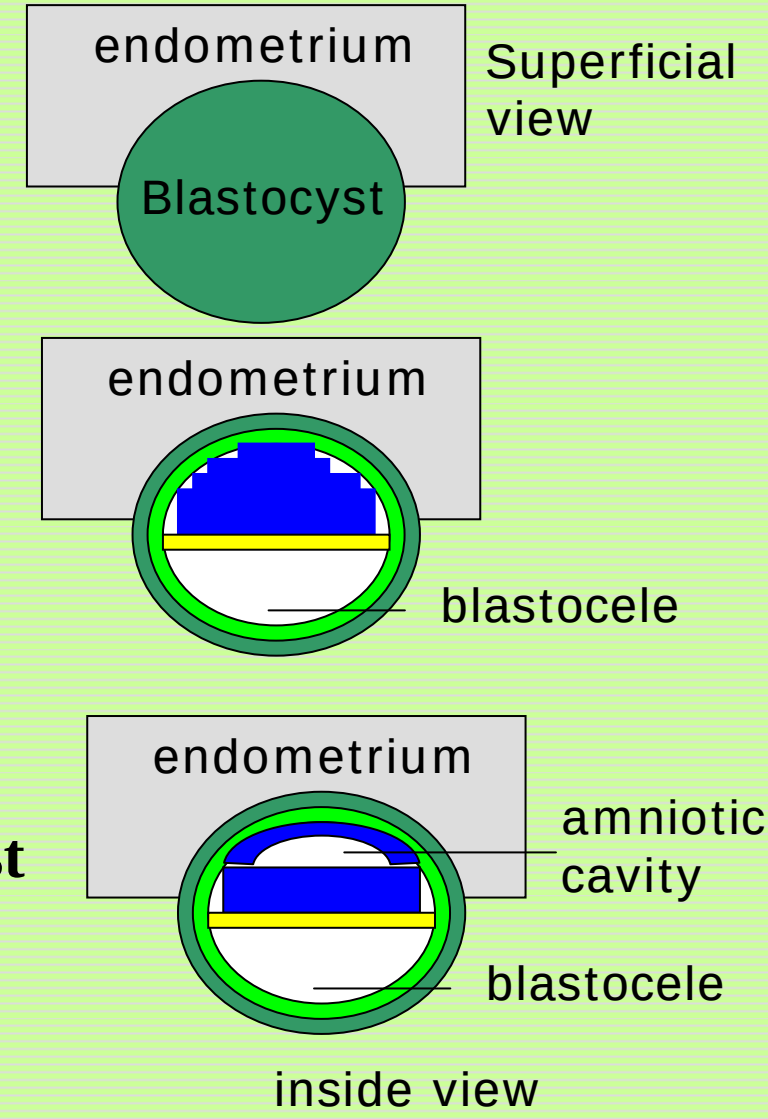


Figure 2.10 A. Section of a 107-cell human blastocyst showing inner cell mass and trophoblast cells. **B.** Schematic representation of a human blastocyst recovered from the uterine cavity at approximately 4.5 days. *Blue*, inner cell mass or embryoblast; *green*, trophoblast. **C.** Schematic representation of a blastocyst at the ninth 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 day of development.

Day 8

- Blastocyst is partially embedded in endometrium.
- Trophoblast
  - outer syncytiotrophoblast
  - inner cytotrophoblast
  - CTs→STs
- Embryoblast
  - high columnar epiblast
  - small cuboidal hypoblast
- bilaminar germ disc
  - primordium of human body.
- amniotic cavity within the epiblast



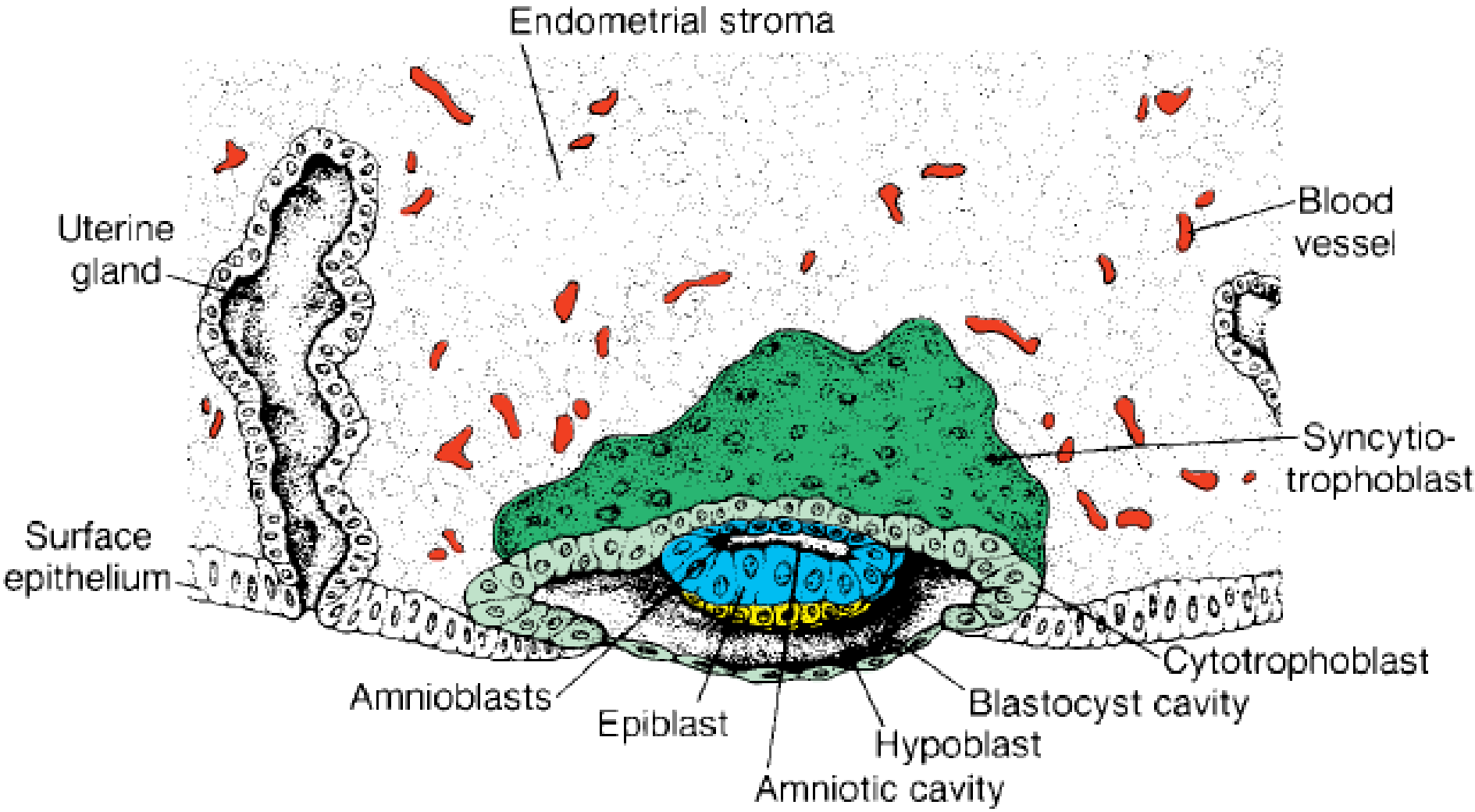
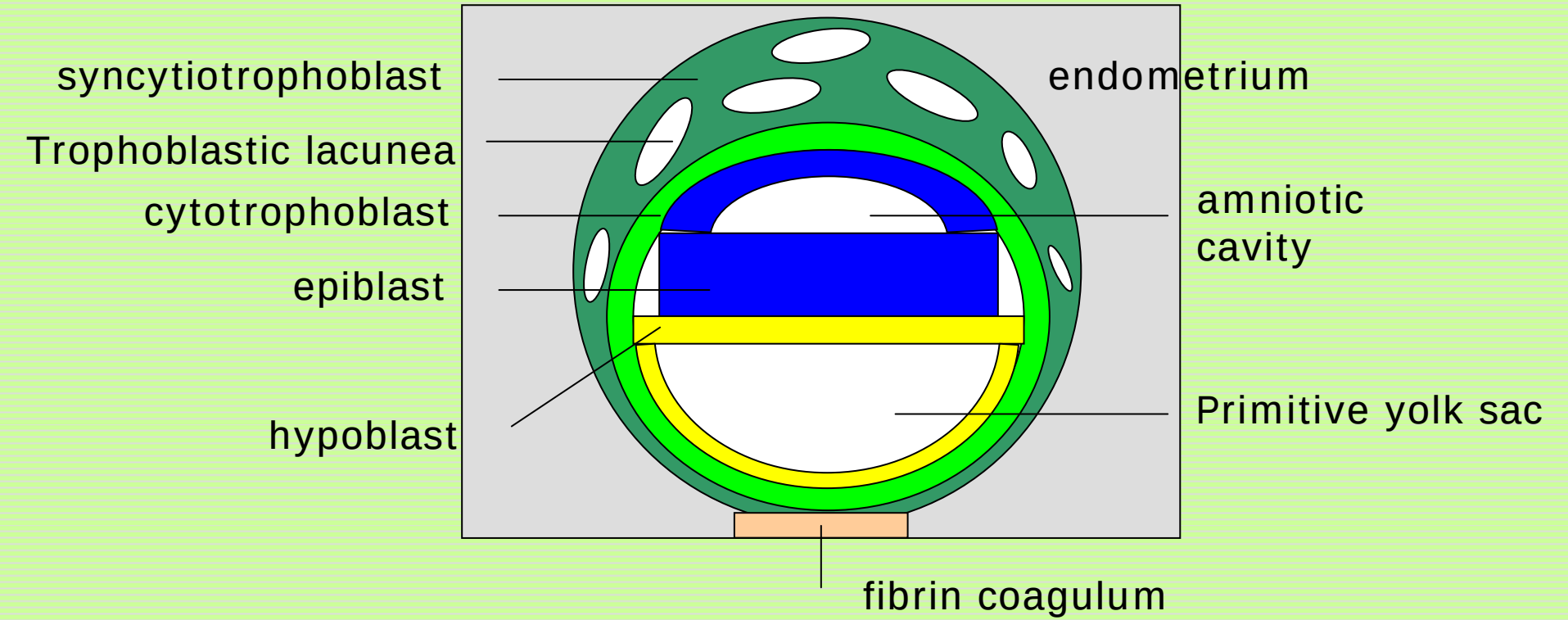


Figure 3.1 A 7.5-day human blastocyst, partially embedded in the endometrial stroma. The trophoblast consists of an inner layer with mononuclear cells, the cytotrophoblast, and an outer layer without distinct cell boundaries, the syncytiotrophoblast. The embryoblast is formed by the epiblast and hypoblast layers. The amniotic cavity appears as a small cleft.

Day 9

- Blastocyst is deeply embedded in the endometrium.
- Defect in epithelium is closed by a fibrin coagulum.
- Vacuoles in trophoblast fuse to form large lacunae.
- Flattened cells from hypoblast form primitive yolk sac (exocoelomic cavity).



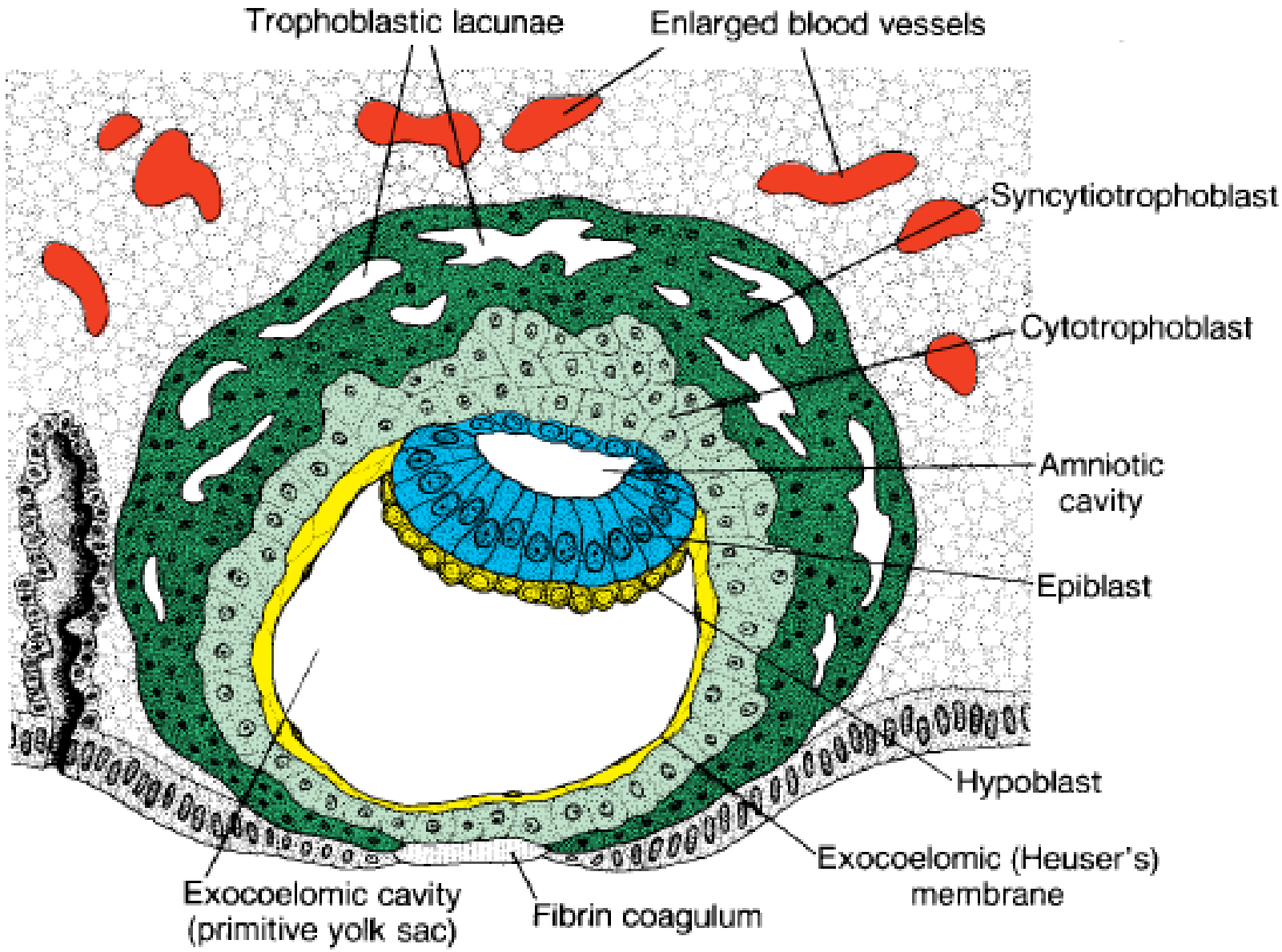
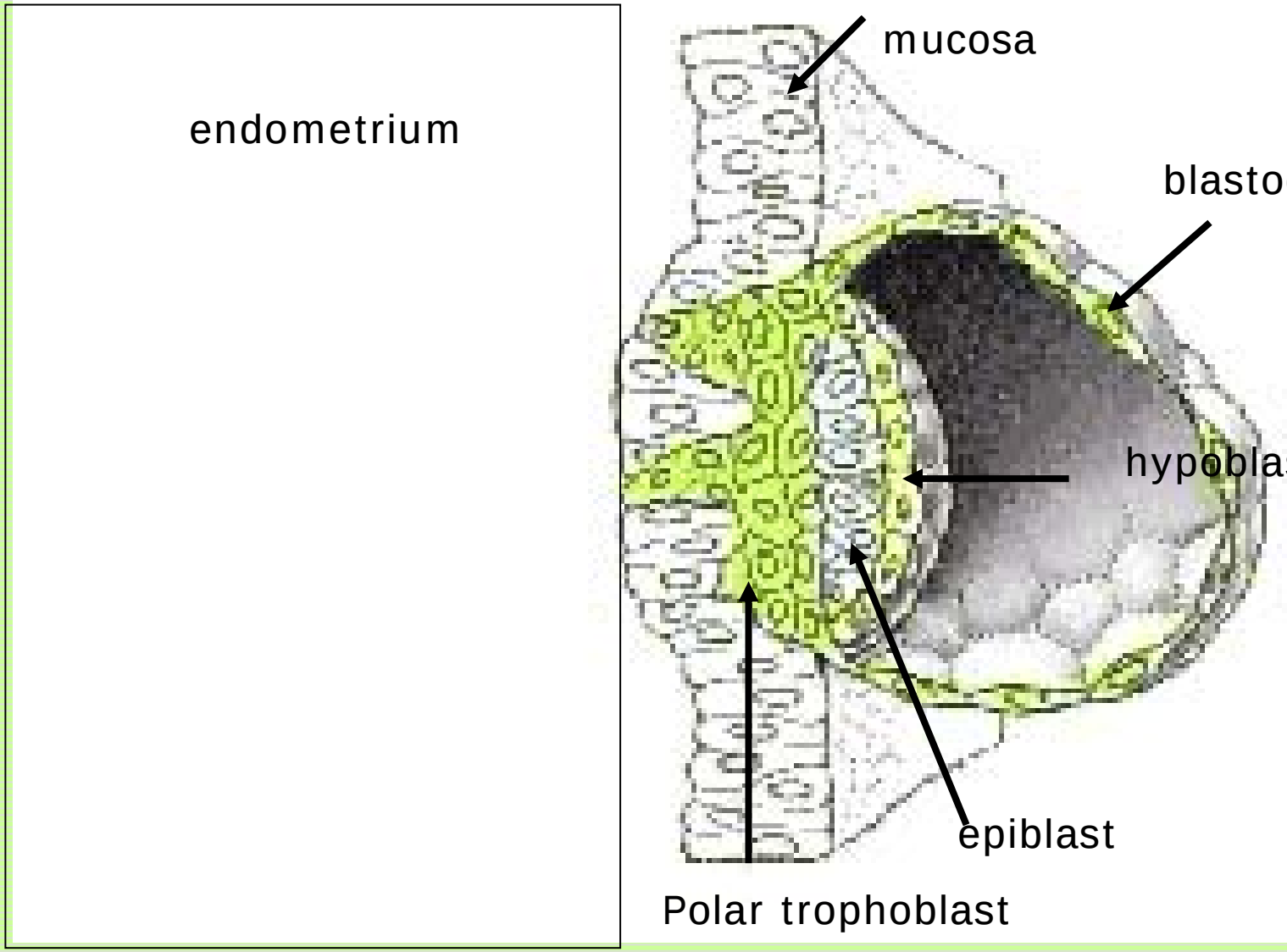


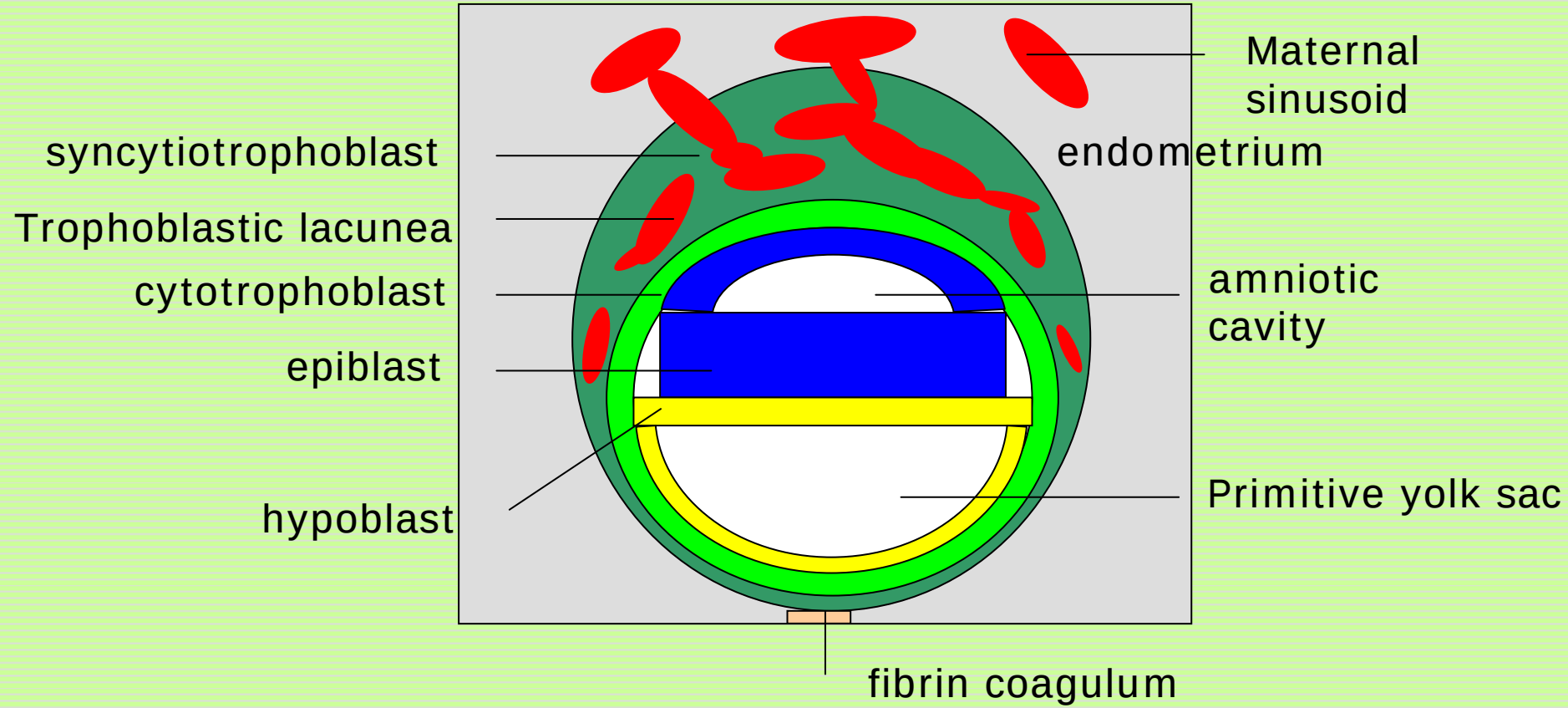
Figure 3.3 A 9-day human blastocyst. The syncytiotrophoblast shows a large number of lacunae. Flat cells form the exocoelomic membrane. The bilaminar disc consists of a layer of columnar epiblast cells and a layer of cuboidal hypoblast cells. The original surface defect is closed by a fibrin coagulum.



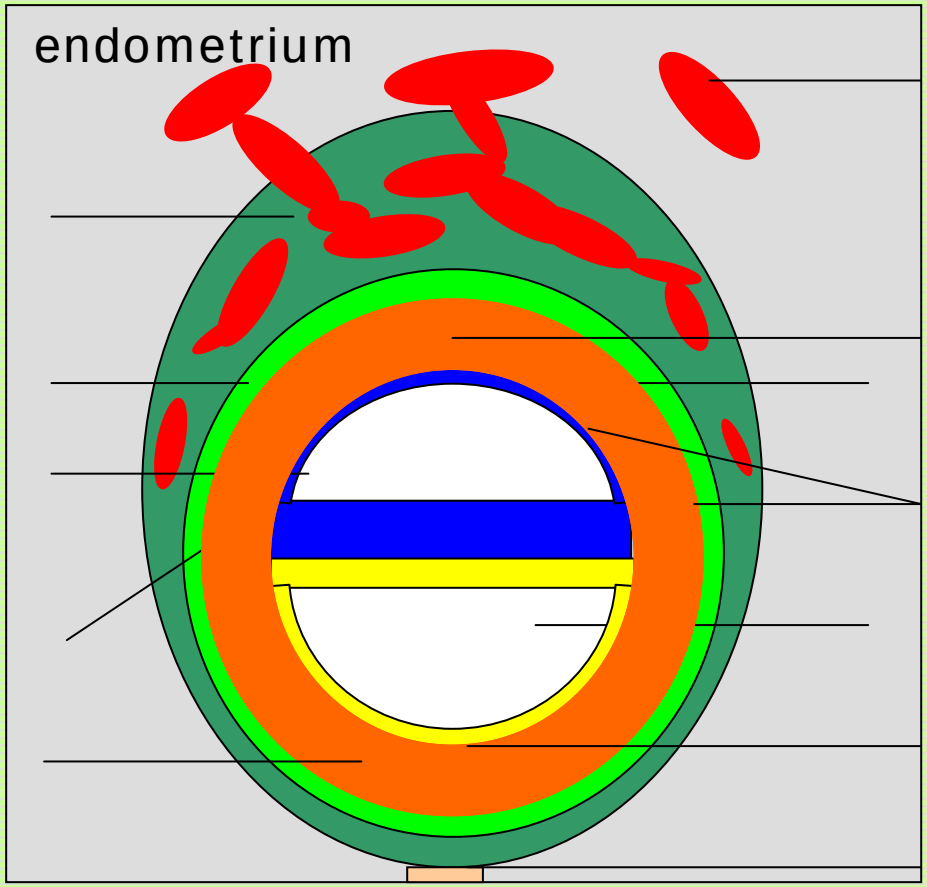
Formation of bilaminar germ disc, amniotic cavity, primitive yolk sac, cytotrophoblast; syncytiotrophoblast from day 6 to day 9

Days 11 and 12

- Blastocyst is completely embedded in endometrium.
- surface epithelium almost entirely covers defect.
- Syncytiotrophoblast cells eroded maternal sinusoids, which become continuous with lacunae in syncytium, establishing uteroplacental circulation.



- Extraembryonic mesoderm form and fills the space between cytotrophoblast, amnion and primitive yolk sac membrane.
- Extraembryonic coelom develops inside extraembryonic mesoderm.
  - Extraembryonic somatopleuric mesoderm lines cytotrophoblast and amnion
  - Extraembryonic splanchnopleuric mesoderm lines yolk sac.
- Germ disc is connected to trophoblast by body/connecting stalk.



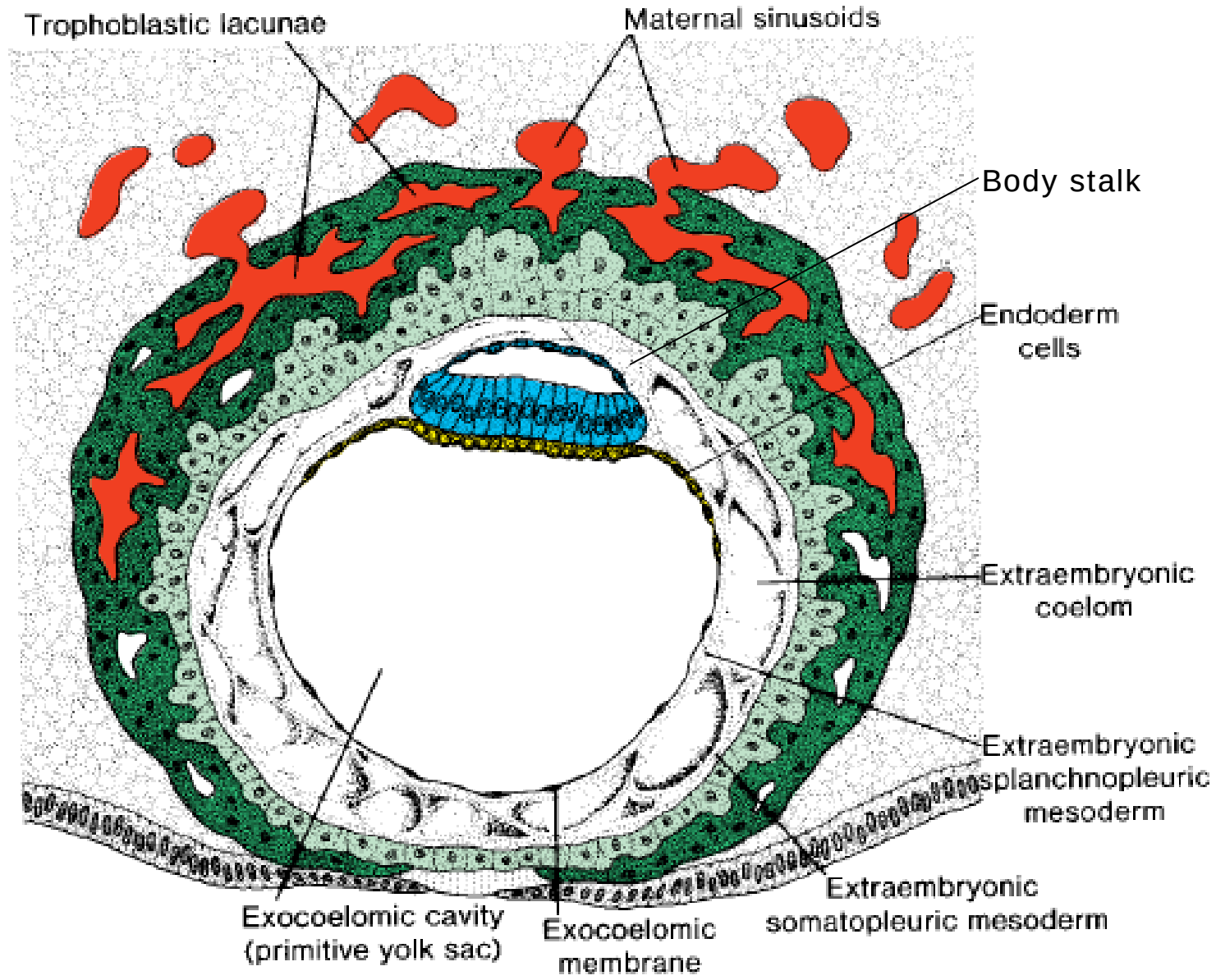
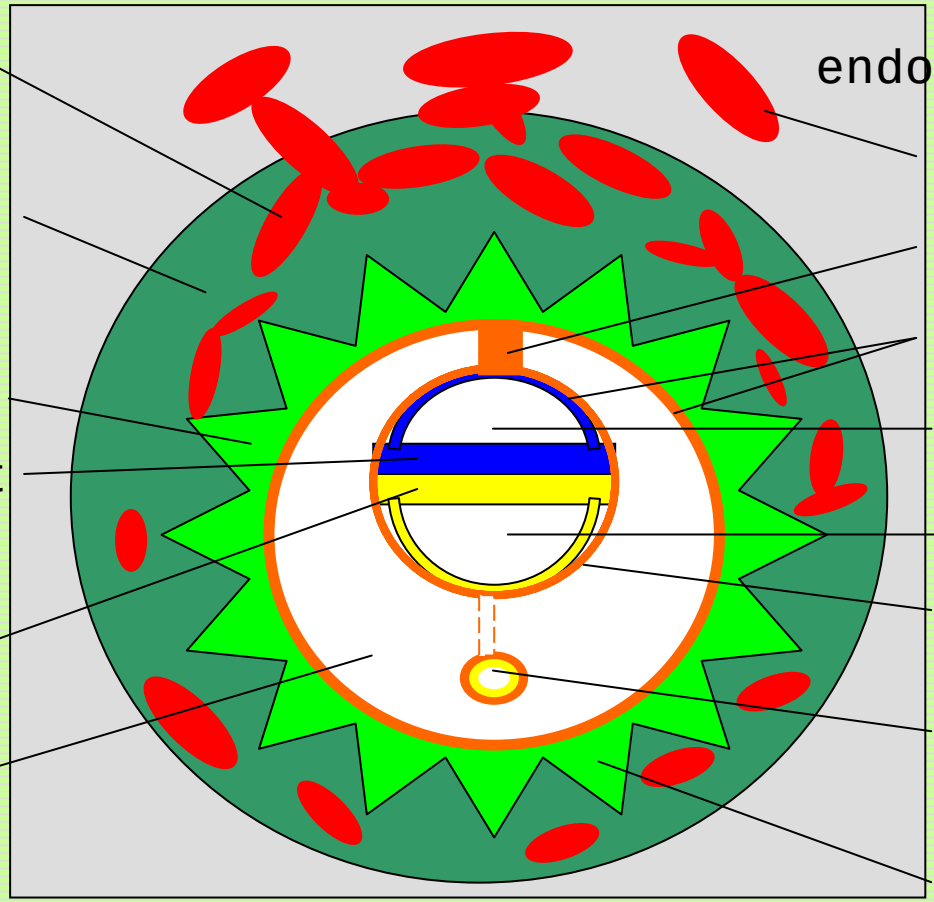


Figure 3.4 Human blastocyst of approximately 12 days. The trophoblastic lacunae at the embryonic pole are in open connection with maternal sinusoids in the endometrial stroma. Extraembryonic mesoderm proliferates and fills the space between the exocoelomic membrane and the inner aspect of the trophoblast.

Day 13

- **The defect in the endometrium has usually healed.**
- **Primary villi :cytotrophoblast penetrate into syncytiotrophoblast**
- **Cells from hypoblast migrate along the inside of the primitive yolk sac membrane, forming secondary/definitive yolk sac.**



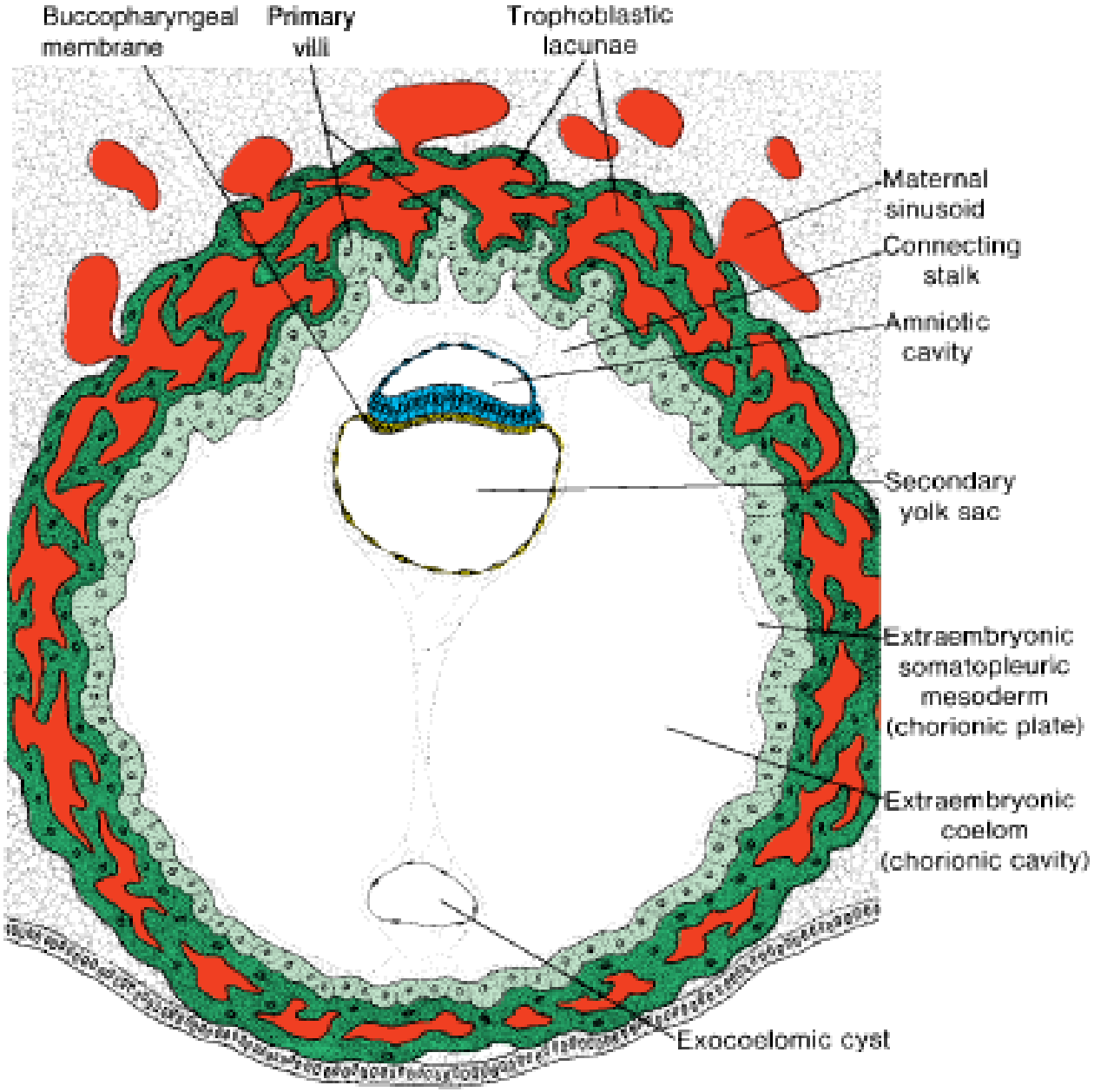
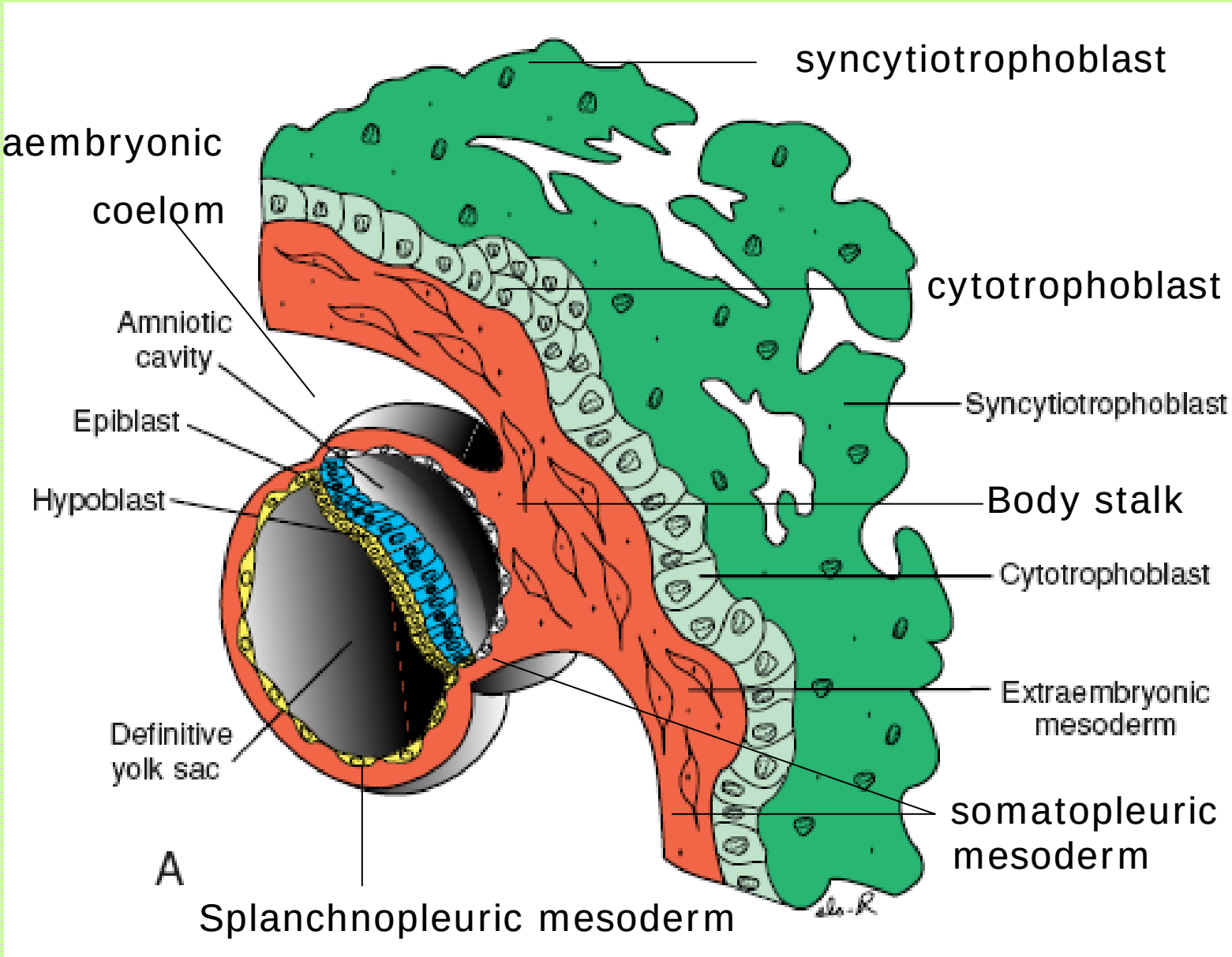
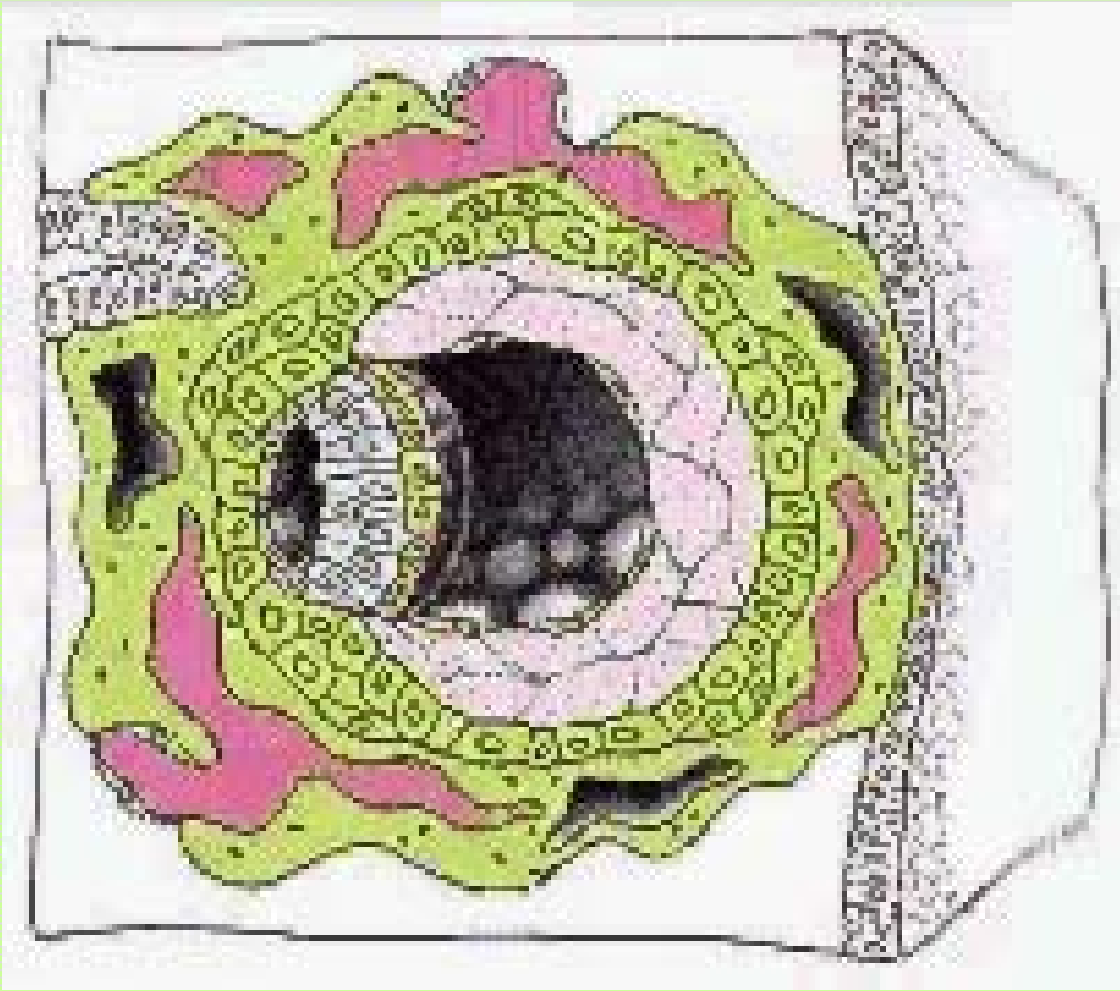


Figure 3.6 A 13-day human blastocyst. Trophoblastic lacunae are present at the embryonic as well as the abembryonic pole, and the uteroplacental circulation has begun. Note the primary villi and the extraembryonic coelom or **chorionic cavity.** The secondary yolk sac is entirely lined with endoderm.



Implantation site at the end of the second week.

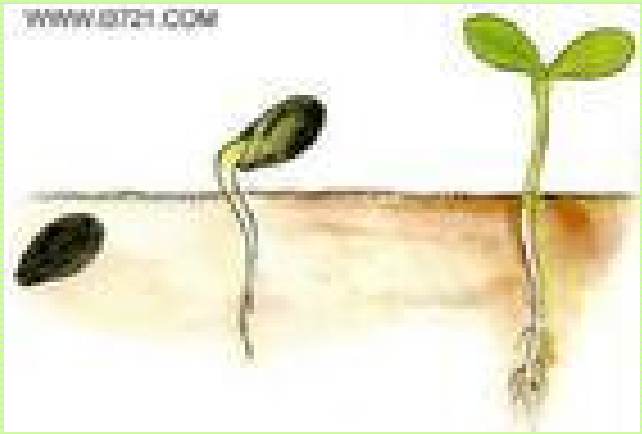
Formation of extraembryonic mesoderm and definitive yolk sac

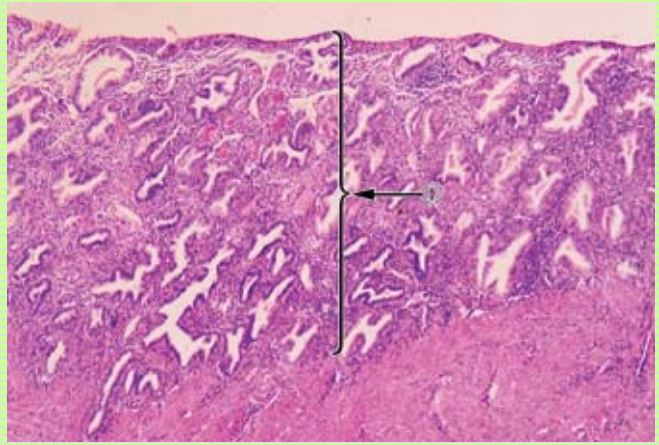


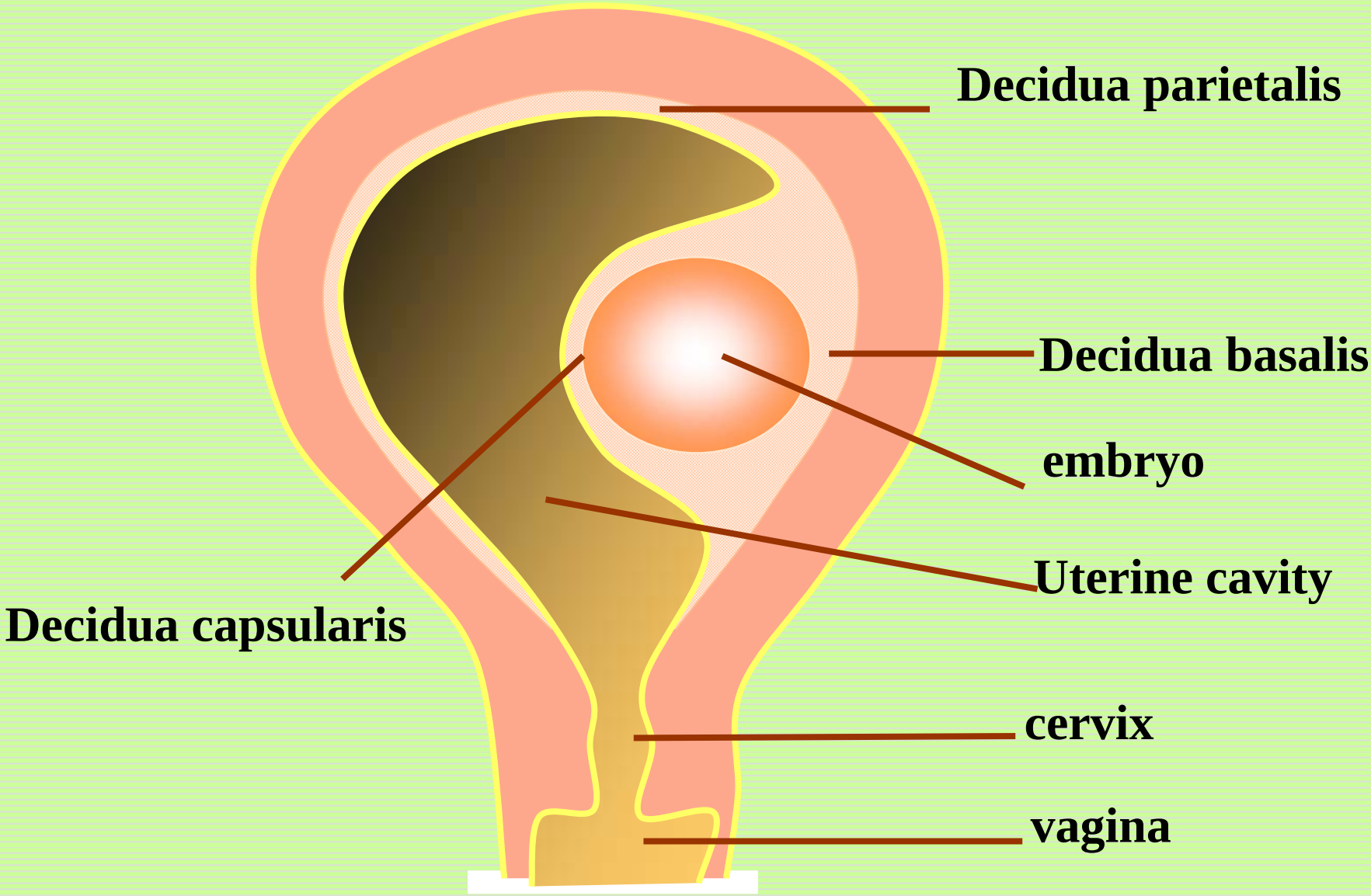
uteroplacental circulation; Eextraembryonic mesoderm
Extraembryonic coelom ; secondary yolk sac

5.2 Uterus at time of implantation

- Menstrual cycle
  - follicular/proliferative phase
  - Secretory/progestational phase
    - Coiled uterine glands and arteries, succulent tissue
    - stroma cell → predecidual cell → decidual cell
      polyhedral and loaded with glycogen and lipids
  - menstrual phase
- Decidua reaction: endometrium →decidua

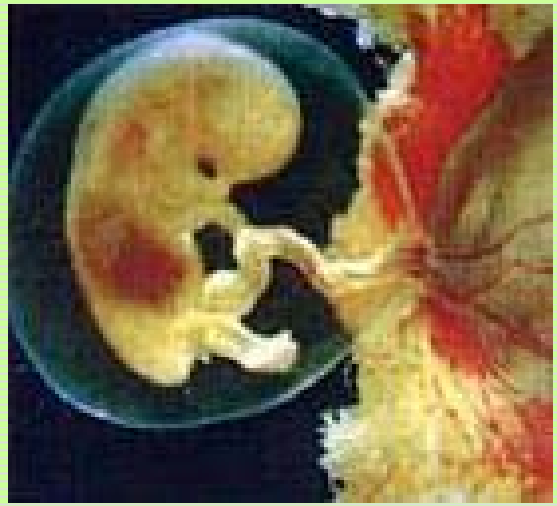






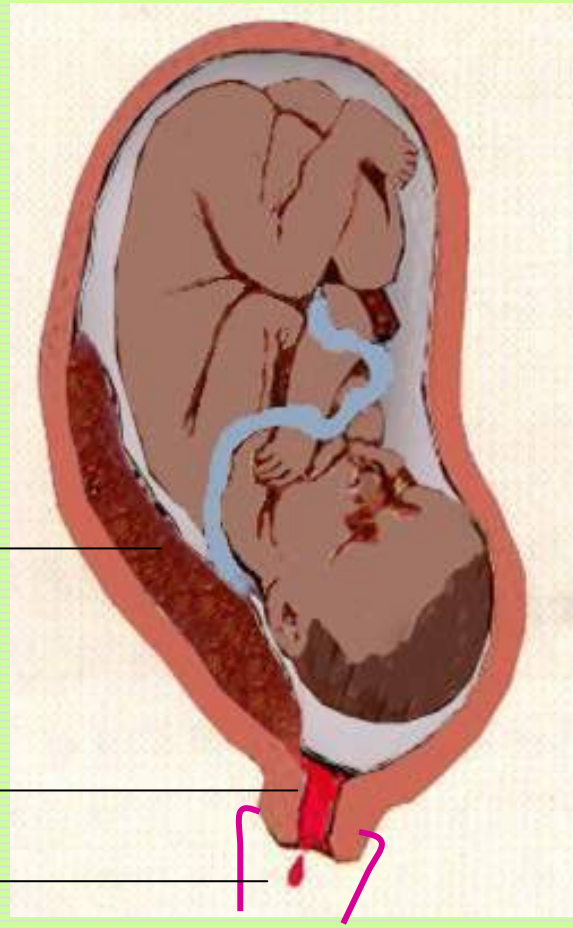
Relationship between the embryo and the endometrium

- **Conditions of implantation:**
  - **- endometrium is in secretory phase——— soil**
  - **- morula reach uterine cavity on time——— spring**
  - **- zona pellucide disappears in time——— covering coat**
- **Almost all contraceptive measures are based on blocking these three conditions.**



5.3 Abnormal Implantation

- **Abnormal implantation within the uterus**
  - **internal opening of the cervix**
  - **placenta previa bridges the opening and causes severe bleeding in the second part of pregnancy and during delivery.**



Extrauterine or ectopic pregnancy

- abdominal cavity, ovary, uterine tube, particularly ampulla
- Embryo dies about the second month of gestation.

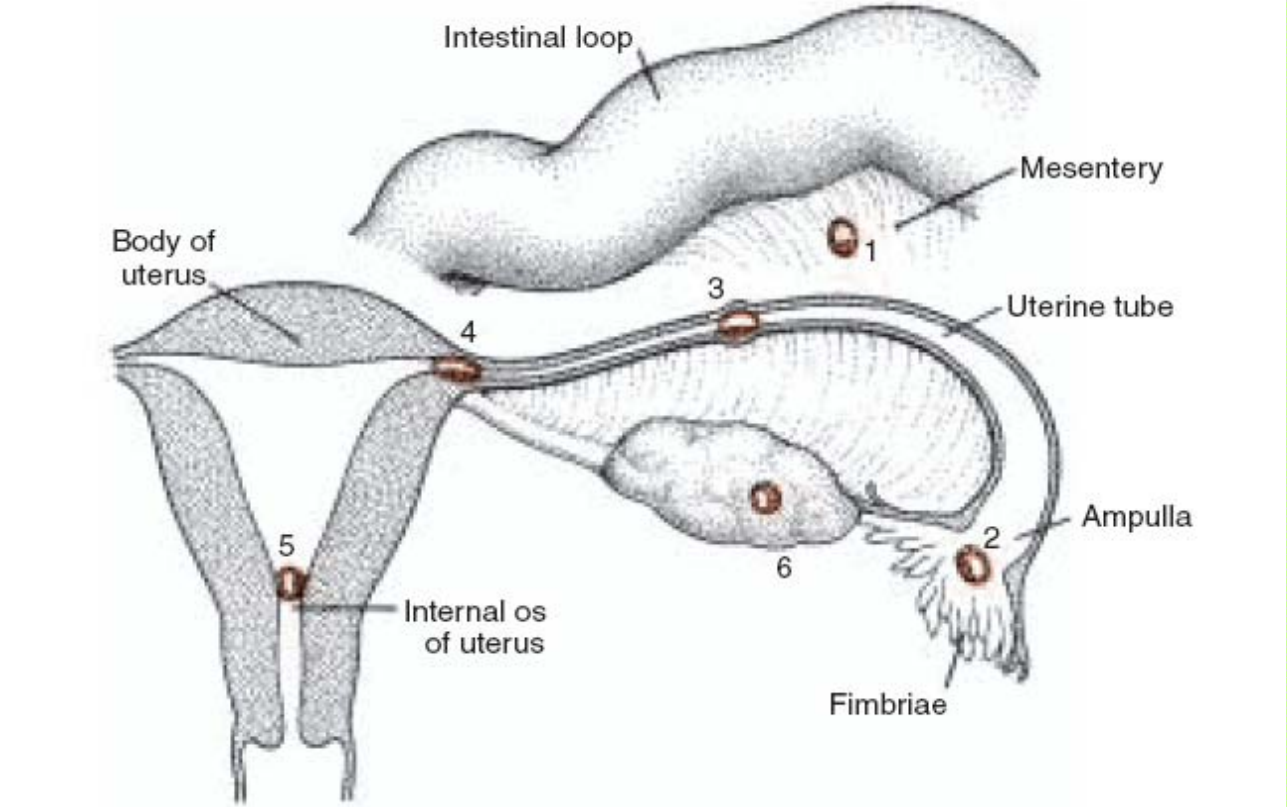


Figure 3.8 Abnormal implantation sites of the blastocyst. *1*, implantation in the abdominal cavity. The ovum most frequently implants in the rectouterine cavity (Douglas' pouch) but may implant at any place covered by peritoneum. *2*, implantation in the ampullary region of the tube. *3*, tubal implantation. *4*, interstitial implantation, that is, in the narrow portion of the uterine tube. *5*, implantation in the region of the internal os, frequently resulting in placenta previa. *6*, ovarian implantation.

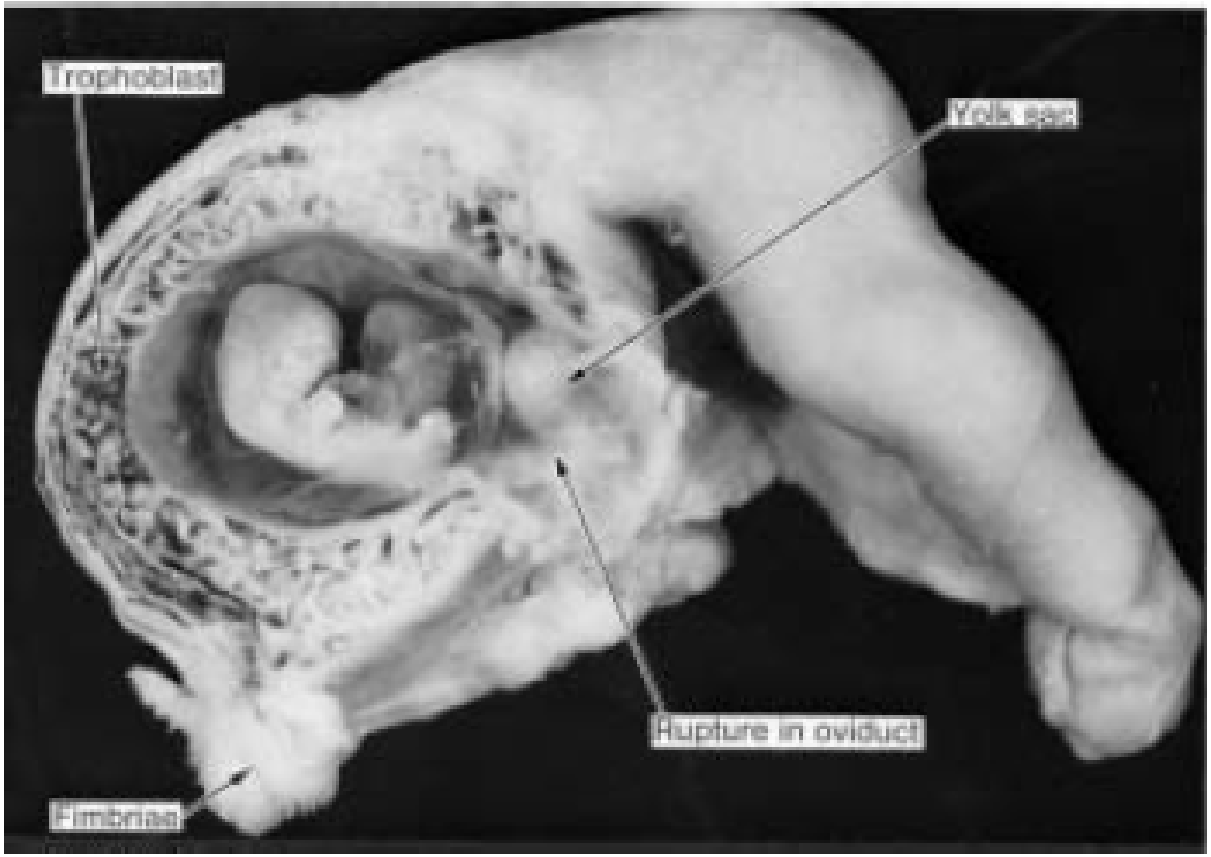
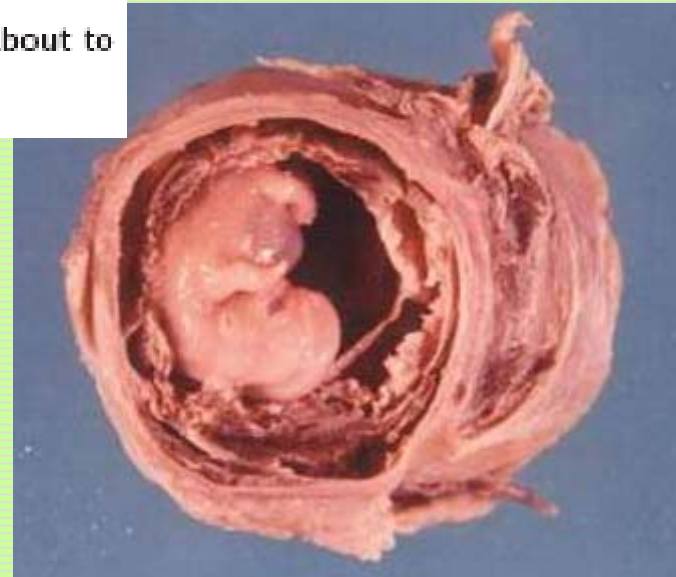


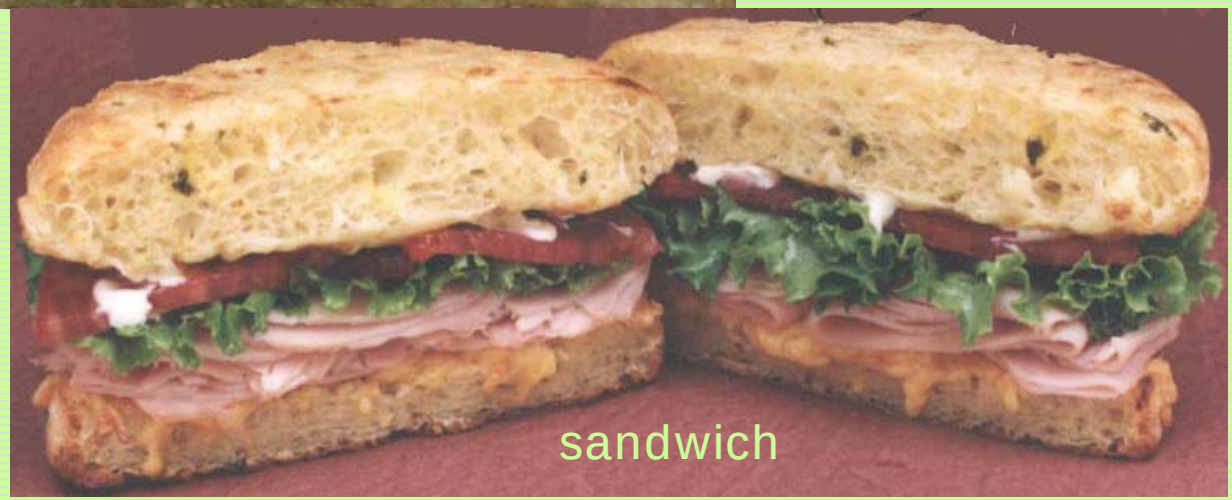
Figure 3.9 Tubal pregnancy. Embryo is approximately 2 months old and is about to escape through a rupture in the tubal wall.



Chapter 2
General Embryology

Third week:
Trilaminar germ disc


The peacock is spreading its tail


sandwich

6. Formation of trilaminar germ disc

6.1 Formation of intraembryonic Mesoderm and Endoderm

- **The third week**
- **Epiblast form primitive streak at caudal midline.**
- **The cephalic end of the streak is primitive node.**
- **Primitive streak invaginate, forming primitive groove.**
- **Part of invaginated epiblast migrate into and displace hypoblast, creating embryonic endoderm.**
- **Others come to lie between epiblast and endoderm, forming mesoderm, which contacts with extraembryonic mesoderm.**
- **Cells remaining in the epiblast then form ectoderm.**

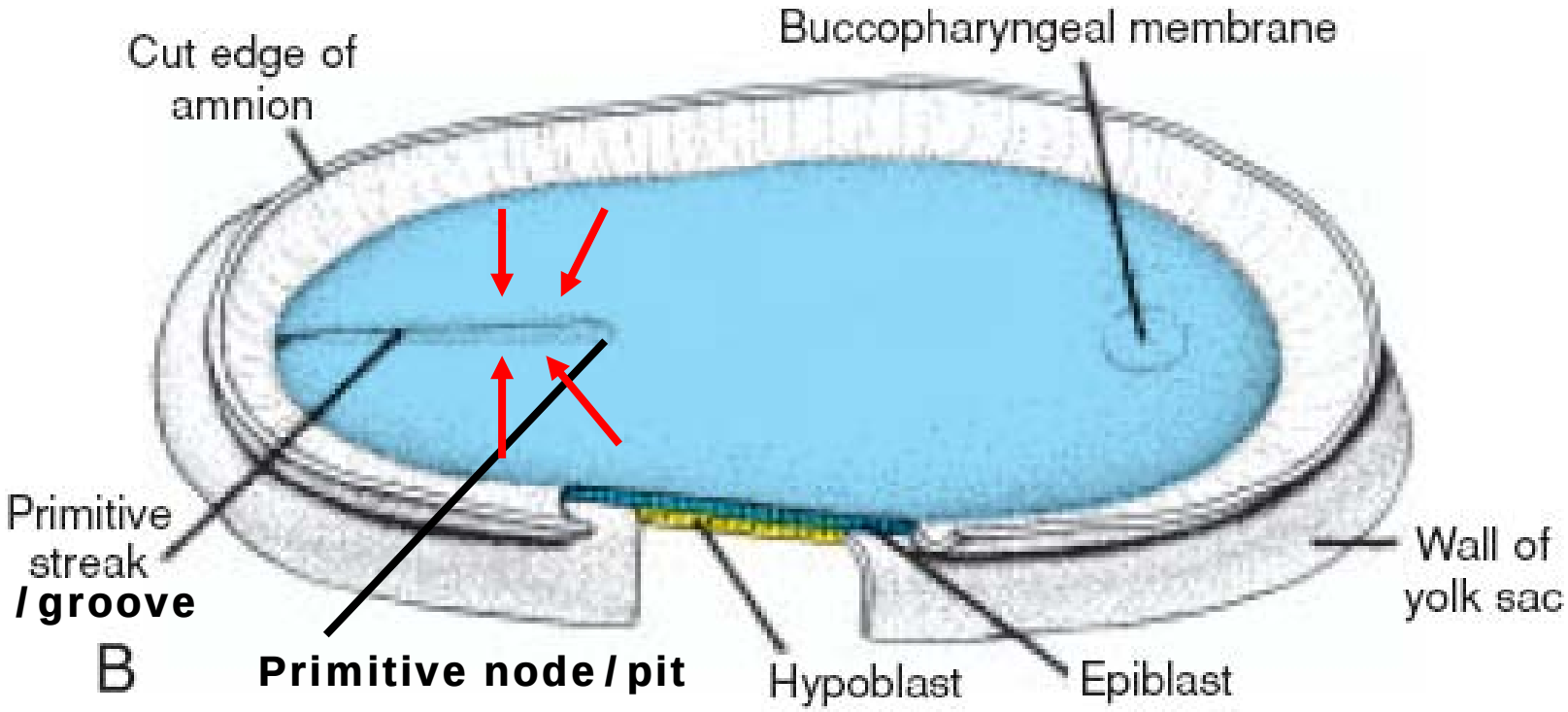
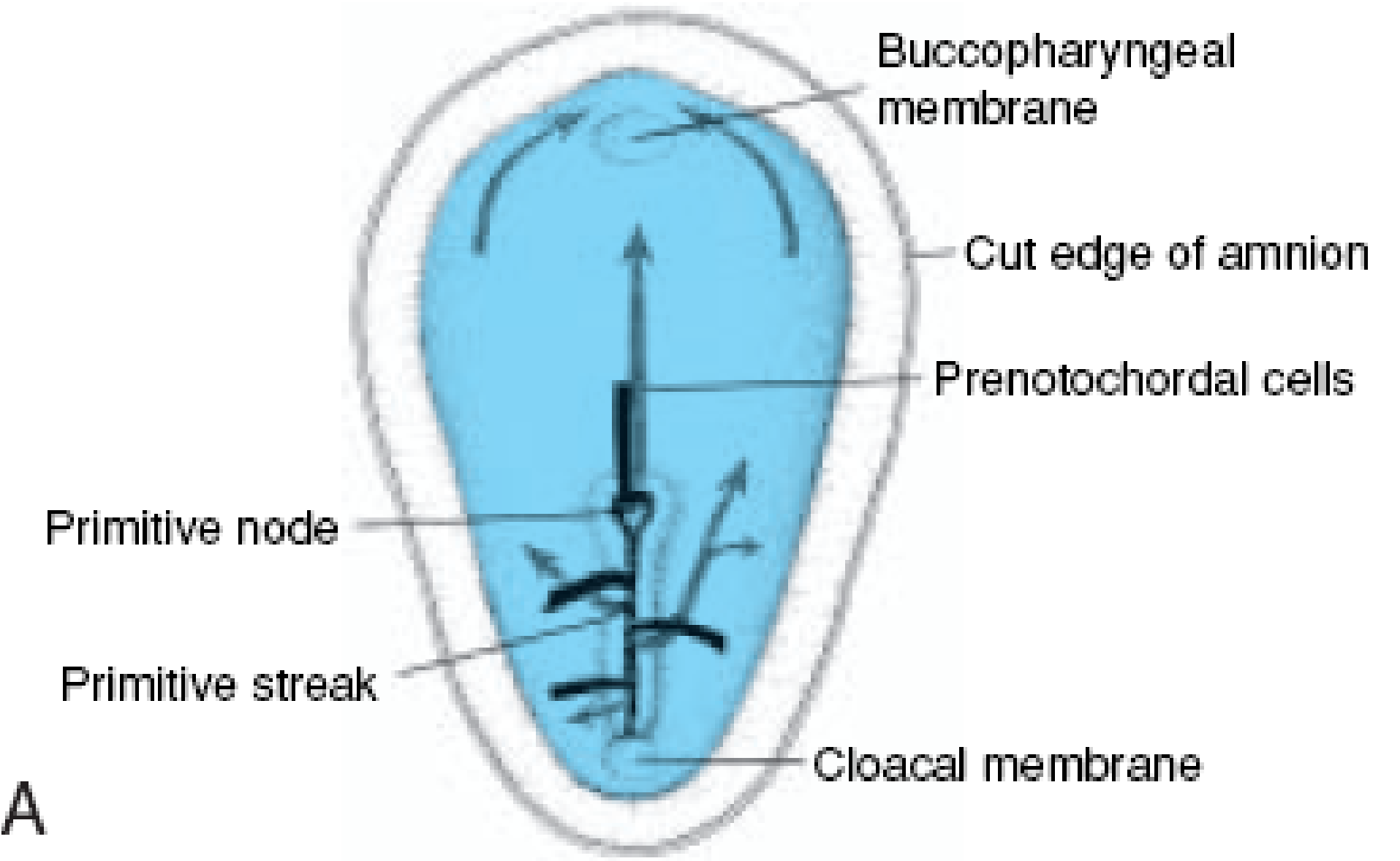
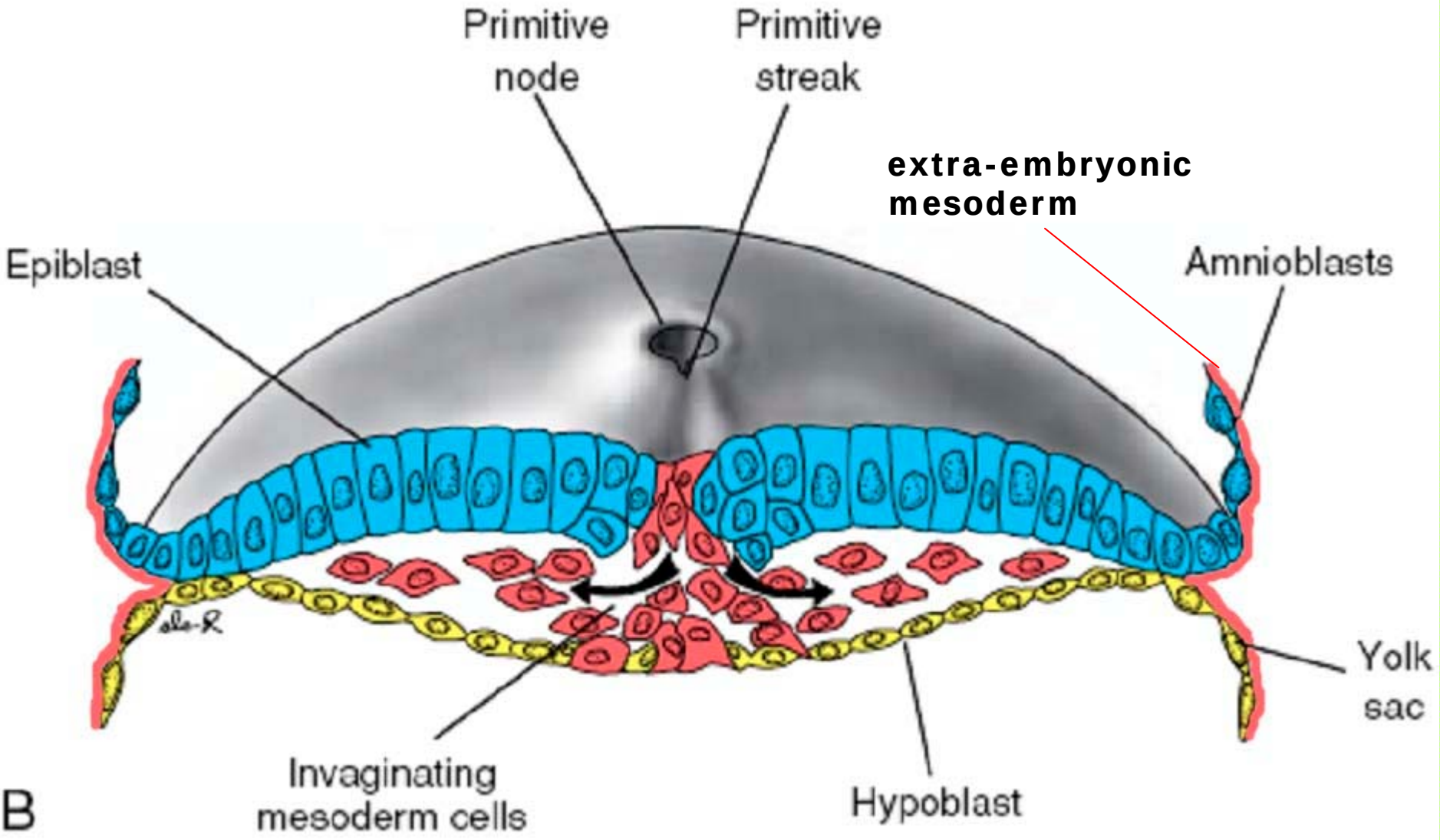


Figure 4.1 A. Implantation site at the end of the second week. **B.** Representative view of the germ disc at the end of the second week of development. The amniotic cavity has been opened to permit a view on the dorsal side of the epiblast. The hypoblast and epiblast are in contact with each other and the primitive streak forms a shallow groove in the caudal region of the embryo.

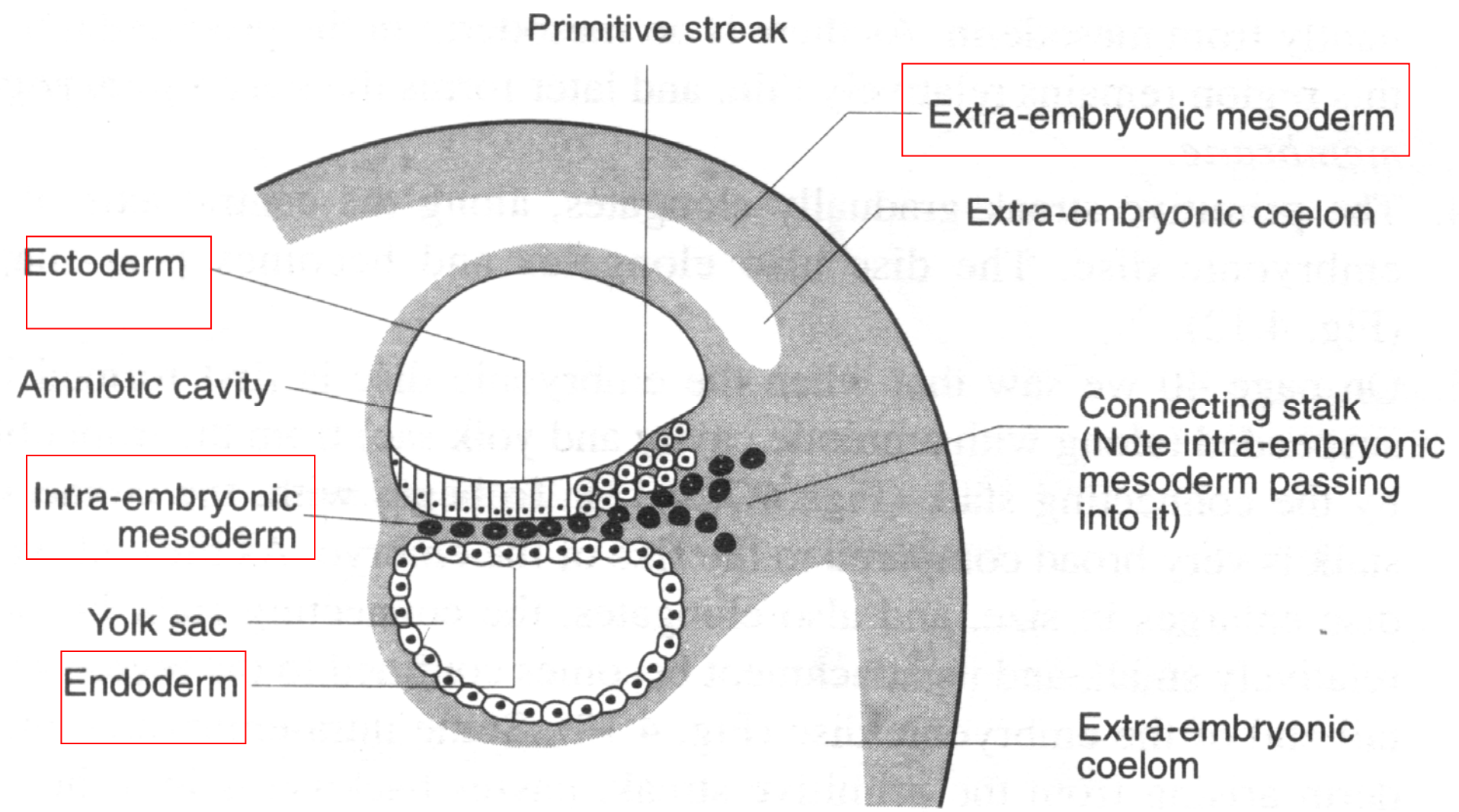
Cells of epiblast migrate toward caudal axial line of germ disc to form a longitudinal cellular column called primitive streak.The cephalic end of streak is a slightly elevated area called primitive node. Epiblasts of primitive streak and nod invaginate, forming a primitive groove and pit.



Dorsal side of the germ disc from a 16-day embryo indicating the movement of surface epiblast cells (*solid black lines*) through the primitive streak and node and the subsequent migration of cells between the hypoblast and epiblast (*broken lines*).



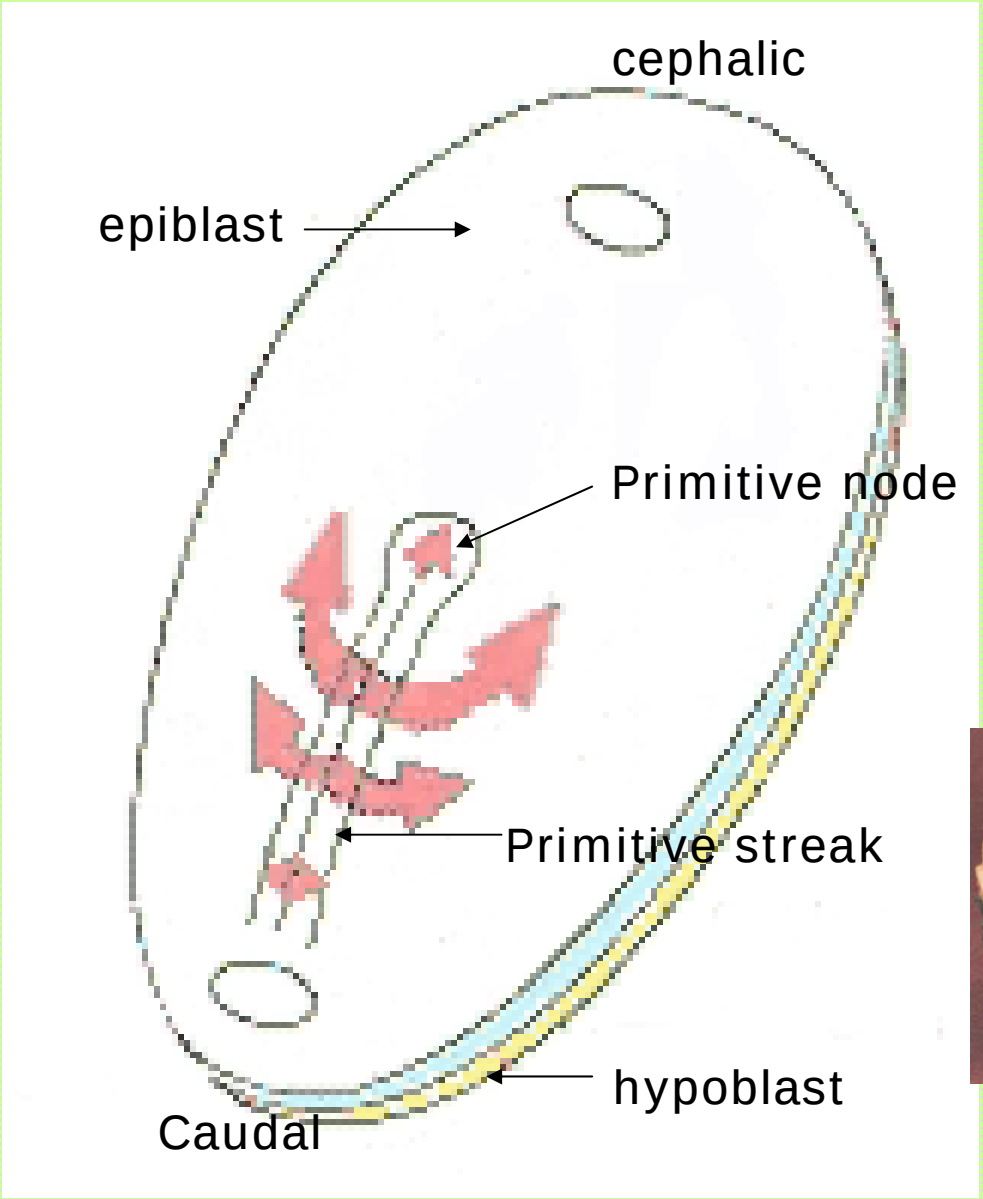
Cross section through the cranial region of the streak at 15 days showing invagination of epiblast cells. The first cells to move inward displace the hypoblast to create the definitive endoderm. Once definitive endoderm is established, inwardly moving epiblast forms mesoderm.



a sagittal section through the germ disc

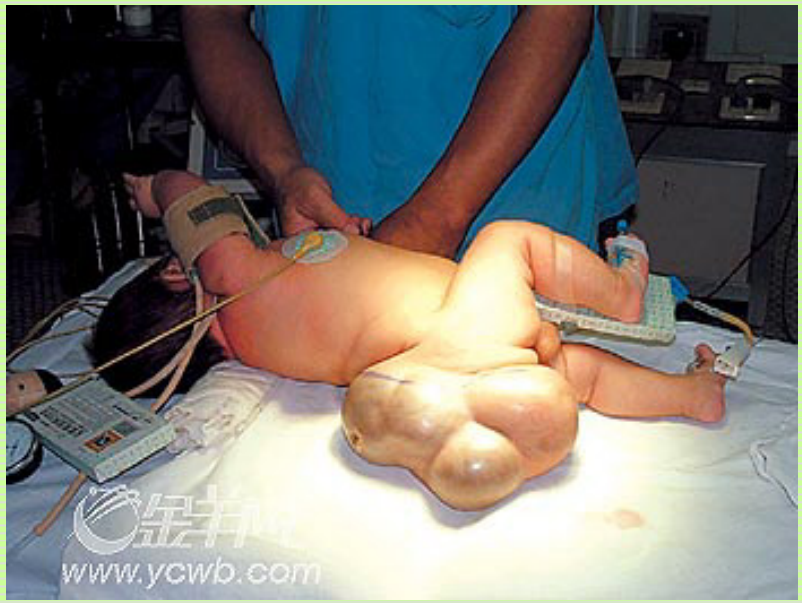
Interembryonic mesoderm establishes contact with extraembryonic mesoderm covering the yolk sac and amnion.

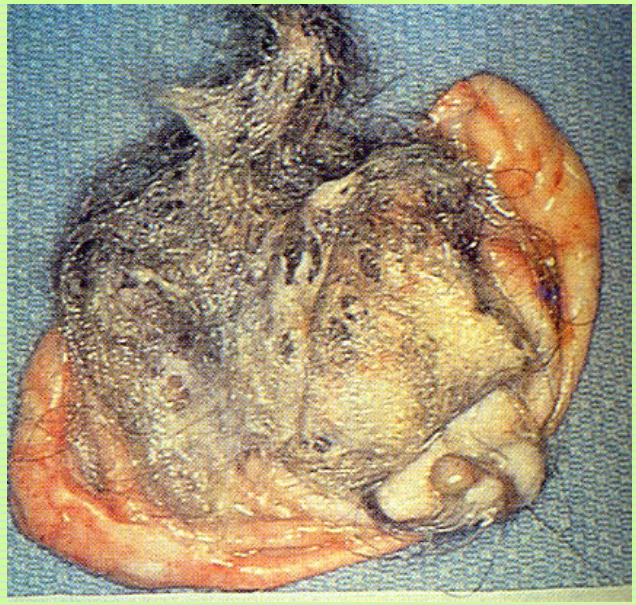
Cells remaining in the epiblast then form ectoderm.



Formation of intraembryonic mesoderm and notochord

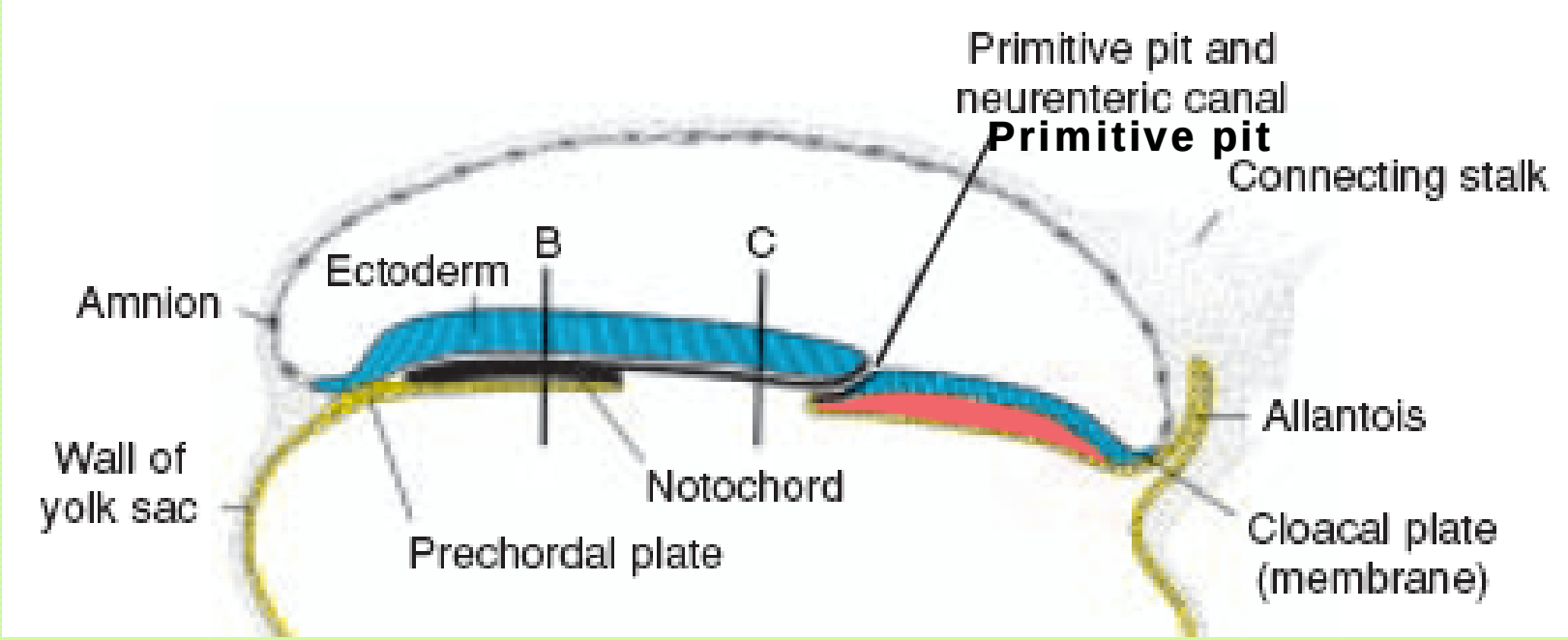
- Primitive streak disappears gradually.
- Sometimes, remnant of the primitive streak persists in sacrococcygeal region and form teratoma.



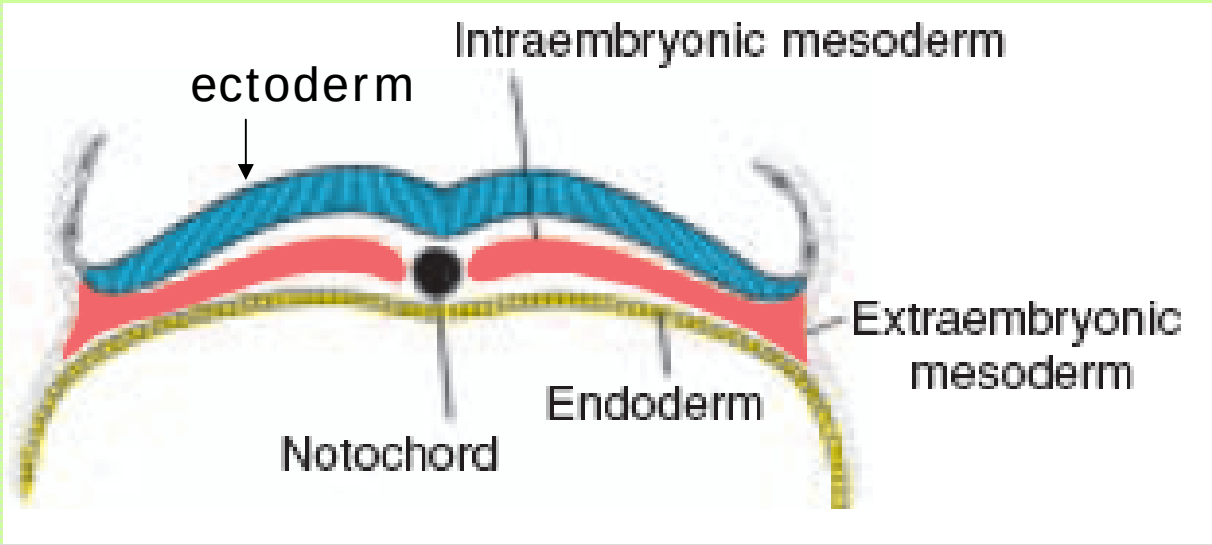


6.2 Formation of the Notochord

- **Prenotochordal cells invaginating in the primitive pit move forward cephalad between epiblast and endoderm.**
- **The notochord extend cranially to the prechordal plate and caudally to the primitive pit.**
- **Notochord induces the formation of neural plate.**
- **Residual notochord degenerate to nucleus pulposus of intervertebral discs.**

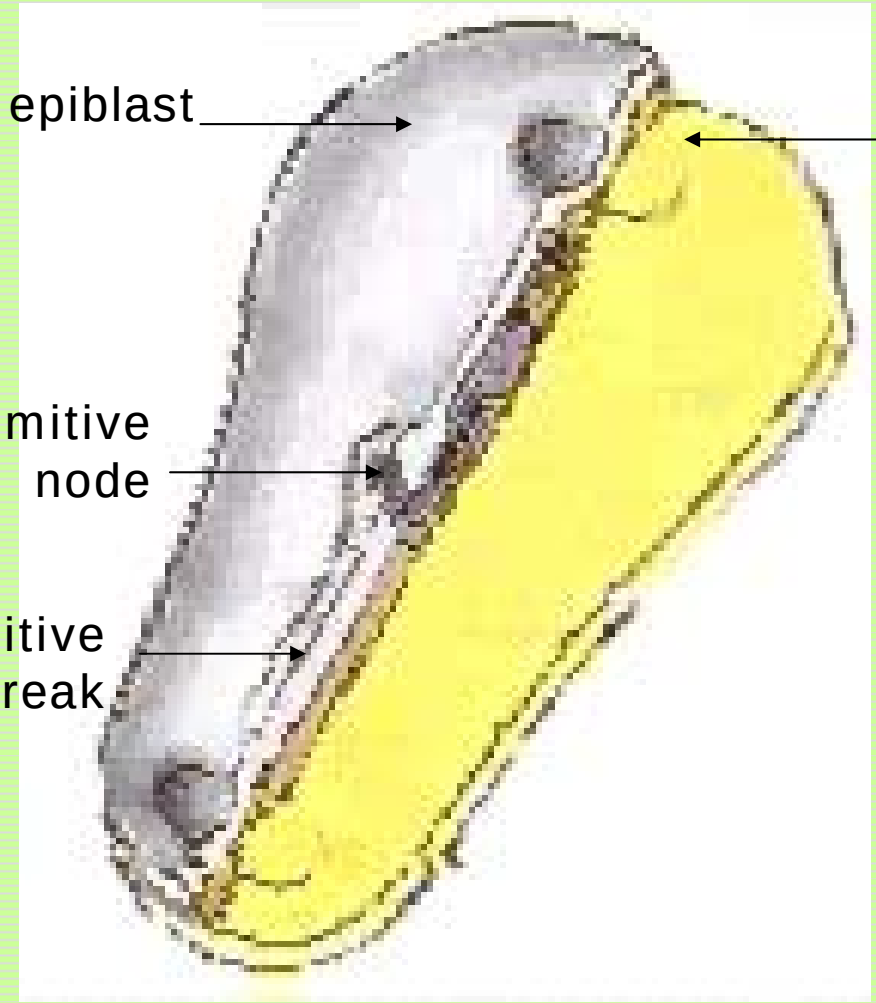


Drawing of a sagittal section through a 17-day embryo. The most cranial portion of the definitive notochord has formed.



Schematic view showing the definitive notochord.

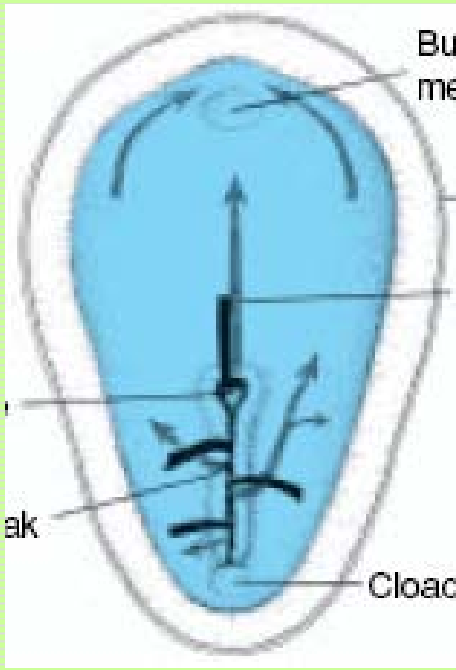
Formation of notochord

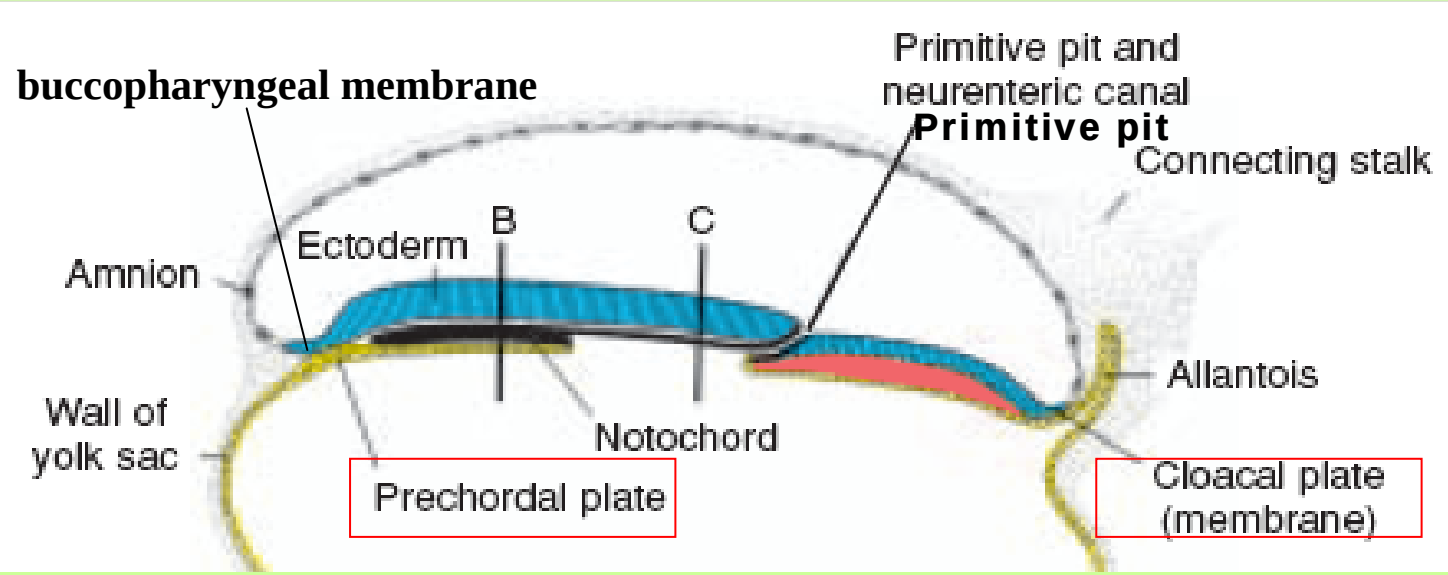


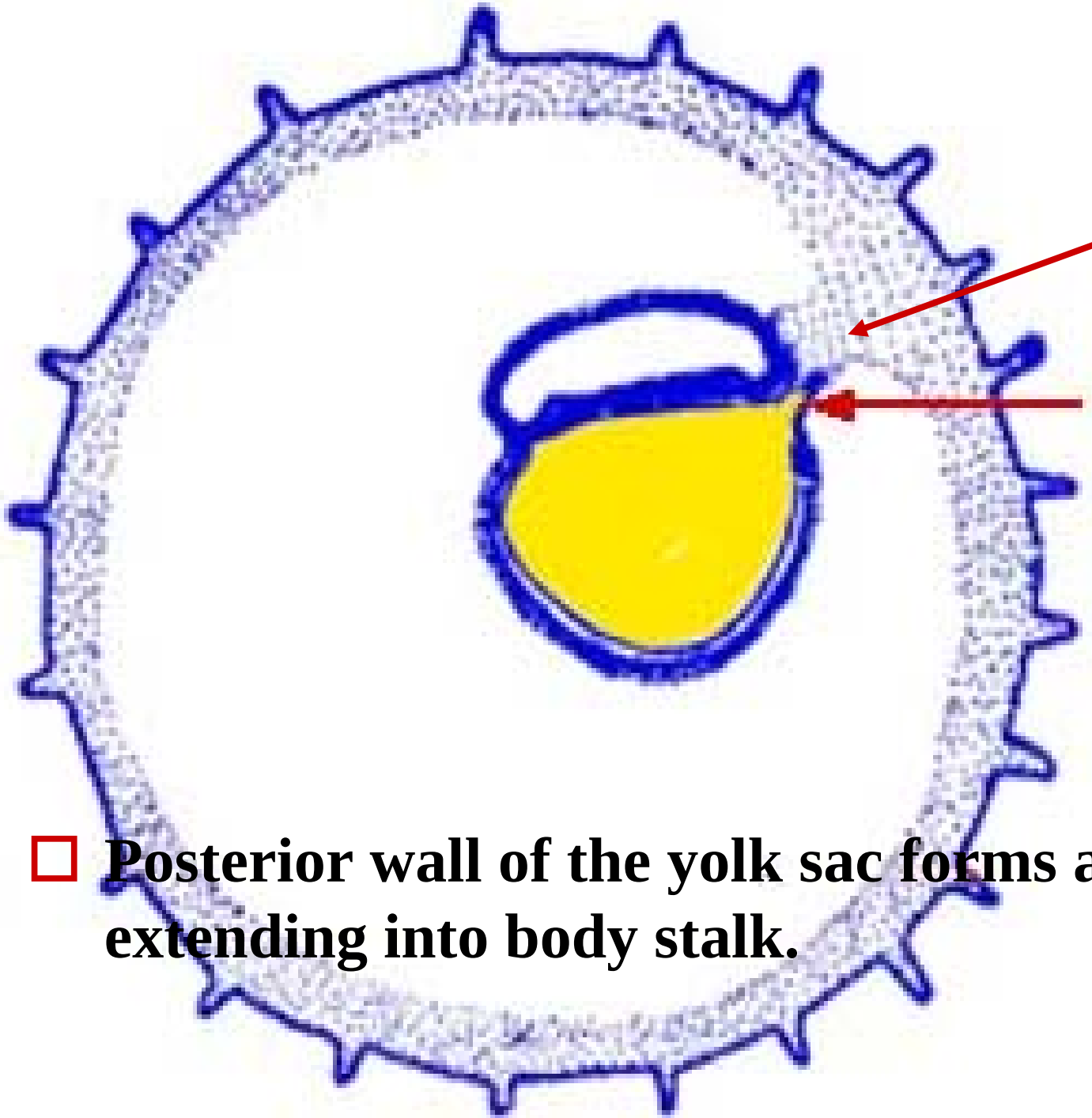
The primitive streak shortens and disappears gradually following the formation of notochord.

6.3 Formation of the allantois

- The cranial buccopharyngeal membrane
  - future opening of the oral cavity.
- The caudal cloacal membrane
  - future opening of reproductive tract and anus.







- **Posterior wall of the yolk sac forms allantois extending into body stalk.**

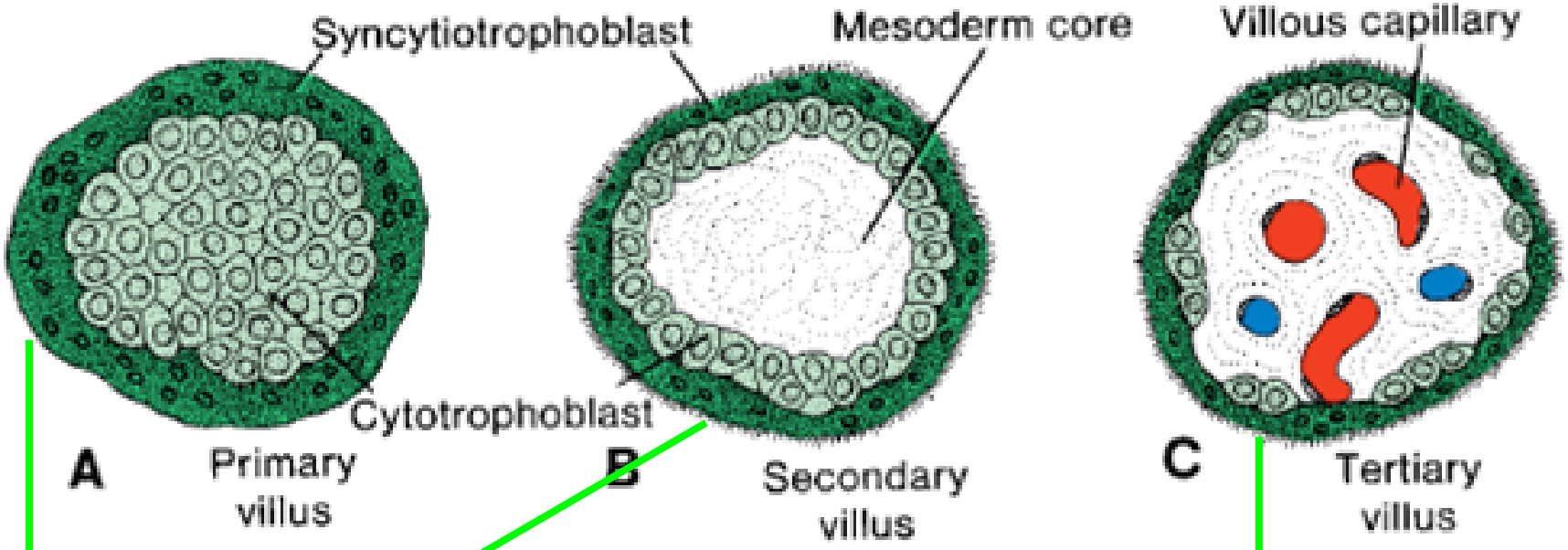
6.4 Growth of the Embryonic Disc

- **The flat and round embryonic disc gradually becomes elongated, with a broad cephalic and a narrow caudal end.**
- **Continuous migration of cells from primitive streak in cephalic direction.**
- **Thus formation of the germ layers continues in caudal segments while cranial structures are differentiating, causing the embryo to develop cephalocaudally.**

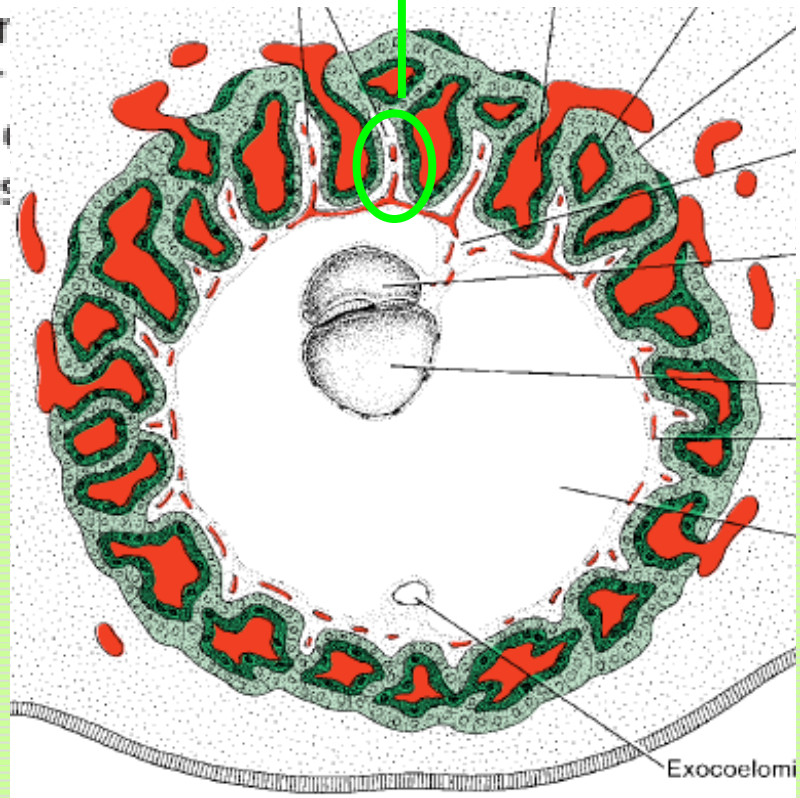
6.5 Further Development of the Trophoblast

Third week:

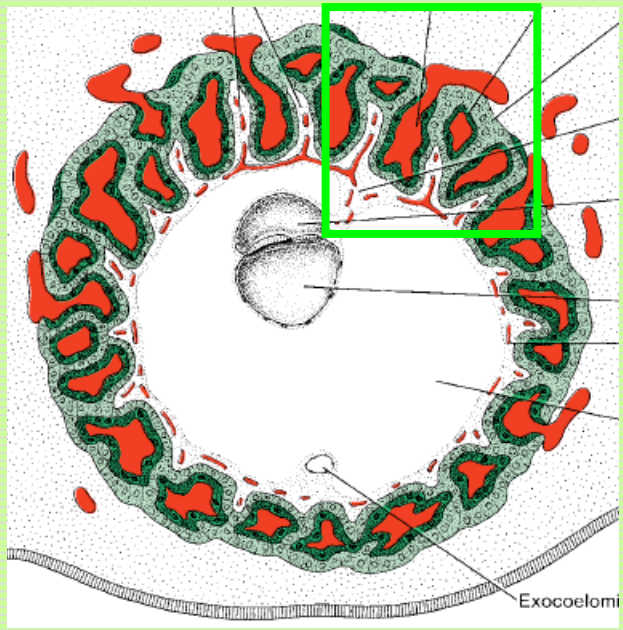
- **primary villus**
  - cytotrophoblastic core covered syncytial layer.
- **secondary villus**
  - mesodermal cells penetrate primary villus
- **tertiary villus or definitive placental villus**
  - mesodermal cells differentiate into blood cells and small blood vessels
  - Capillaries in tertiary villi contact with capillaries in mesoderm of the chorionic plate and in the connecting stalk.



illus. **A.** Transver
covered by a layer
nesoderm covere
syncytium. **C.** Mes



- **Chorionic plate**
  - trophoblast and the extraembryonic mesoderm
- **Chorion**
  - chorionic plate and villi



- **Stem or anchoring villi**
  - from chorionic plate to decidua basalis
- **Free (terminal) villi**
  - branch from the sides of stem villi
- **Cytotrophoblast shell**
  - surrounding the trophoblast entirely and attaching the chorionic sac firmly to the decidua.
- **Intervillous lacuna filling with mother's blood cells.**
- **The embryo is suspended in chorionic cavity by body stalk.**

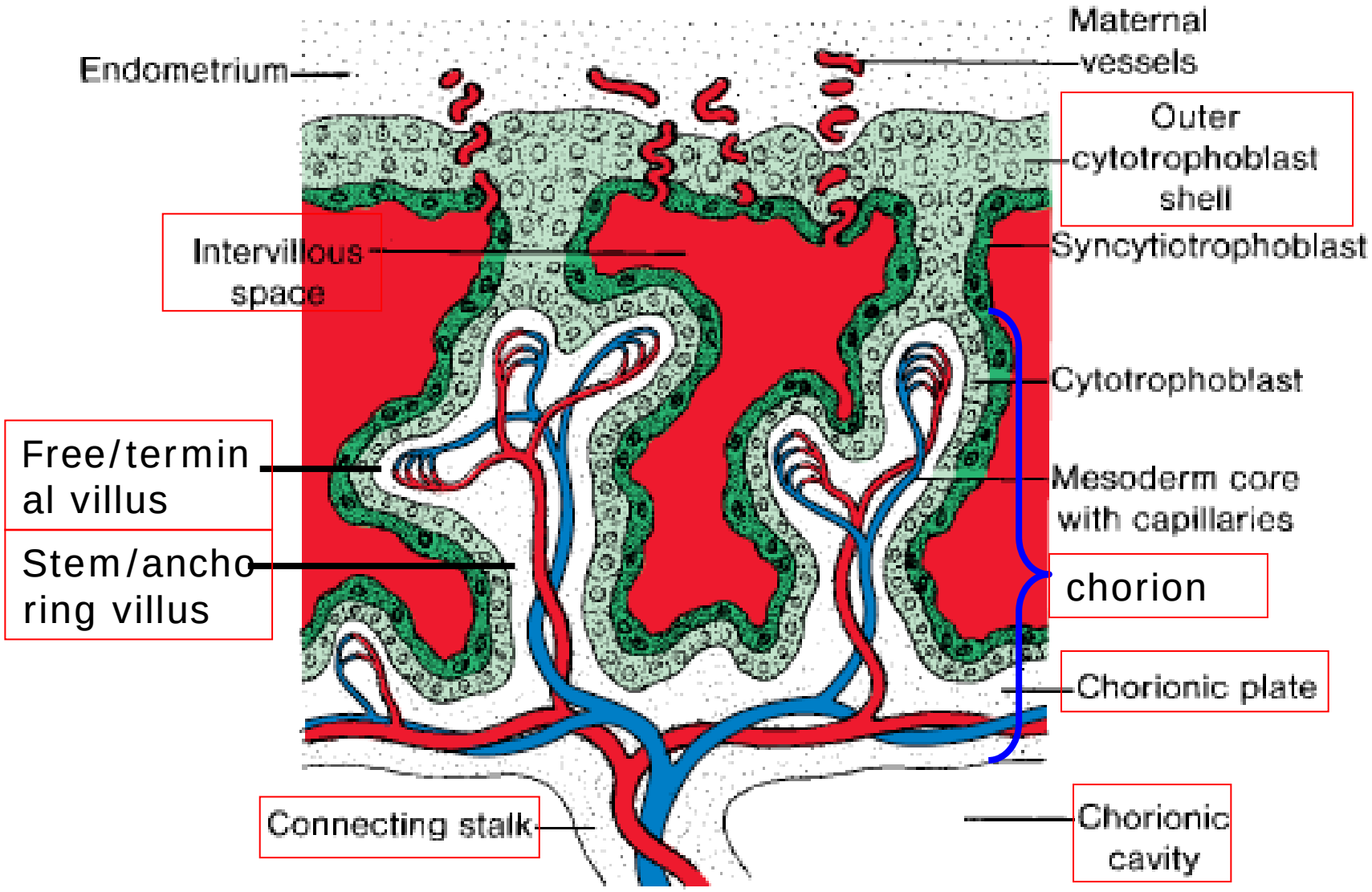


Figure 4.16 Longitudinal section through a villus at the end of the third week of development. Maternal vessels penetrate the cytotrophoblastic shell to enter intervillous spaces, which surround the villi. Capillaries in the villi are in contact with vessels in the chorionic plate and in the connecting stalk, which in turn are connected to intraembryonic vessels.

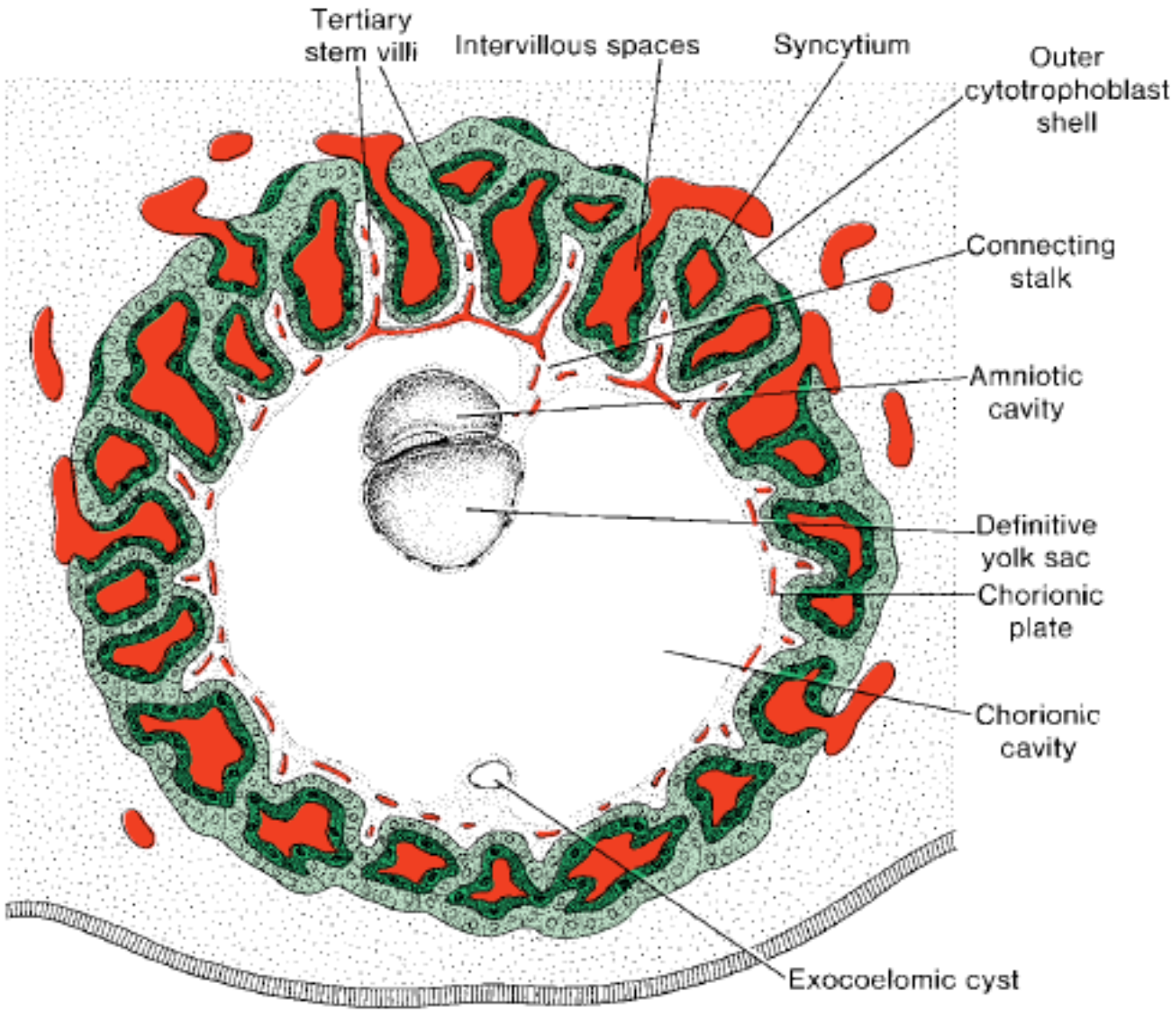
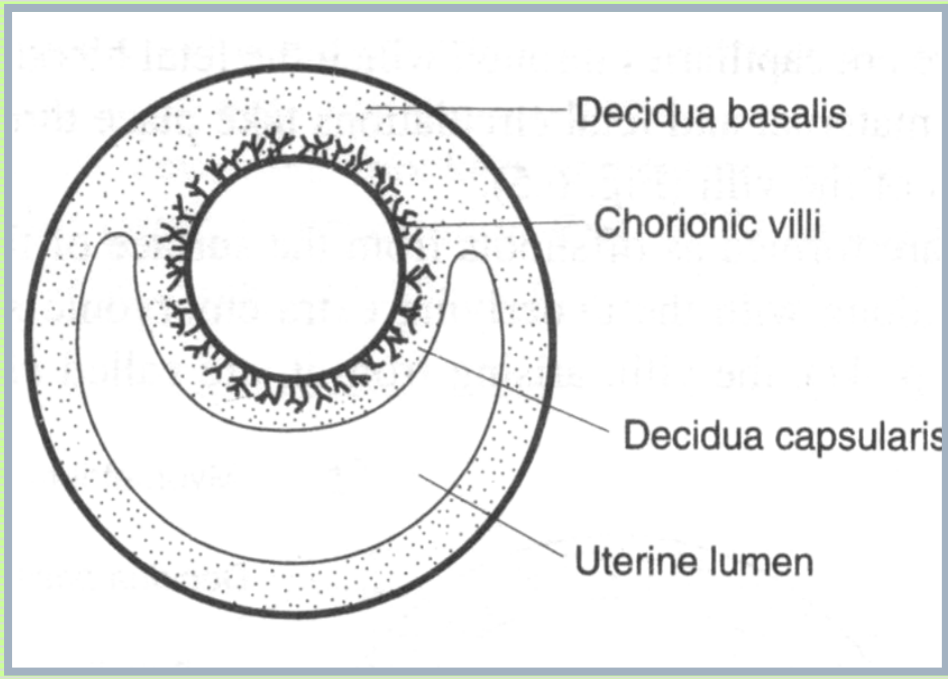
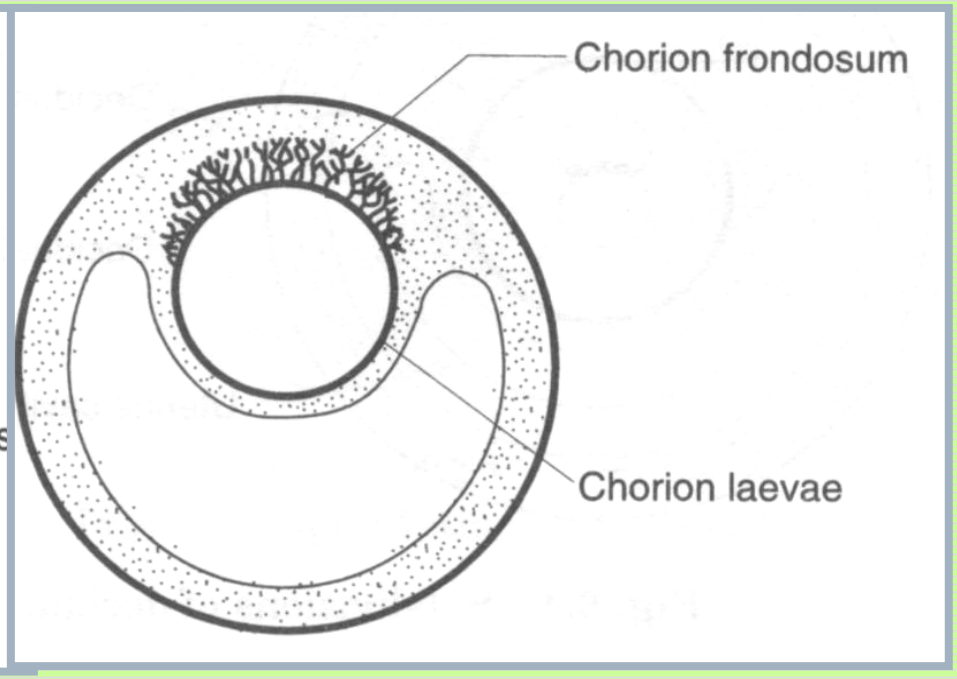
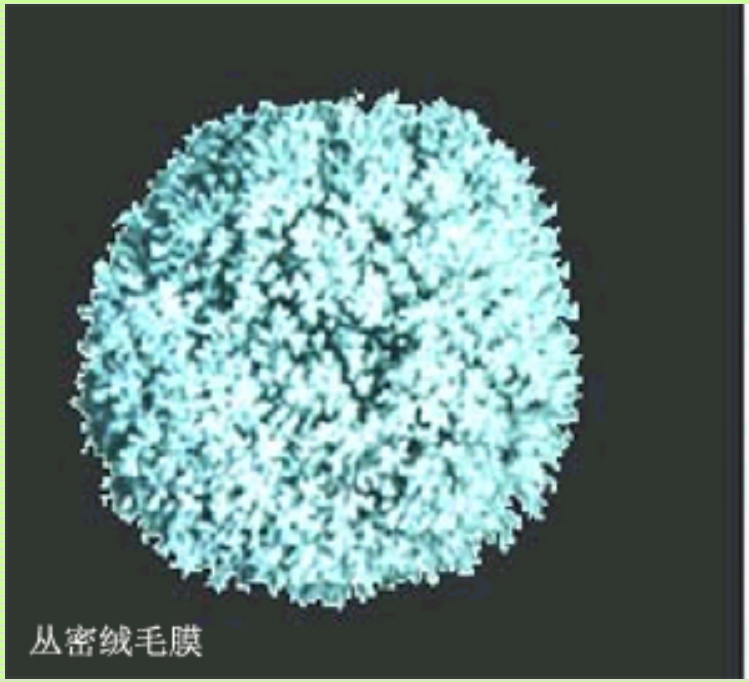


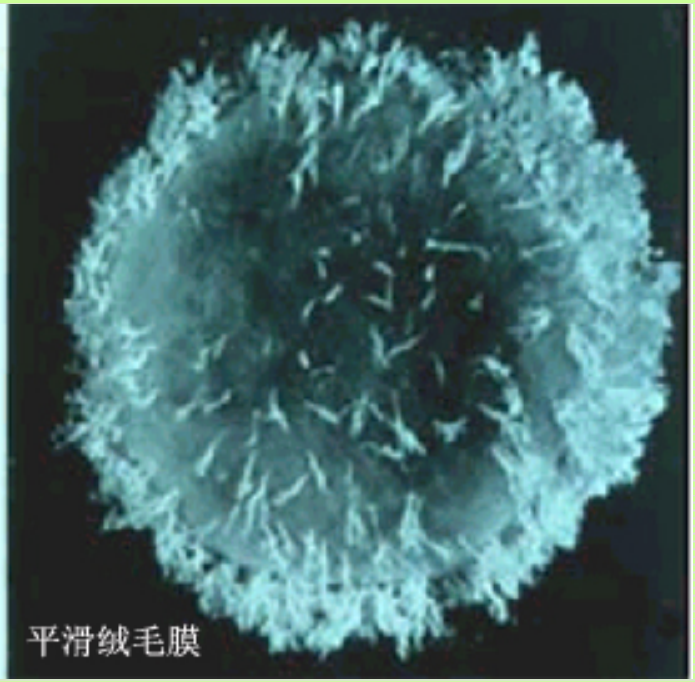
Figure 4.17 Presomite embryo and the trophoblast at the end of the third week. Tertiary and secondary stem villi give the trophoblast a characteristic radial appearance. Intervillous spaces, which are found throughout the trophoblast, are lined with syncytium. Cytotrophoblastic cells surround the trophoblast entirely and are in direct contact with the endometrium. The embryo is suspended in the chorionic cavity by means of the connecting stalk.

- After 6 weeks, the villi penetrating the decidua basalis grow densely
- Villous chorion or chorion frondosum.
- Smooth chorion or chorion laeve.



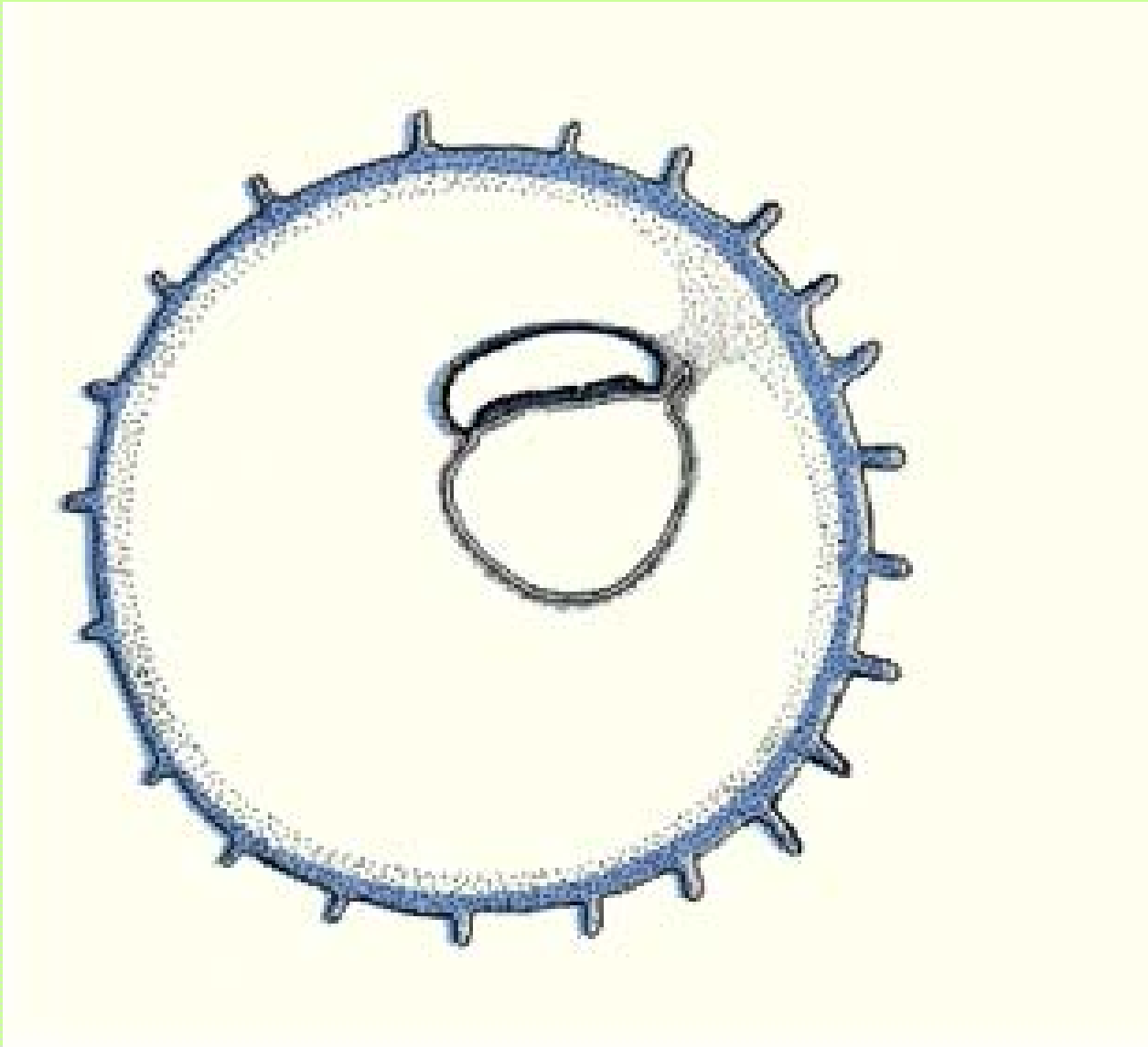






Villous chorion

Smooth chorion



Development of Chorion

Key points

- Concept, normal and abnormal site & phase of implantation
- Structure of decidua
- Structure of two-layered embryo
  - epiblast and hypoblast
- Structure of three-layered embryo
  - ectoderm, mesoderm and endoderm
- Reason of sacrococcygeal teratomas
- Function of notochord
- Structures of three types of villi
- Concept of chorionic plate, chorion, stem villus, free villus, cytotrophoblast shell, villous chorion, smooth chorion