Anatomy

Marrow Edition 8

MARROW

Instructions

- Notes are to be used in conjunction with Marrow videos.

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// ME821-PPL

Contents

Head and Neck

Upper Limb

Thorax

Abdomen

Lower Limb

General Anatomy

GAMETOGENESIS

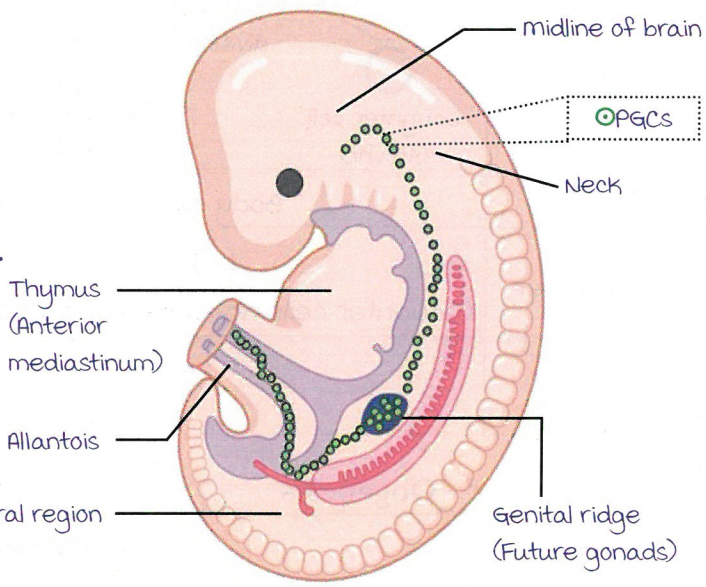
----- Active space -----

Basics

00:00:50

Primordial germ cell (PGC) :

- Pleuripotent cell.
- Gives origin to male & female gametes.
- Produced by cells of epiblast during 2nd week.
- Migrates to yolk sac by 4th week.
- Migrates to genital ridge (Gonads) by 5th week.



Embryo

Note :

- Pre-embryonic period : 0–2nd week.
- Embryonic period : 3rd–8th week.
- Fetal period : 9th week–birth.

Type of cell	Description	Example
Pleuripotent cell	Ability to form all germ layers.	Primordial Germ cell
Totipotent cell	Ability to form entire embryo & extraembryonic tissue.	Each cell (Up to 8 cell stage)
multipotent cell	Ability to form ≥ 1 category of cells.	Hematopoietic stem cells
Oligopotent cell	Can form 1 category of cells.	Vascular stem cells
Unipotent cell	Forms only 1 type of cells.	Hepatic cells

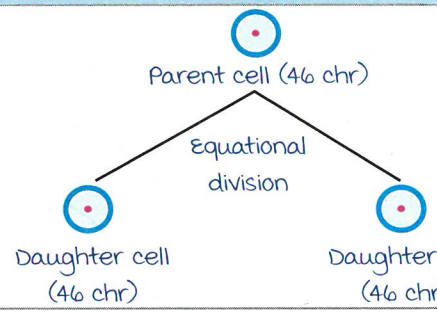
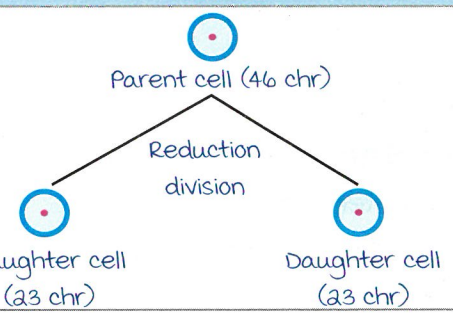
Applied Aspect :

- Craniopharyngeal teratoma : D/t abnormal migration of PGC to neck.
- Sacrococcygeal teratoma :
  - Causes :
    1. Abnormal migration of PGC to sacrum & coccyx.
    2. Persistence of primitive streak.


Sacrococcygeal teratoma

----- Active space -----

Mitosis v/s Meiosis

	Mitosis	Meiosis
Type of division		
Occurs in	Body cells	Germ cells
Crossing over	(–) (Daughter cells resemble parent cells).	(+) Exchange of chromosome material (Daughter cells dont resemble parent cells).
Age at occurrence		Female : Intrauterine life. Male : After puberty.

Oogenesis

00:12:15

PGC reaches ovary by 5th week.

↓

Oogonium

↓ Mitosis

All oogonia become 1° oocyte (By 5th–7th month)

↓ Enters meiosis I

Completes prophase

↓

Enters resting (Diplotene) phase and remains there until puberty.

↓

After puberty : 1° oocyte.

Meiosis I resumes

↓ ↓

2° oocyte — 1st polar body

↓ Enters meiosis II

Completes prophase & metaphase

↓

Arrested in metaphase for 24 hours

↓

Ovulation : Graafian follicle ruptures to release 2° oocyte.

↓

Sperm entry within 24 hours of metaphase arrest.

⊕ ⊖

2° oocyte completes meiosis II — Corpus luteum formed from the ruptured graafian follicle.

↓ ↓ ↓

Ovum — 2nd polar body — Persists for 14 days.

Sperm → Fertilization ↓

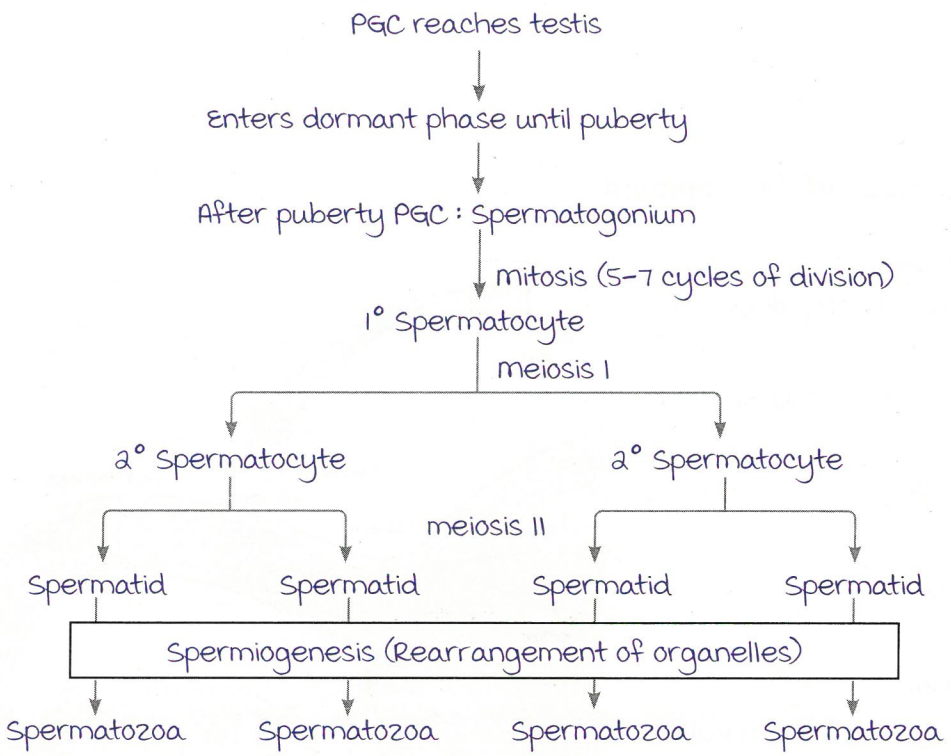
Zygote (Fertilized egg) — Shrinks to form white scar (Corpus albicans).

Polar body :

- Cells without cytoplasm.
- D/t unequal division of cytoplasm.

Spermatogenesis

00:22:02 ----- Active space -----



- Site of meiosis in males : Seminiferous tubules.
- Site of maturation of sperm : Epididymis.
- Site of capacitation (Conditioning) of sperm : Female genital tract (in 6-8 hrs).

Differences between spermatogenesis & oogenesis :

	Spermatogenesis	Oogenesis
Process begins	At puberty	In intrauterine life
Polar body formation	Absent	Present
Gametes formed	1 primary spermatocyte ↓ 4 Spermatids.	1 primary oocyte ↓ Ovum.

High Yield Points :

1. Spermatogenesis completed in 74 days > 64 days > 60 days.
2. 2° oocyte in metaphase arrest for 24 hrs.
3. Viability of sperm in female genital tract for 48 hrs.
4. Most fertile period : 2 days before ovulation till 1 day after ovulation.
5. Indicators of ovulation :
   a. LH surge : Occurs 36 hrs before ovulation
   b. LH peak : Occurs 12 hrs before ovulation > at the time of ovulation.

----- Active space -----

1ST AND 2ND WEEK OF DEVELOPMENT

1st week of development

00:00:16

Stages :

Day 0 : Fertilization (In ampulla).

↓

12–24 hr after ovulation : Zygote

↓

Day 1 : 2 cell

↓

4 cell

↓

Day 3 : 8 cell

↓

16 cell

} Morula (16 > 8 cells)

↓

Day 4 : 32 cell – Advanced morula. (Enters uterine cavity).

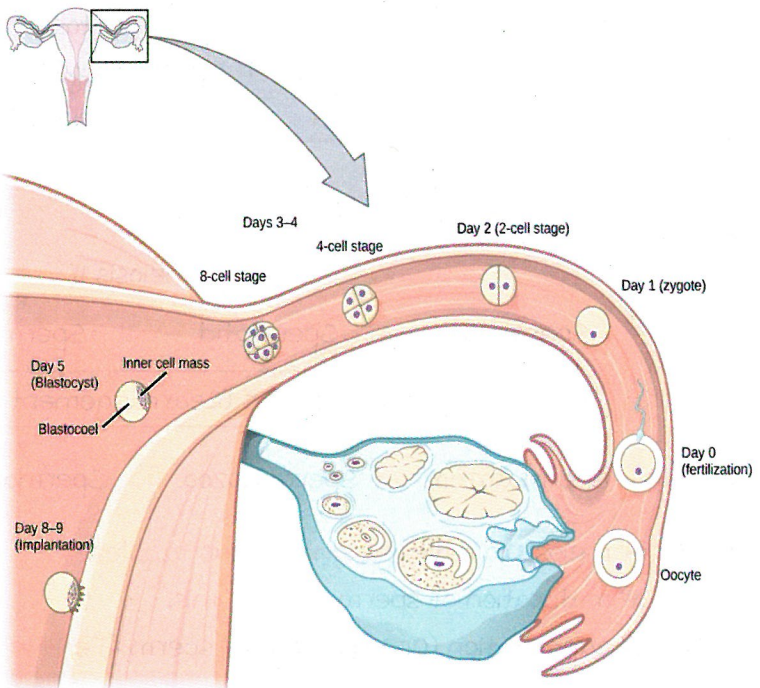
↓

Uterine fluid enters advanced morula.

↓ Forms

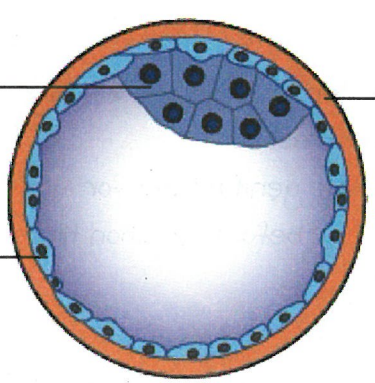
Day 4–5 : Blastocyst. → Day 6–7 : Implantation.

- Blastocyst is implanted in endometrium.
- Ends by day 10–11.
- Bleeding d/t erosion of endometrium (Hartman sign).



Stages of fertilization

Blastocyst :



Embryoblast :
- Inner cell mass
- Forms embryo.

Trophoblast :
- Outer cell mass
- Forms placenta.

Zona pellucida :
- Prevents implantation & polyspermy.
- Disappears by day 5.

USG :

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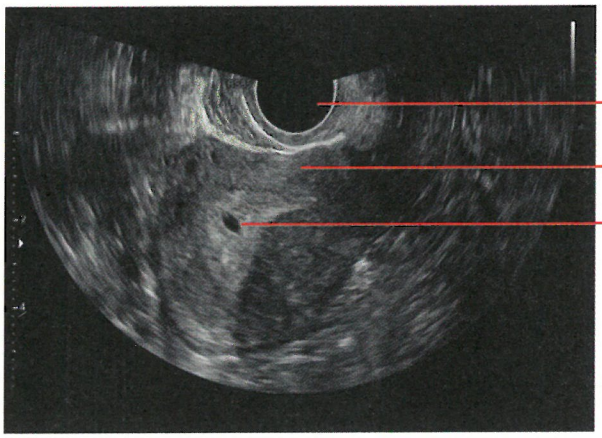


Endometrial cavity

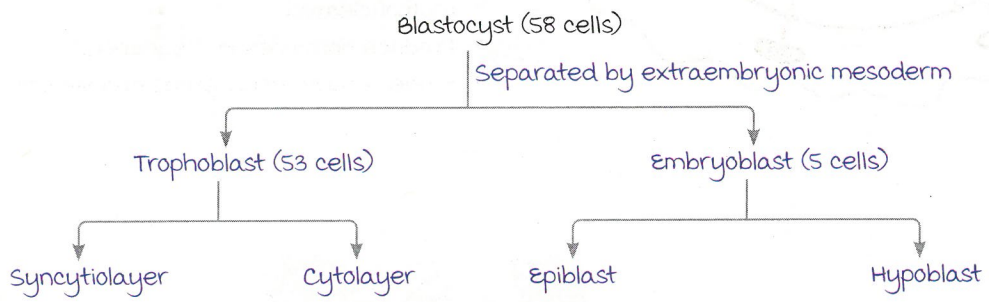
Decidua (Endometrium in pregnancy)

Gestational sac (Blastocyst) :

- Intradecidual sign.
- Implanted in deep layer of decidua.

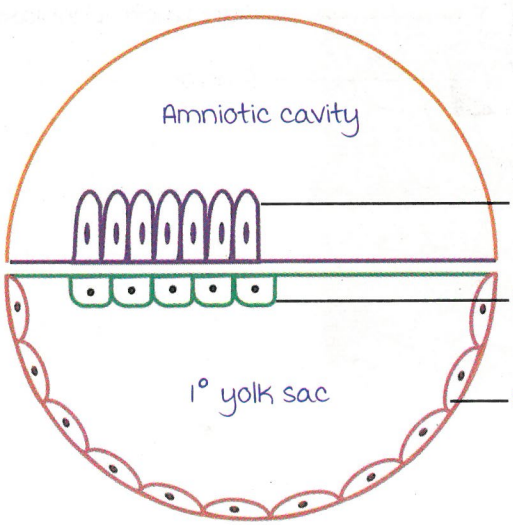
Second week of development

00:13:15



CELLS :

Embryoblast :



Epiblast: Column cells. (Dorsal aspect)

Hypoblast : Cuboidal cells. (Ventral aspect)

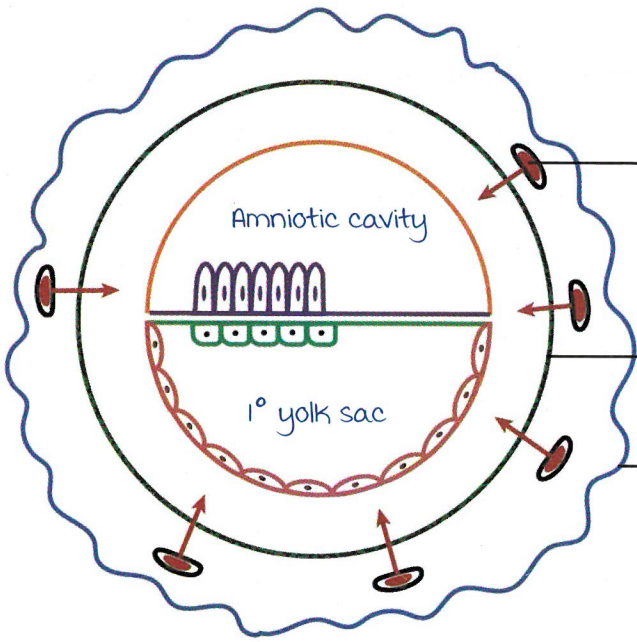
Exocoelomic membrane : Squamous cells.

Double bubble/double bleb sign :

- D/t → Amniotic cavity.
  → 1° yolk sac.

----- Active space -----

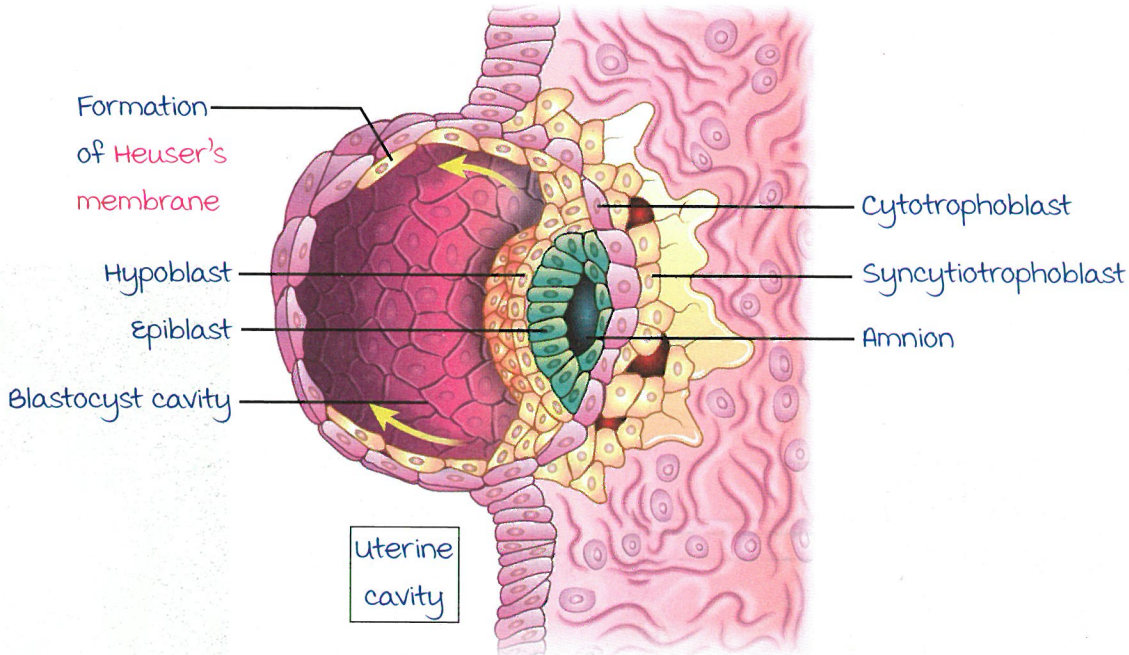
Trophoblast :



Lacunae filled with blood :
- Blood diffuses into embryoblast. → Uteroplacental circulation established by day 15.

Cytotrophoblast :
- Well defined cell membrane+

Syncytiotrophoblast :
- Cell wall absent.
- Multinucleated.
- Produce hormones in pregnancy.
- Erodes endometrial glands and vessels.



Extraembryonic mesoderm :

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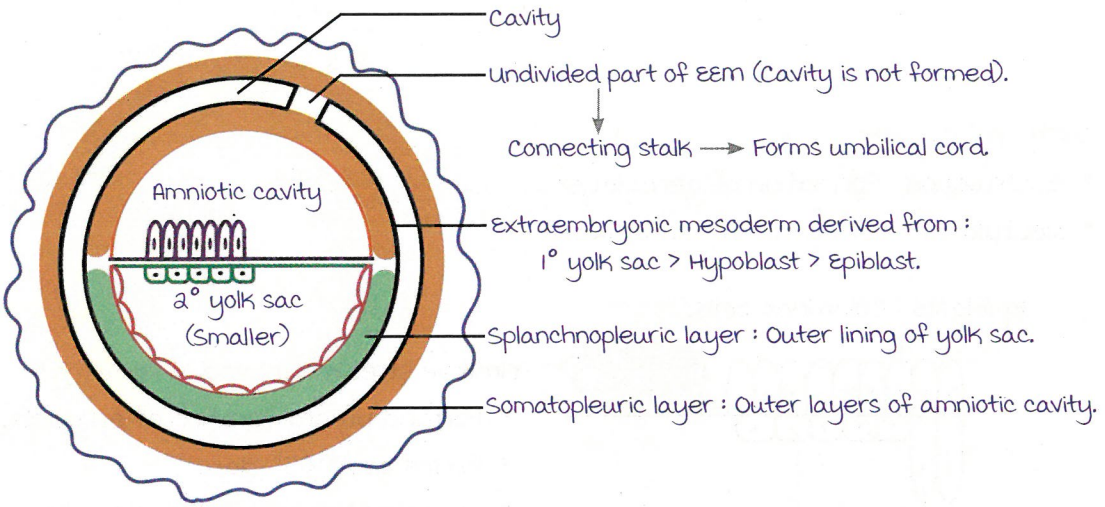


HCG :

Produced by : Syncytiotrophoblast.

Function : stimulates production of progesterone (Essential to maintain pregnancy).

Assay :

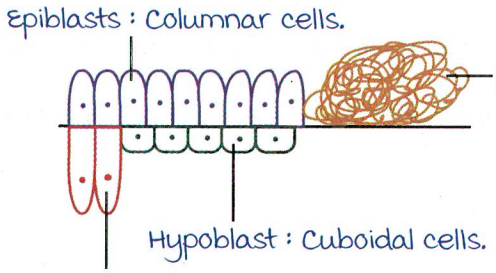
- Sample → Maternal blood : By 8th day. } Or 1st day of missed period.
  Maternal urine : By 9-10th day. }
- Doubling → Normal intrauterine pregnancy : Every 48h.
  Ectopic pregnancy : Absent (↑ but doesn't double).
- Critical value : 2000 IU. → Normal intrauterine pregnancy : Gestational sac visible.
  Ectopic pregnancy : Gestational sac absent.

----- Active space -----

3RD WEEK DEVELOPMENT

Events in 3rd week :

- Gastrulation : Formation of germ layers.
- Neurulation : Formation of neural tube.



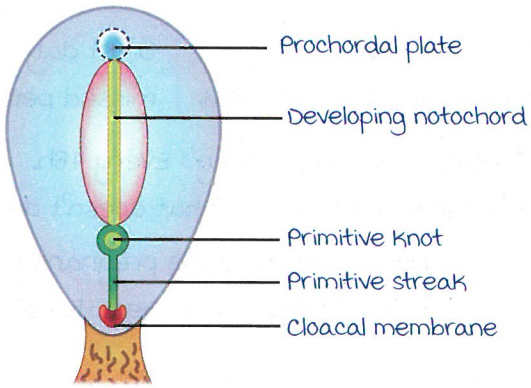
Primitive streak (Tail end of embryo) :

- Formed by proliferation of epiblasts.
- Forms at 14th/15th day.
- Indicates beginning of gastrulation.

Prechordal plate (Indicates future head end) : Columnar hypoblast cells.

↓ Forms

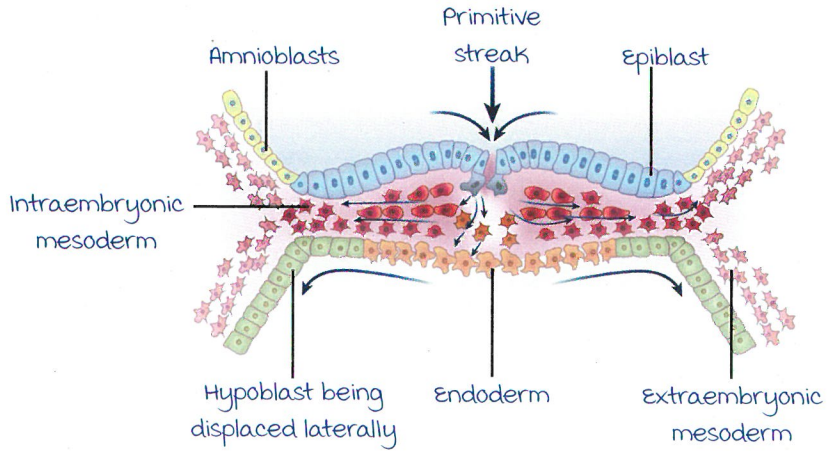
Oro/buccopharyngeal membrane —(Ruptures & forms)→ Oral cavity.



Gastrulation

00:04:55

- Formation of germ layers.
- Occurs in 3rd week in cranio-caudal sequence.
- All germ layers are derived from epiblast.



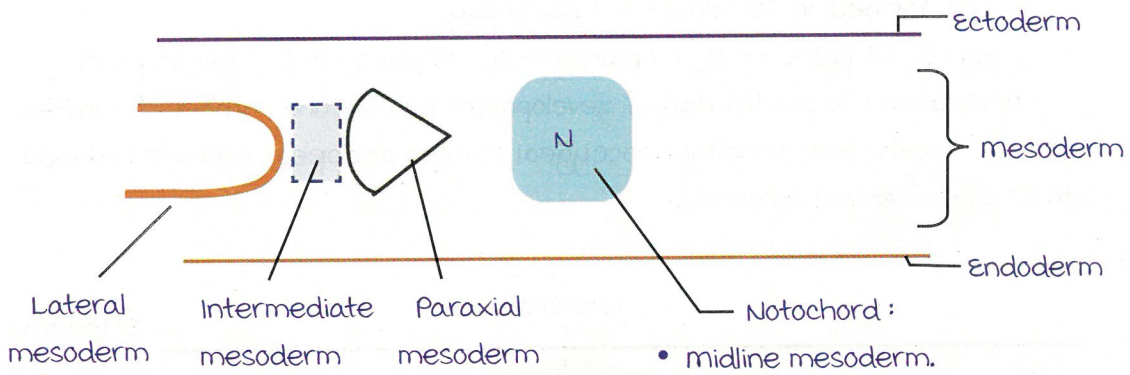
Germ layers

----- Active space -----

Endoderm :
- 1st germ layer to be formed.
- Develops from epiblasts.
- Replaces all hypoblasts.

mesoderm :
- 2nd germ layer to be formed.
- Develops from primitive streak. (Epiblasts)

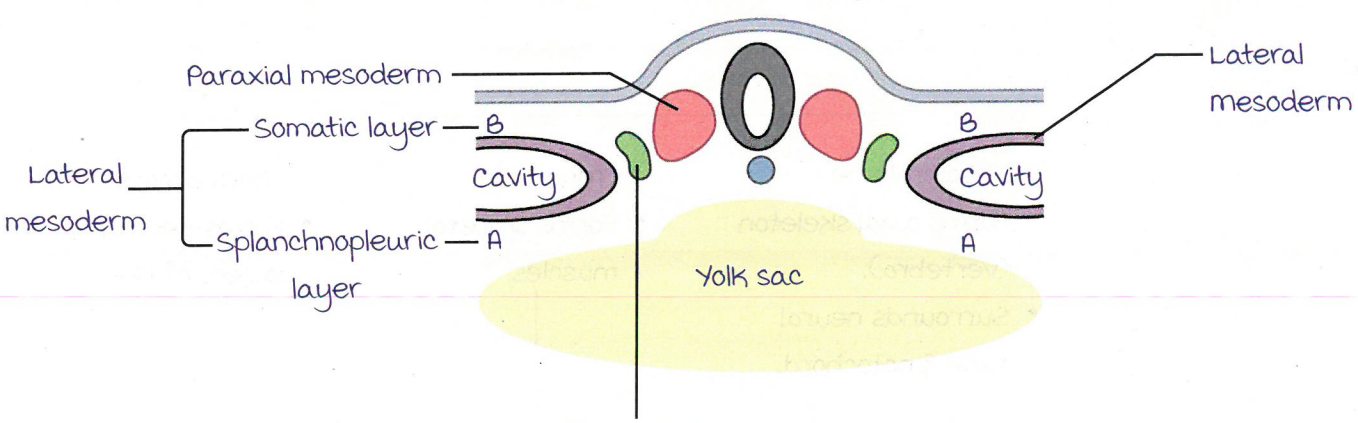
Ectoderm :
- Last germ layer to be formed.
- Develops from remains of epiblast.



- midline mesoderm.
- Derived from primitive streak (Epiblast).
- Disappears and forms :
  - Nucleus pulposus > Apical ligament of Dens.

Applied aspect :
- Persistence of notochord → Chordoma (Congenital tumor).

MESODERM



Intermediate mesoderm :
- Forms urogenital system :
  - Kidney.
  - Gonads.
  - mesonephric duct.
  - Para mesonephric duct.

----- Active space -----

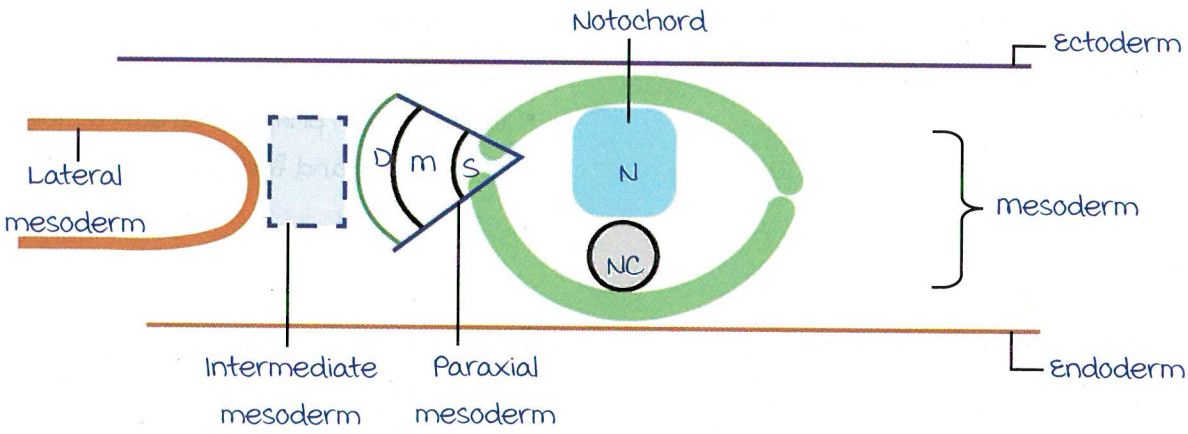
Paraxial mesoderm :

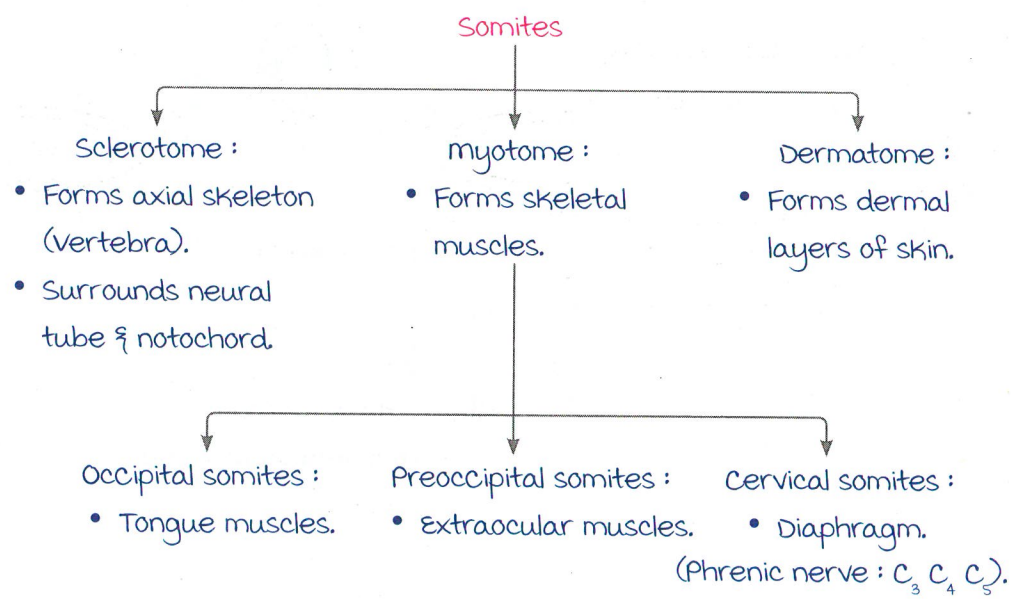
Forms somites in cranio-caudal sequence.

Somites :

- Sequence of formation :
  - Occipital → Cervical → Thoracic → Lumbar → Sacral → Coccygeal.
- Somatic period : 20th day – 35th day/5th week.
  - 1st pair formed on 20th day → 3 pairs/day.
    E.g : D_{a1} : 4 pairs → D_{a2} : 7 pairs → D_{a3} : 10 pairs → D_{35} : 42–44 pairs.
  - Application : To predict day of development by counting number of somites.
- After 5th week : Few occipital & coccygeal somites disappear and are reduced to 37 pairs (Remain constant).

Subdivisions :





----- Active space -----

Lateral mesoderm :

Cavity : Forms body cavities (Pericardial, Pleural, Peritoneal).

Divided by cavity into :

Splanchnopleuric layer/Cardiogenic layer :

Forms :

1. Splanchnopleuric layer of body cavities.
2. Cardiac muscle & smooth muscles.
3. Heart tube.

Somatic layer :

Forms :

1. Somatic layer of body cavities.
2. Appendicular skeleton :
   - Upper limb/lower limb bones.

Note :

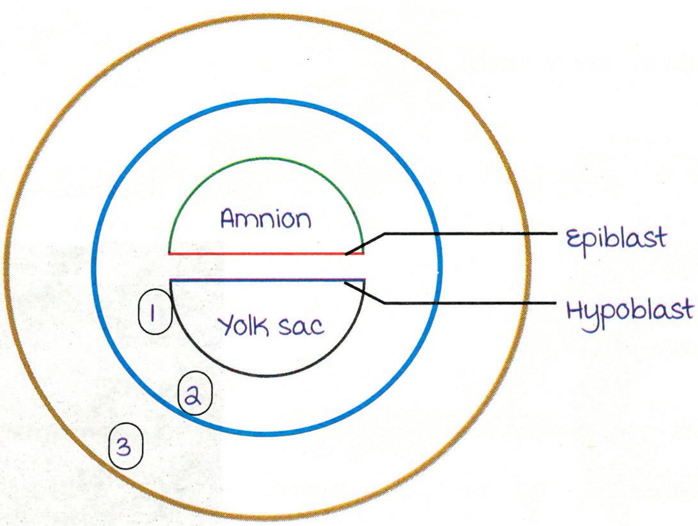
- Heart beat : Starts by 21st day.
- Cardiac activity : Visible on USG by 6th–7th week.

Development of Placenta

00:27:32

Develops from both maternal and fetal contribution.

Chorion :



1. Extraembryonic mesoderm
2. Cytotrophoblast
3. Syncytiotrophoblast

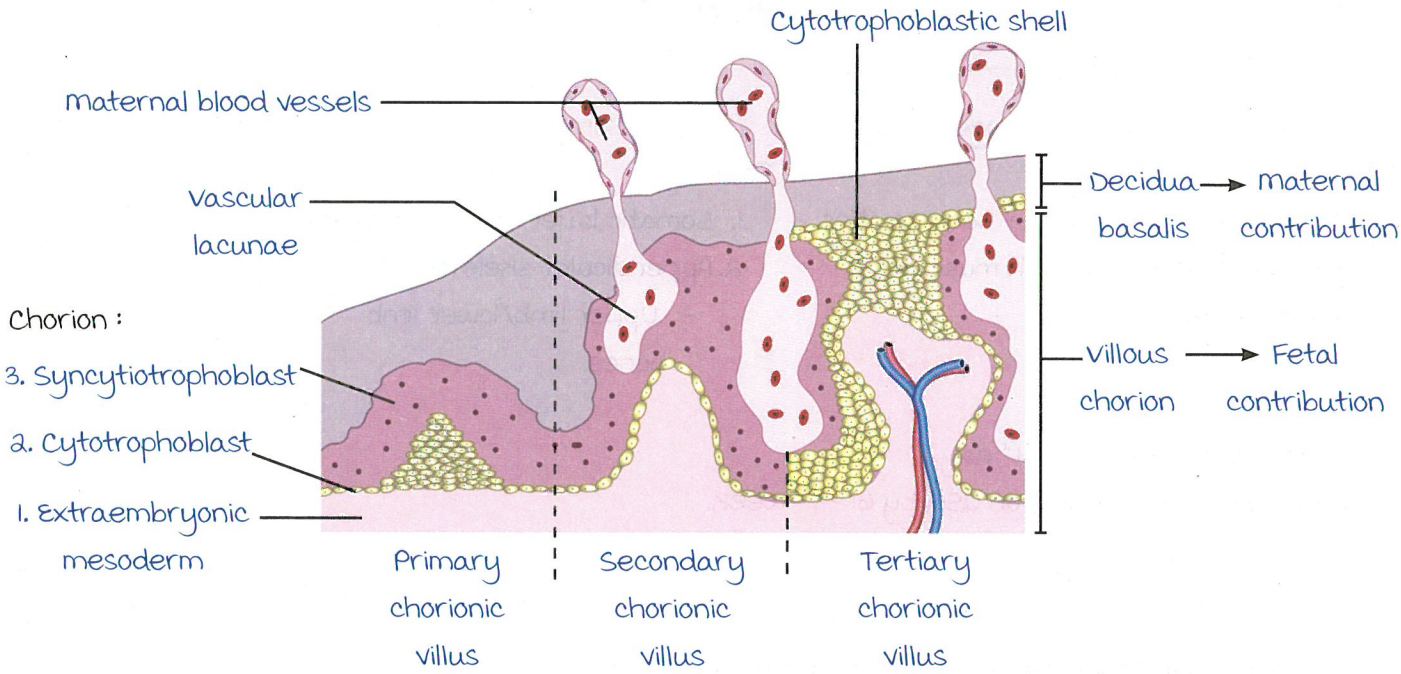
+ Blood vessels

- Cytotrophoblast + Syncytiotrophoblast → 1° Chorionic villus
- Extraembryonic mesoderm + 1° Chorionic villus → 2° Chorionic villus
- 2° Chorionic villus + Blood vessels → 3° Chorionic villus

----- Active space -----

Chorionic villi :

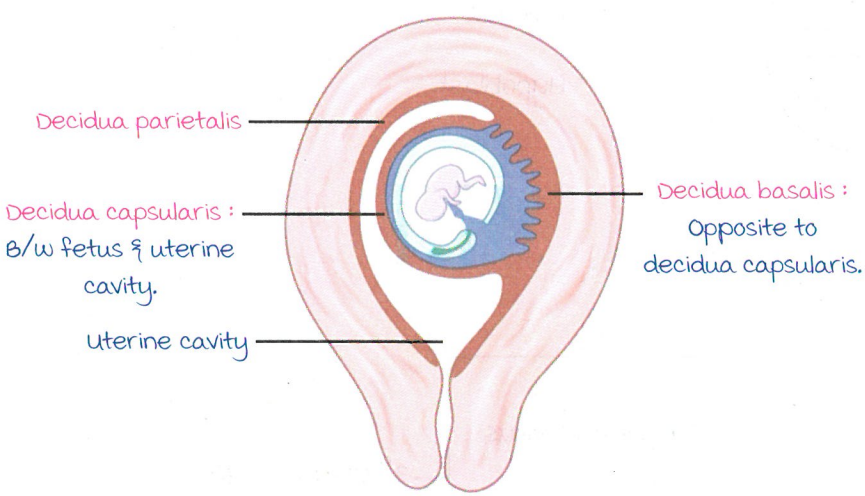
- Finger like projections.
- Fetal contribution of placenta.



Decidua :

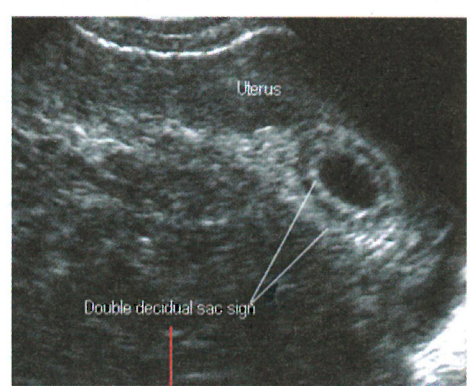
Endometrium during pregnancy.

Parts :



USG :

Double decidual sac sign :



2 concentric rings :

- Inner : Decidua capsularis.
- Outer : Decidua parietalis.

HISTOLOGY : PART 1

----- Active space -----

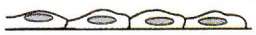
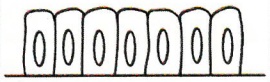
Epithelium

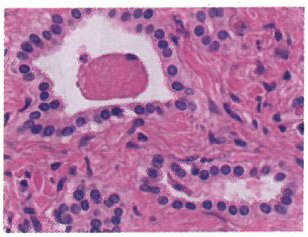
00:00:17

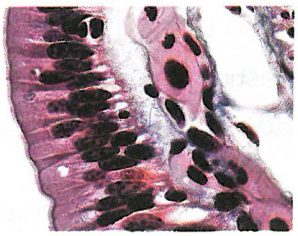
TYPES

- Simple (One layer)
- Compound (multiple layers)

Simple epithelium :

Features	Simple squamous	Simple cuboidal	Simple columnar
Length : Breadth of cell	 Length < Breadth	 Length = Breadth	 Length > Breadth
Nucleus	Flat	Round	Elongated
Function	Exchange	Secretion	Secretion
Seen in	(Mnemonic : 3BA) Bowman's capsule Blood vessel Body cavities Alveoli	(Mnemonic : TOK) Thyroid follicles Germinal epithelium of ovary Tubules of Kidney	Stomach Large intestine Uterus


Simple cuboidal epithelium


Simple columnar epithelium

Pseudostratified epithelium :

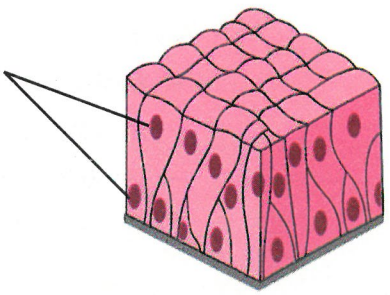
Single layer of cells with nuclei arranged at different levels

↓

Appears stratified (Pseudostratified)

Pseudostratified ciliated columnar :

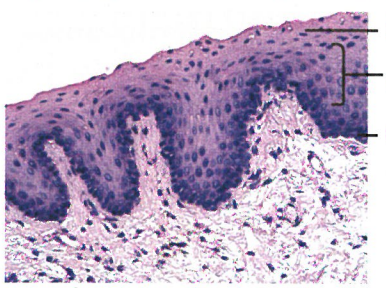
Seen in → Trachea, Bronchus


Pseudostratified epithelium

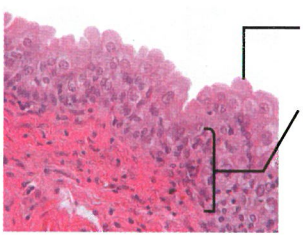
----- Active space -----

Compound/stratified epithelium :

Features	Stratified squamous	Stratified cuboidal	Stratified columnar	Transitional/ Urothelial cells
Apical layer	Squamous	Cuboidal	Columnar	Umbrella/inverted 'U' shaped cells
Intermediate layer	Polygonal cells			
Basal layer	Columnar cells			
Seen in	• Skin • Tongue • Tonsils • Esophagus • Lower part of anal canal • Vagina	Ducts of : • Exocrine glands • Sweat glands	Membranous & penile urethra	• Ureter • Urinary bladder • Prostatic urethra



Stratified squamous epithelium

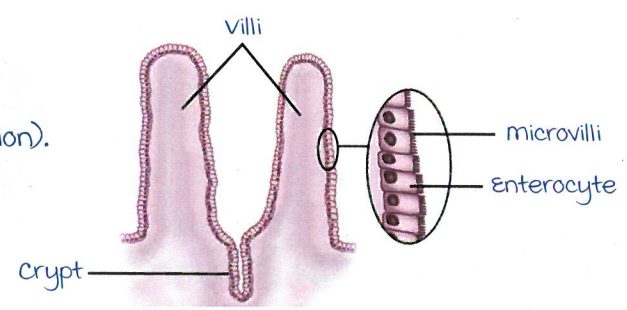


Transitional epithelium

SURFACE PROJECTIONS

Microvilli :

- ↑es surface area.
- Seen in :
  - Small intestine (Absorption).
  - Gall bladder (Storage).



Lumen of small intestine

Cilia :

Function : Motility.

a. Simple ciliated columnar :

- Seen in :
  - Eustachian tube.
  - Middle ear.
  - Ventricles of brain.
  - Fallopian tube.