
# ANATOMY

ED.08

# GAMETOGENESIS

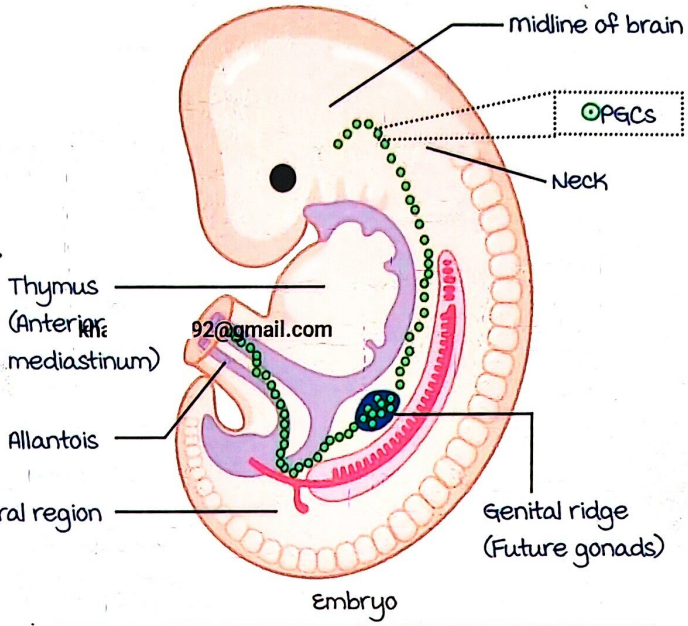
----- Active space ----

## 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

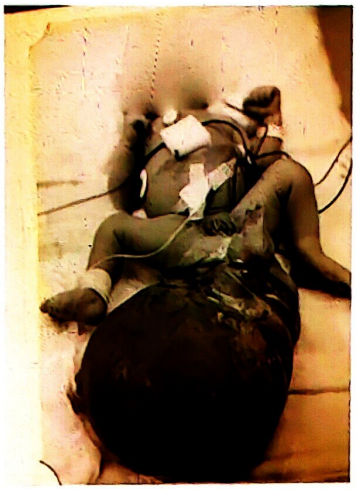
Note :

- 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

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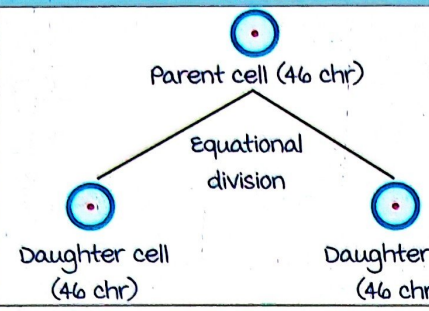
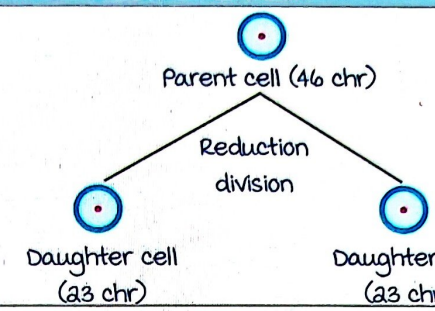
## Mitosis v/s Meiosis

| | Mitosis | Meiosis |
|---|---|---|
| Type of division |   |   |
| Occurs in | Body cells | Germ cells |
| Crossing over | (–)<br>(Daughter cells resemble parent cells). | (+) Exchange of chromosome material<br>(Daughter cells dont resemble parent cells). |
| Age at occurrence | | Female : Intrauterine life.<br>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 if 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

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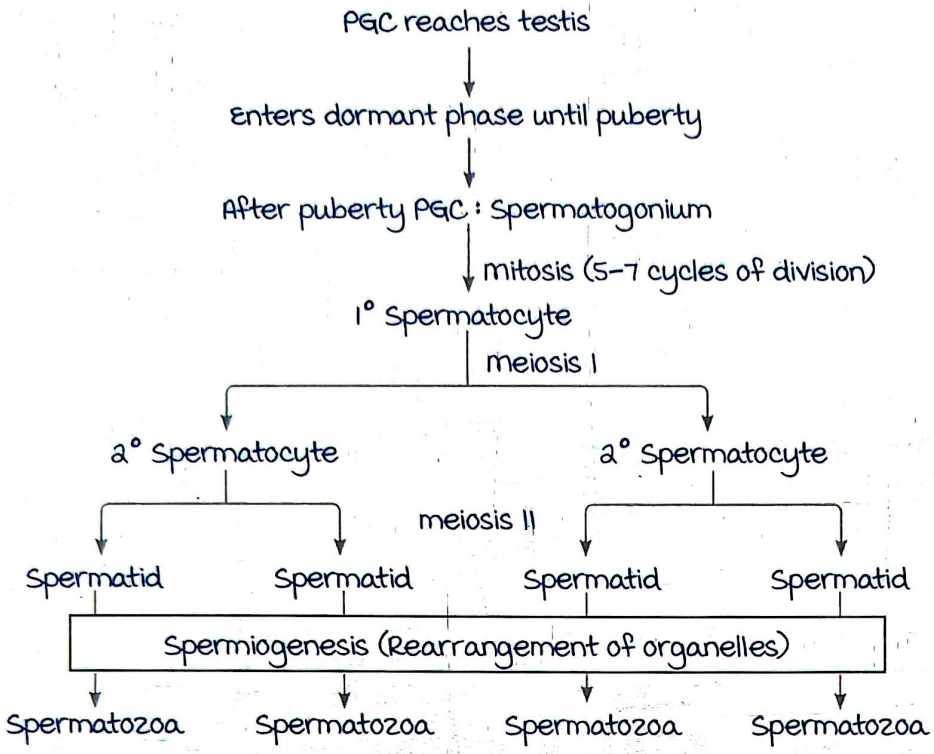




- Site of meiosis in males : Seminiferous tubules.
- Site of maturation of sperm : Epididymis.
- Site of capacitation (Conditioning) of sperm : Female genital tract (in 6-8 hrs).

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 arrests 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.

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# 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).

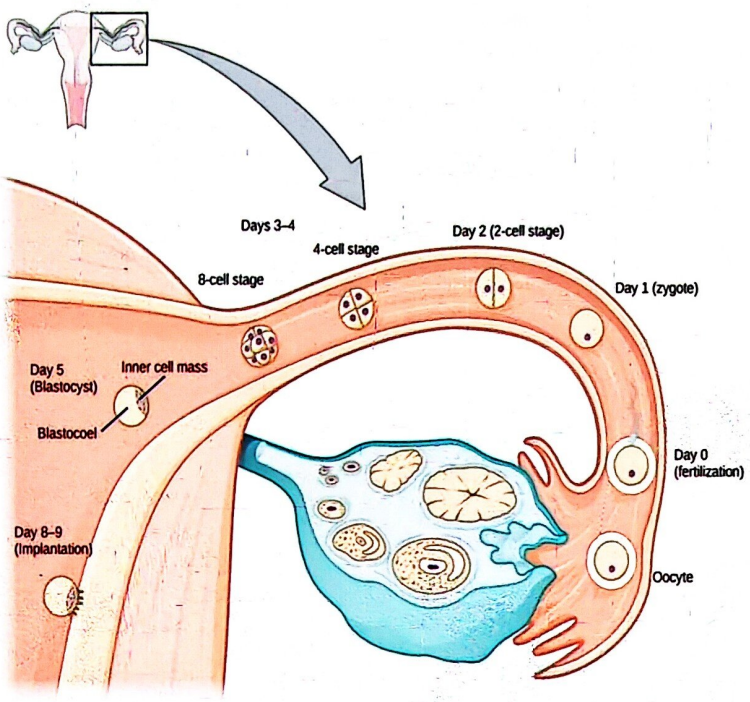
↓

Uterine fluid enters advanced morula.

↓ Forms

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

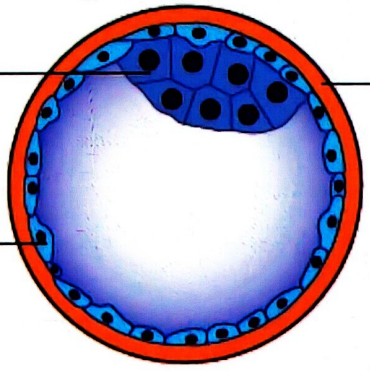
- Blastocyst is implanted in endometrium.
- Ends by day 10-11.
- Bleeding d/t erosion of endometrium (Hartman sign).




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.



Feedback

USG :

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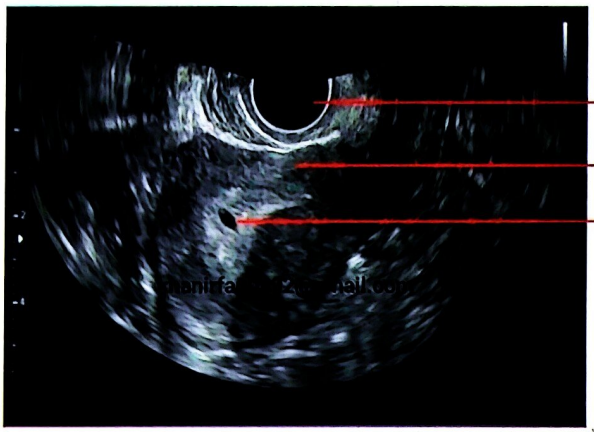


Endometrial cavity

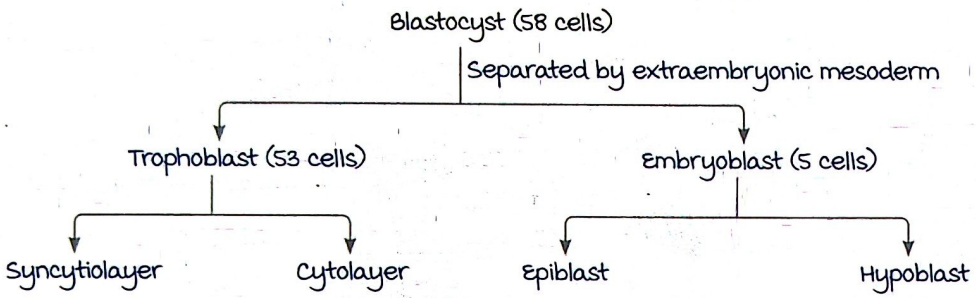
Decidua (Endometrium in pregnancy)

Gestational sac (Blastocyst) :

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

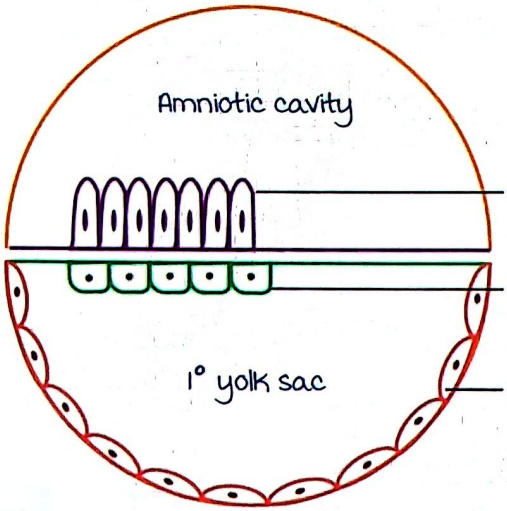
## Second week of development

00:13:15




CELLS :

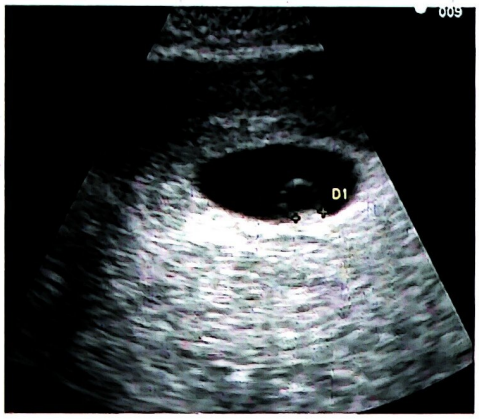
Embryoblast :




Epiblast: Column cells. (Dorsal aspect)

Hypoblast : Cuboidal cells. (Ventral aspect)

Exocoelomic membrane : Squamous cells.



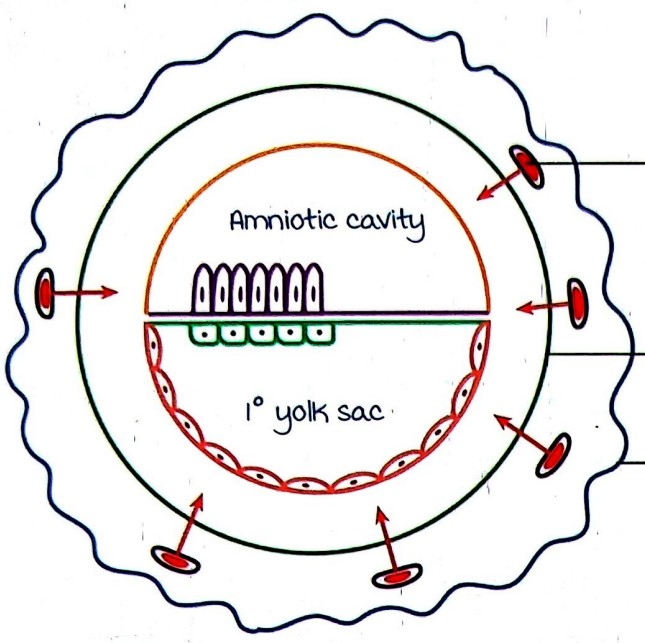

Double bubble/double bleb sign :

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

Feedback

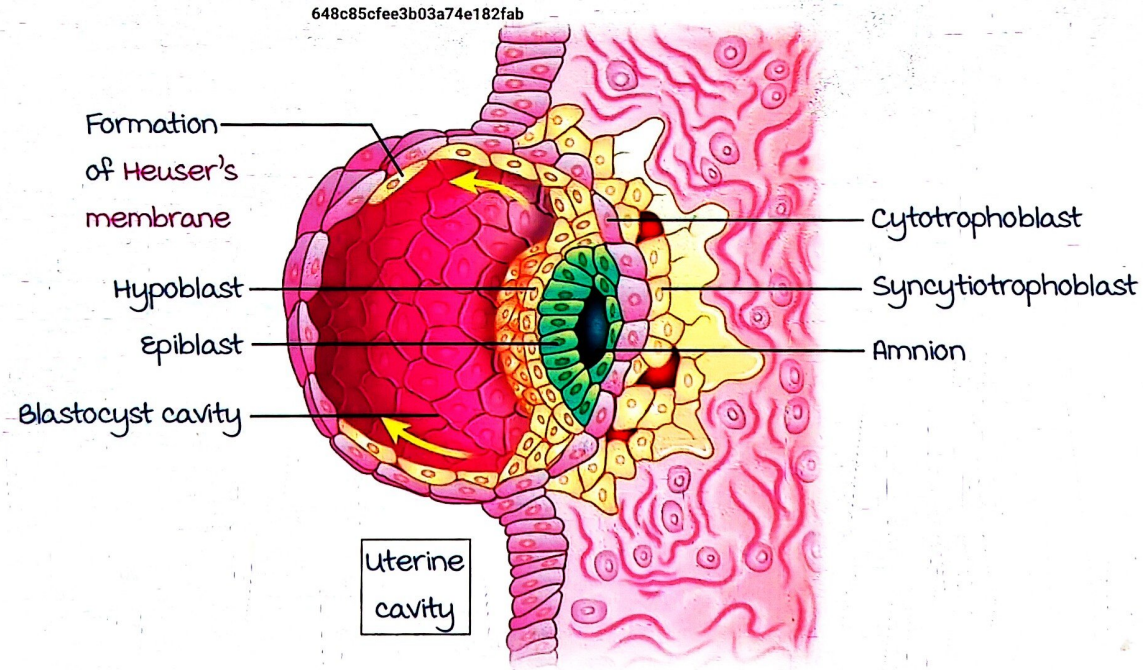
----- Active space -----

## 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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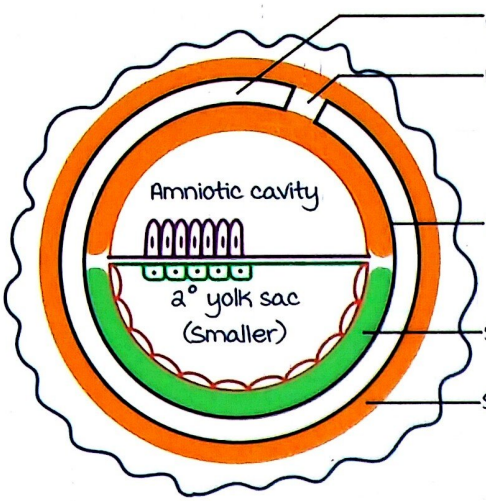



Cavity

Undivided part of EEM (Cavity is not formed).

Connecting stalk → Forms umbilical cord.

Extraembryonic mesoderm derived from :
1° yolk sac > Hypoblast > Epiblast.

Splanchnopleuric layer : Outer lining of yolk sac.

Somatopleuric layer : Outer layers of amniotic cavity.

## HCG :

Produced by : Syncytiotrophoblast.

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

Assay :

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

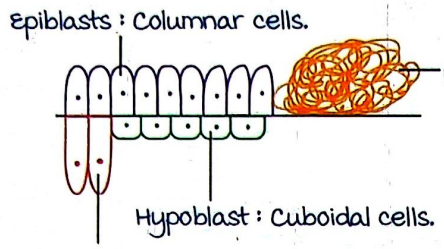
Feedback

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

# 3RD WEEK DEVELOPMENT

**Events in 3rd week :**

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



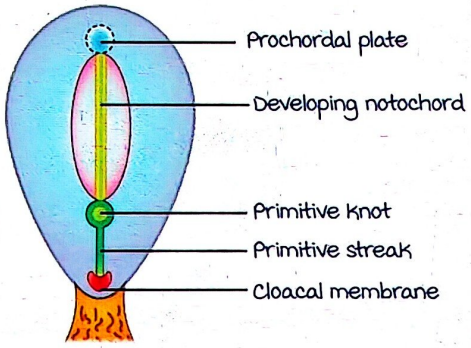

Primitive streak (Tail end of embryo) :

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

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

↓ Forms

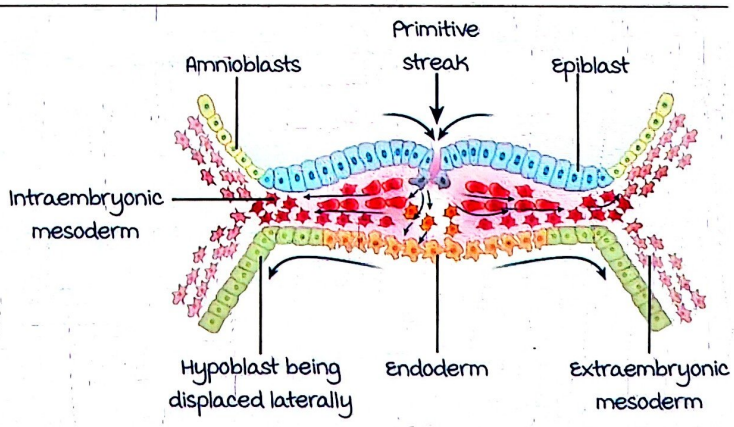
Oro/buccopharyngeal membrane → (Ruptures & forms) → Oral cavity.




## 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

- Endoderm : 1st germ layer to be formed.
- Mesoderm : 2nd germ layer to be formed.
- Ectoderm : Last germ layer to be formed.

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

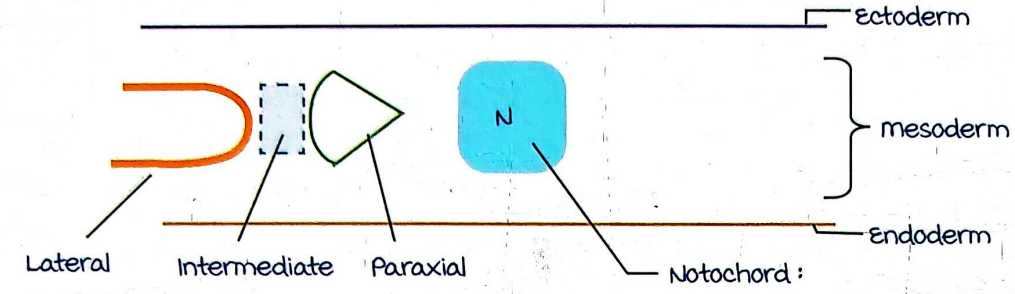
Feedback

Germ layers

**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.

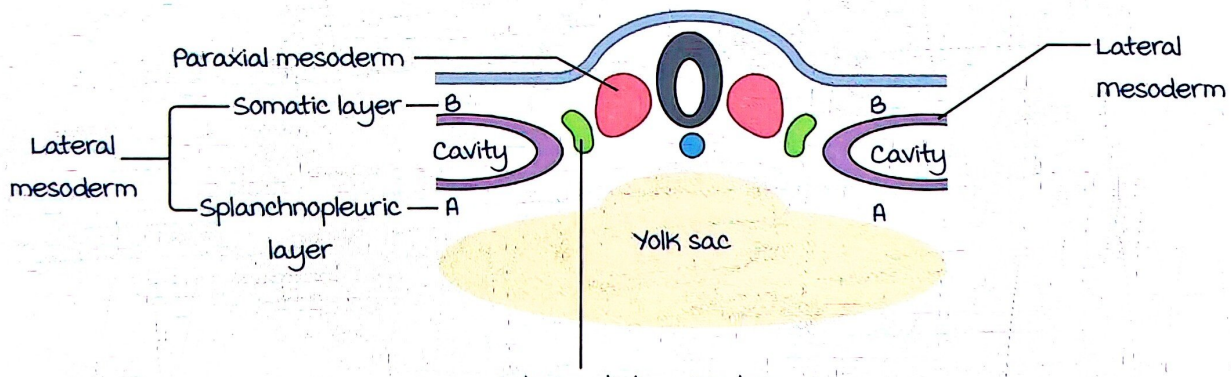



- Midline mesoderm.
- Derived from primitive streak (Epiblast).
- Disappears and forms :
  - Nucleus pulposus > Apical ligament of Dens.



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

## MESODERM




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







**Paraxial mesoderm :**

Forms somites in cranio-caudal sequence.

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

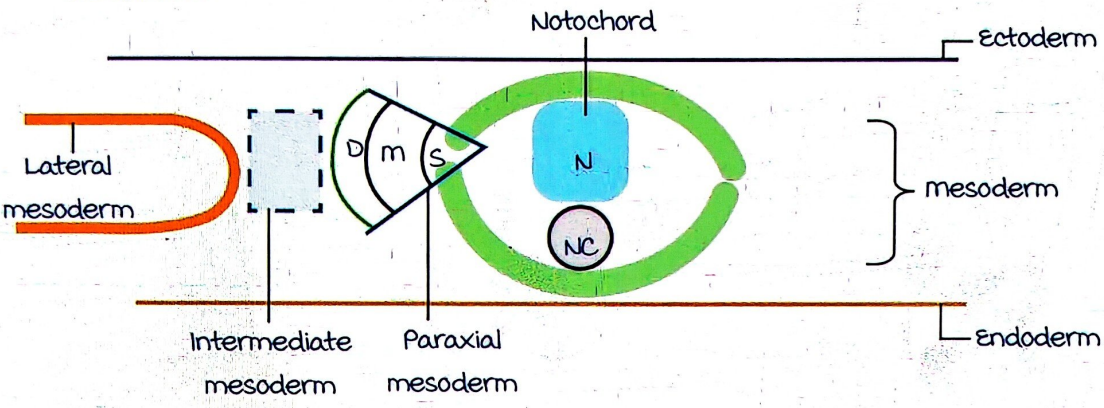
## Paraxial mesoderm :

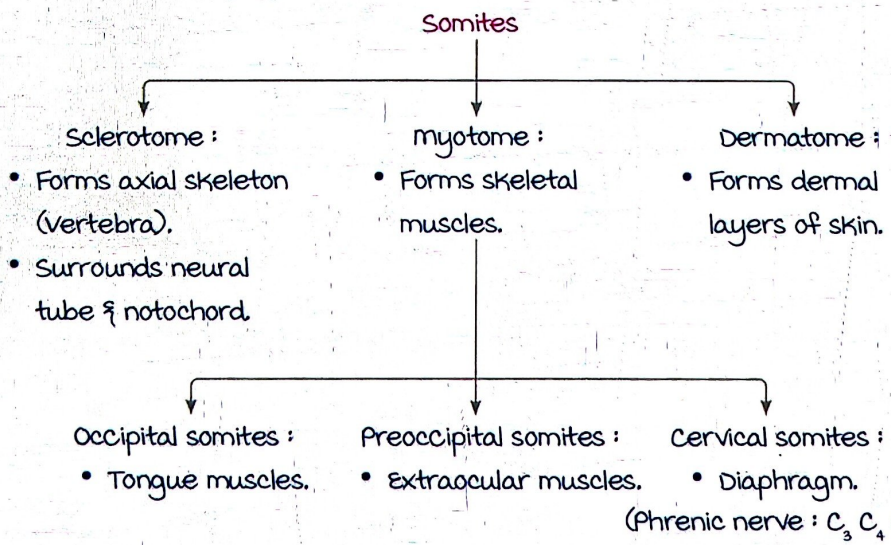
Forms somites in cranio-caudal sequence.

Somites :

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

Subdivisions :










## Lateral mesoderm :

## 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 :

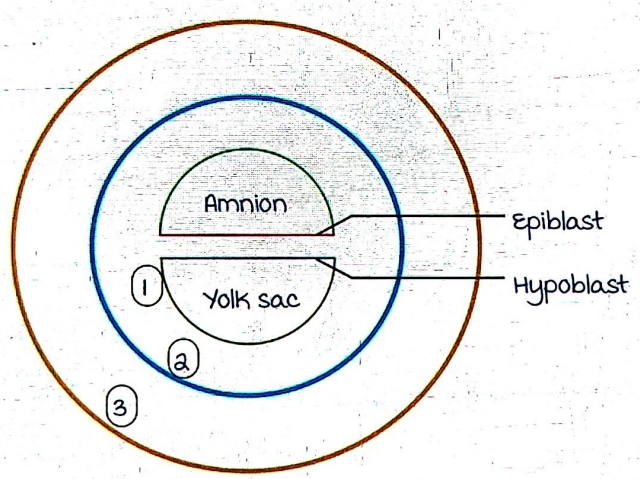
- Heart beat : Starts by 21st day.
- Cardiac activity : Visible on USG by 6th–7th week.

## Development of Placenta

00:27:32

Develops from both maternal and fetal contribution.

**Chorion :**




1. Extraembryonic mesoderm
2. Cytotrophoblast
3. Syncytiotrophoblast

\+ Blood vessels

→ 1° Chorionic villus

→ 2° Chorionic villus

→ 3° Chorionic villus





Feedback

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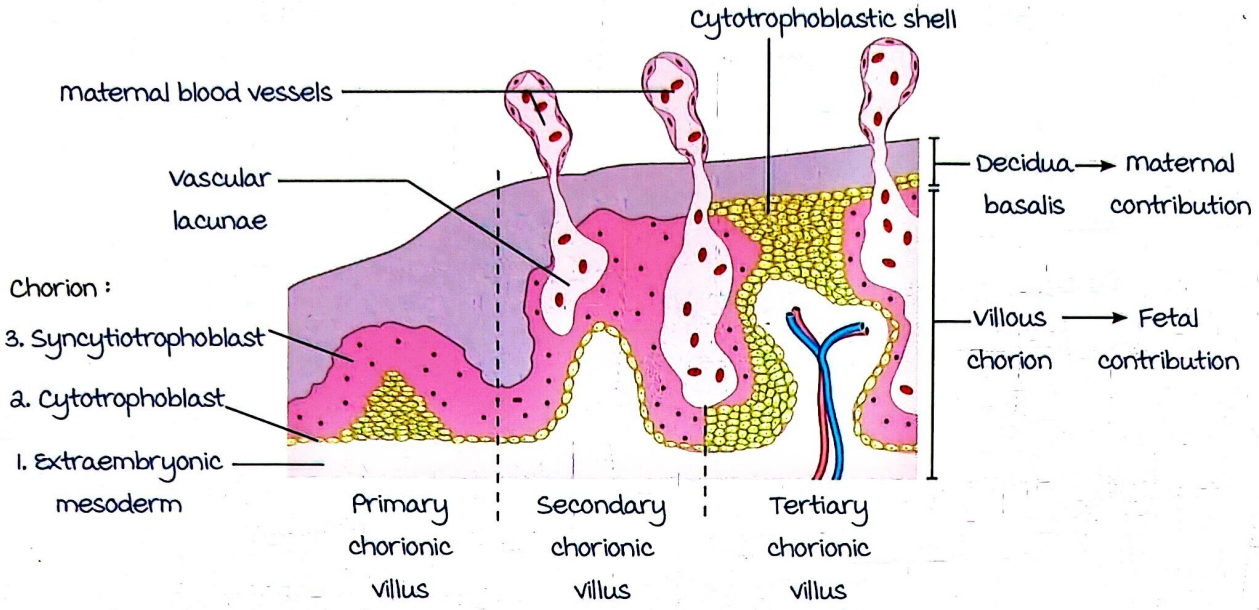
Chorionic villi :

- Finger like projections.
- Fetal contribution of placenta.

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

Chorionic villi :

- Finger like projections.
- Fetal contribution of placenta.

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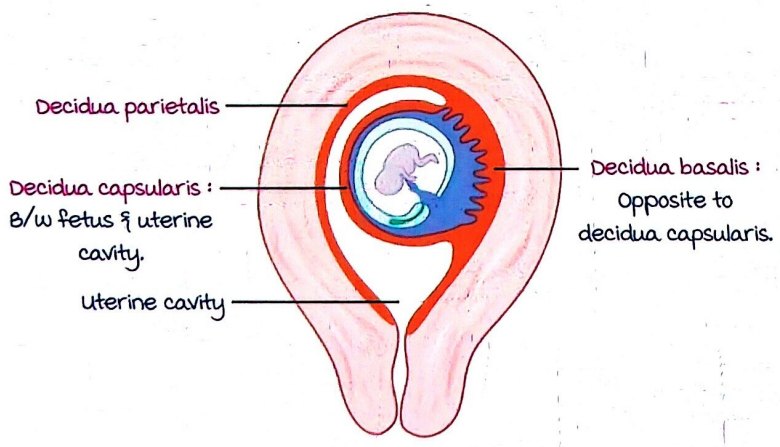
**Decidua :**

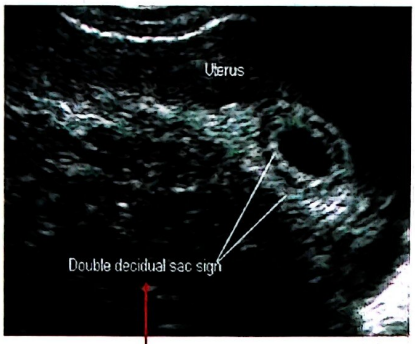
Endometrium during pregnancy.

Parts :




USG :

Double decidual sac sign :




2 concentric rings :

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



Feedback

# HISTOLOGY : PART 1

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

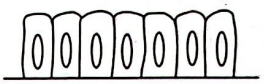
## Epithelium

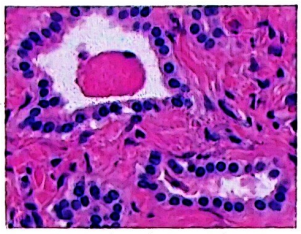
00:00:17

TYPES

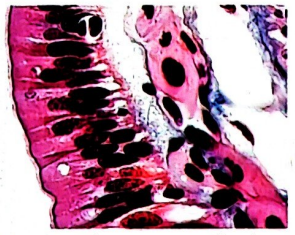
- Simple (One layer)
- Compound (multiple layers)

### 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



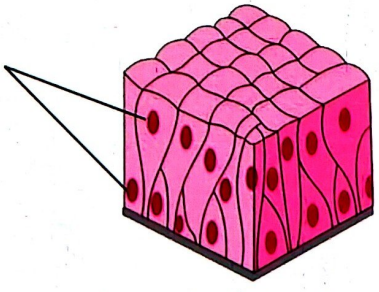
Simple columnar epithelium

### Pseudostratified epithelium :

Single layer of cells with nuclei arranged at different levels

↓

Appears stratified (Pseudostratified)



Pseudostratified epithelium

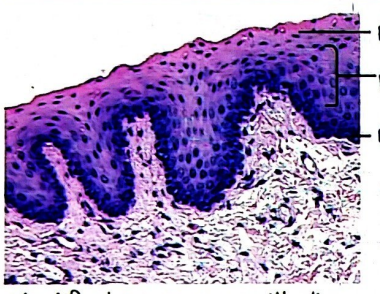
### Pseudostratified ciliated columnar :

Seen in → Trachea, Bronchus

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

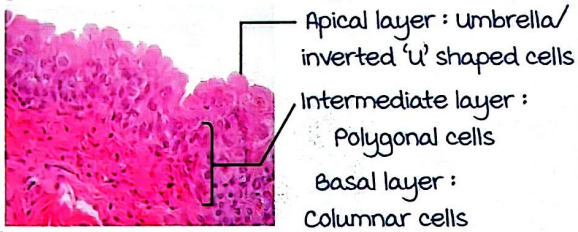
## Compound/stratified epithelium :

| 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<br>• Tongue<br>• Tonsils<br>• Esophagus<br>• Lower part of anal canal<br>• Vagina | Ducts of :<br>• Exocrine glands<br>• Sweat glands | Membranous & penile urethra | • Ureter<br>• Urinary bladder<br>• Prostatic urethra |



Stratified squamous epithelium



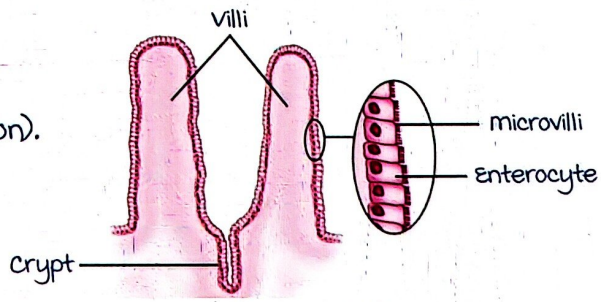


Transitional epithelium

## 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.

b. Pseudostratified ciliated columnar :

- Seen in :
  - Trachea.
  - Bronchus.

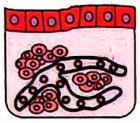
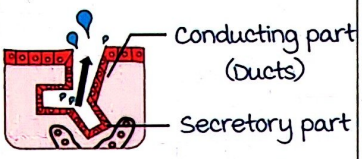

Pseudostratified ciliated columnar epithelium

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

## GLANDS

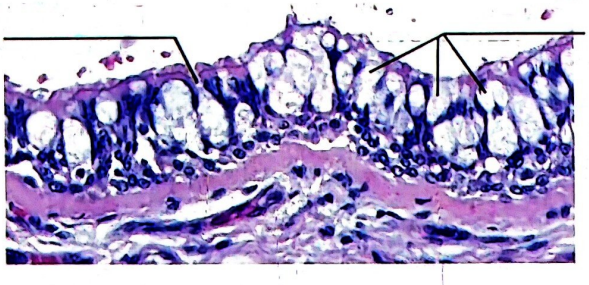
Formed by : Secretory epithelium invaginating into connective tissue.

### Endocrine v/s Exocrine glands :

| Features | Endocrine glands | Exocrine glands |
|---|---|---|
| |  |   |
| Secretions | Hormones | Enzymes |
| Ducts | Absent | Present |
| Secreted via | Bloodstream | Ducts |
| Vascularity | Endocrine > Exocrine | |

### Goblet cells :

- Unicellular glands.
- Secrete mucus via exocytosis.



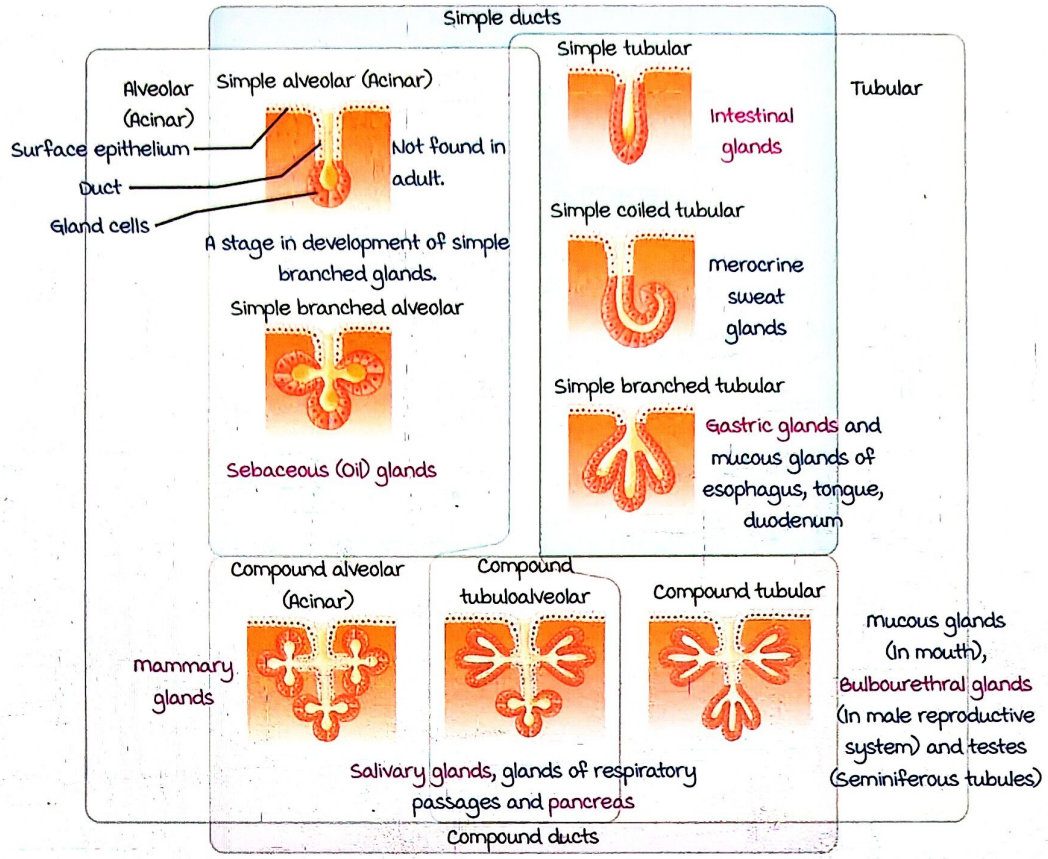

### Types :

1. Based on number of ducts :

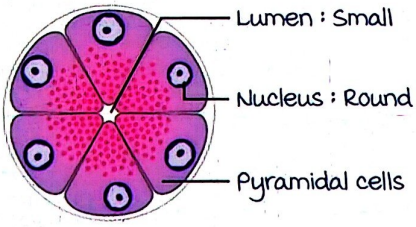
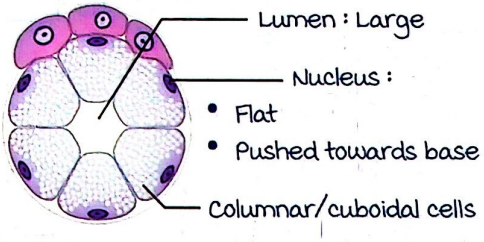
Simple glands : Secrete into single duct.

Compound glands : Secrete into multiple ducts.

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




2. Based on type of secretion :

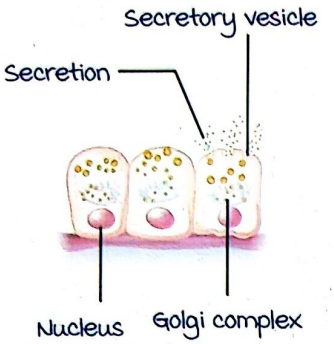
| | Serous | Mucous |
|---|---|---|
| Microscopy |   |   |
| Secretions | Watery | Thick |
| Apical eosinophilia | Present (D/t secretions collected towards apex) | Absent |
| Example | Parotid glands | Sublingual glands |

Note :

Submandibular gland : Mixed gland (Serous + Mucinous acini).

3. Based on mode of secretion :

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

| | Merocrine glands | Apocrine glands | Holocrine glands |
|---|---|---|---|
| Mechanism of secretion |  Exocytosis |  Pinched off portion of cells is the secretion<br>Apex of cell detaches ↓ Pinched off portion = Secretion |  Mature cell dies and becomes secretory product<br>• Whole cell disintegrates<br>• Has multiple layers :<br>– Basal layer : Mitotic ↓ Regenerates disintegrated cells |
| Cell | Intact | Not intact | Not intact |
| Example | • Endocrine glands.<br>• Sweat glands. | • Mammary glands.<br>• Atypical sweat glands of :<br>– Axilla<br>– Pubis | Sebaceous glands |

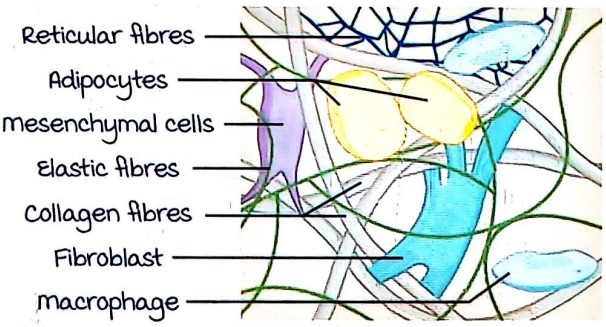
## Connective Tissue

00:32:00

Functions :

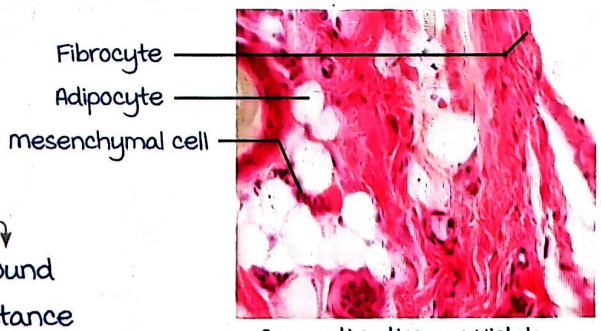
1. Provides support to organs.
2. Provides passage for neurovascular structures.
3. Connects adjacent layers.

Types : → General connective tissue
→ Special connective tissue




Components :

- Cells :
  - Adipocytes
  - Fibroblasts
  - Macrophages
- Matrix
  - Fibres
  - Ground substance




Connective tissue : Histology

Feedback

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

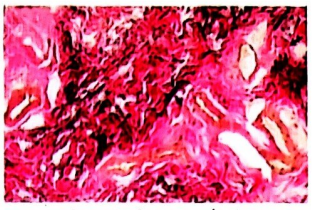
# FIBRES

## 1. Collagen fibres :

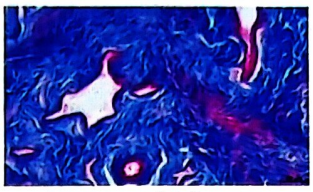
- Long wavy fibres present in bundles.
- Appears white to naked eye.

Appearance on staining :

- Hematoxylin & Eosin (H&E) } Pink
- Van Giessons
- Massons trichrome : Blue
- Silver impregnation : Brown



Van Geisson stain



Massons trichrome

Types :

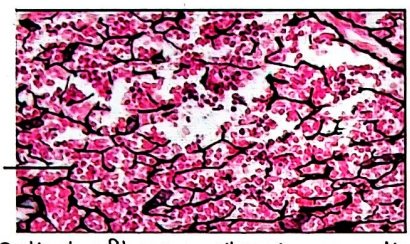
| Type | Example |
|---|---|
| I | • Ligaments • Aponeurosis • Fascia • Dermis (Skin) • Tendons • Fibrocartilage |
| II | Hyaline/elastic cartilage |
| III (Reticular fibers) | Lymphoid organs (Except : Thymus) |
| IV | • Lens capsule • Basement membrane |



## 2. Reticular fibers :

- Short fibers.
- Branch, anastomose & form reticulum (Network).

Appearance on staining : Black

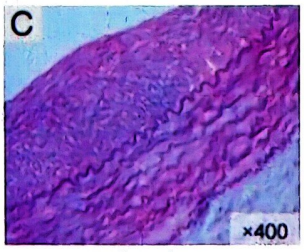



Reticular fibres on silver impregnation

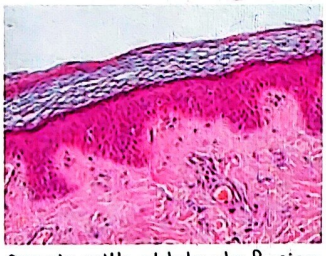
## 3. Elastic fibers :

- Short, non-wavy, single fibers (Not present in bundles).
- Thin (Except in ligamentum flavum)

Appearance on staining :




H & E stain



Orcein with aldehyde fusion

## CELLS

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

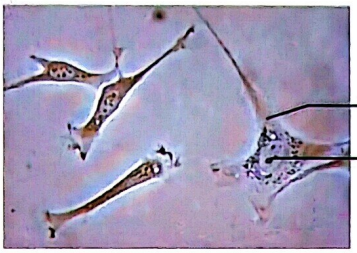
1. Fibroblasts
2. Adipocytes } Intrinsic component
3. Macrophages : Immune system cell.

### 1. Fibroblasts :

m/c cell of connective tissue.

Functions :

- Synthesizes extracellular matrix & collagen.
- Forms skeletal framework for tissues.
- Helps in wound healing.

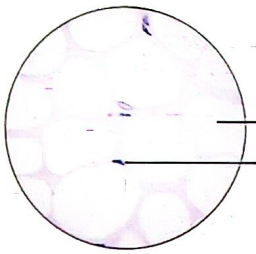



### 2. Adipose tissue :

Aggregation of fat cells.

Types :

White/yellow adipose tissue




Brown adipose tissue :

↑ in newborns


Staining :

- On H&E : Appears as empty space (Xylene & Benzene dissolves fat).
- Special stain : Sudan stain.

Note :

Based on arrangement of fibres

Dense regular fibers :

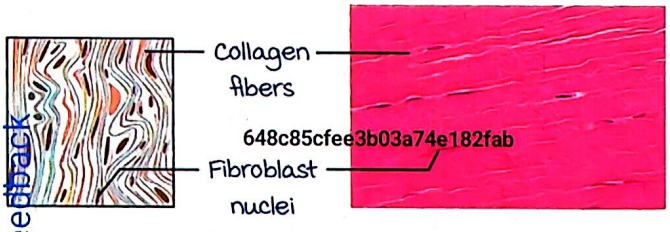
Seen in :

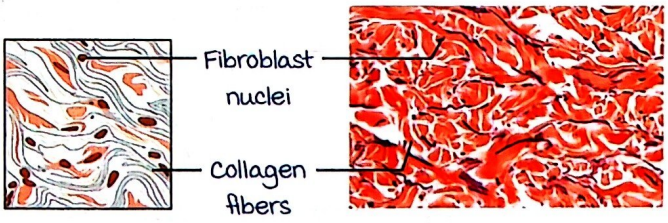
- Aponeurosis
- Ligaments
- Tendons

Dense irregular fibers :

Seen in :

- Dermis of skin
- Organ capsules




Feedback