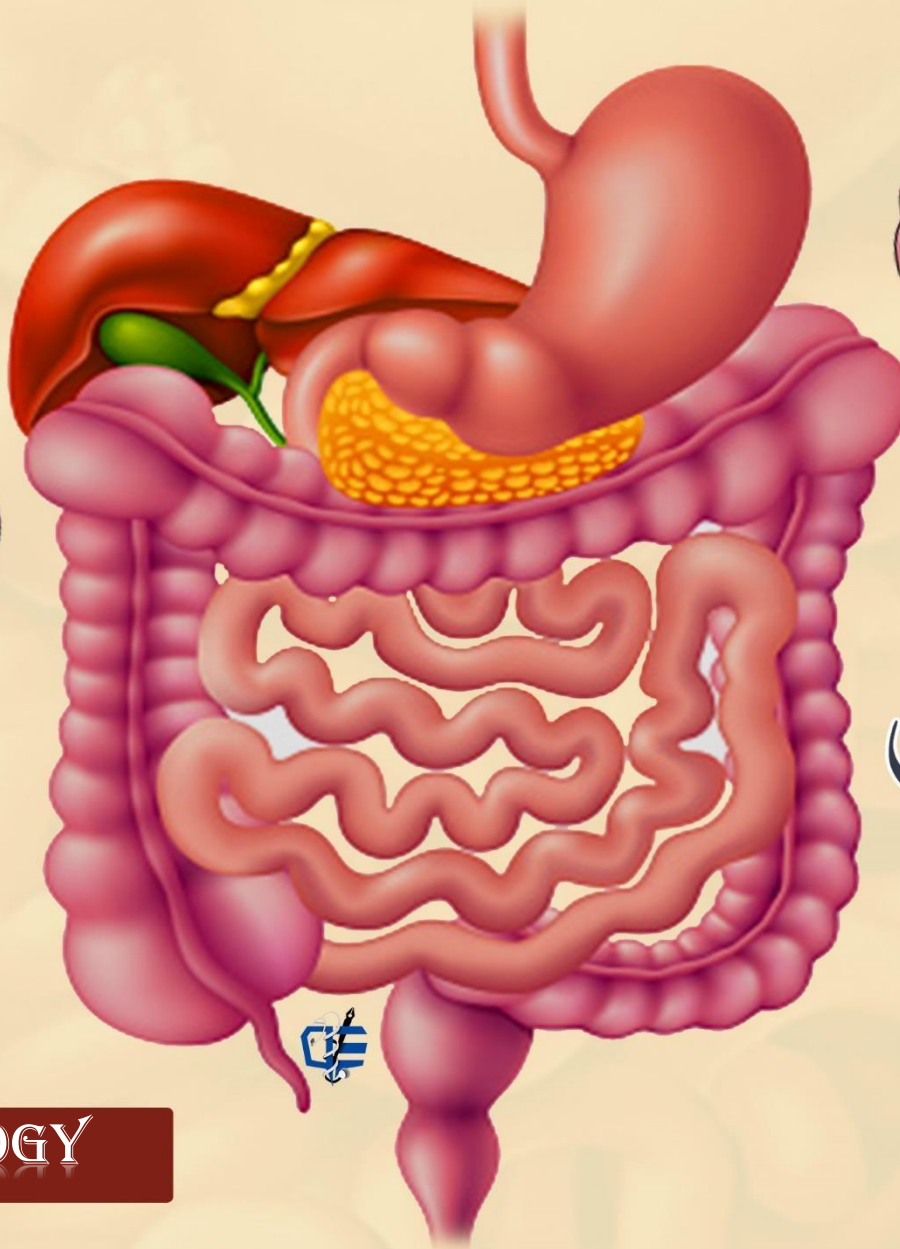


GastroIntestinal System



EMBRYOLOGY

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Notes before starting:

1. Don't be confused because the sheet is long, as I've added extra information for understanding.
2. Words in BLACK are from the slides, words in RED were said by the doctor in the lecture, and extra information are in GREEN

→ Remember: The embryo develops from three primary layers of germ cells, they're:

1. Ectoderm (outer)
2. Mesoderm
3. Endoderm (inner)

→ Development of the oral cavity (0:00 - 3:28)

- The mouth has 2 sources of development: (pic 1)

1. depression in the stomodeum

(lined with **ectoderm**)

(stomodeum: a depression between the brain and the pericardium (كيس يحتوي القلب) in embryo)

2. cephalic end (**upper part**) of the foregut

(lined with **endoderm**)

(foregut: the upper part of the GI tract starting from the mouth to the entrance of the bile duct in the duodenum, you can see it in the embryo before developing organs in pic 2)

- These two points are separated by the buccopharyngeal membrane, this membrane disappears during the 3rd week of development.

- Examples of structures that have origin from the stomodeum anteriorly (ectoderm):

1. Hard palate
2. Sides of the mouth
3. Lips
4. Enamel of the teeth

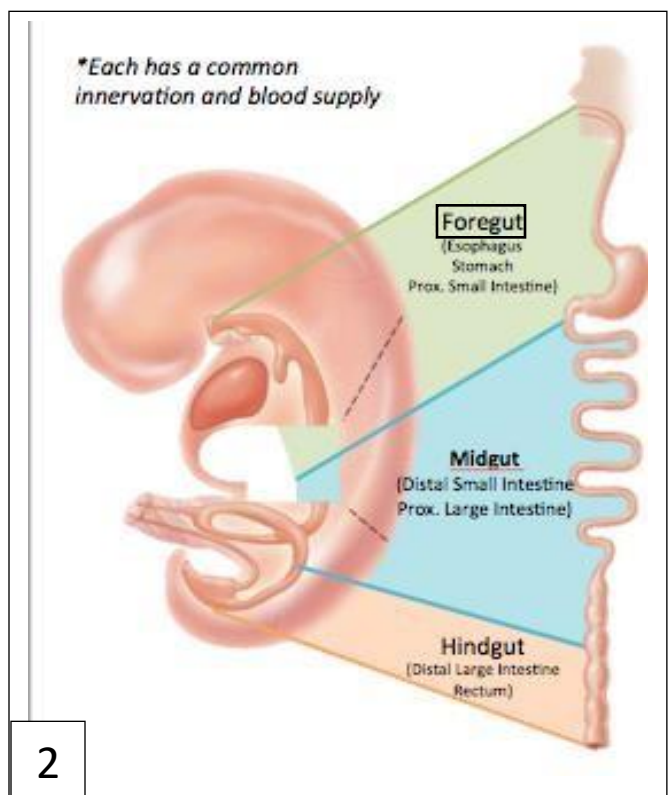
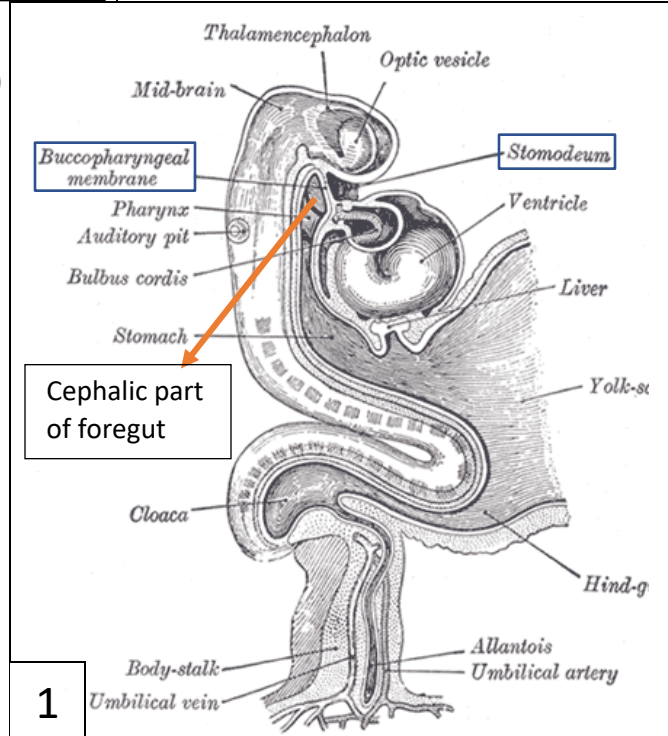
- Examples of structures that have origin from the upper part of the foregut posteriorly (endoderm):

1. Tongue
2. Soft palate
3. Palatoglossus and palatopharyngeal folds
4. Floor of the mouth

- Q: How to know the origin of every structure?

A: We can draw an imaginary line starting from the Body of sphenoid, passing through the Soft palate, and finally reaching the Inner surface of the mandible, inferior to the incisor teeth.

(look at pic 3)



- Mucosa of the oral cavity is formed of epithelial tissue regardless to it's origin (epithelial cells may be formed from either endoderm or ectoderm)

→ Development of the salivary glands

(3:28 - 6:07)

- Remember: There are 3 major salivary glands:

- 1) Parotid gland
- 2) Sublingual gland
- 3) Submandibular gland

Q: What are the steps of forming salivary glands?

1) During the 7th week they arise as groups of a solid outgrowth of cells from the **epithelial cells** of

walls of the developing mouth, is grows through the underlying connective tissue.

- Remember: connective tissues form in embryo from mesenchyme cells. (mesenchyme cells are major component of the mesoderm layer)

2) buds will form from these solid collections of cells, they will grow and branch to form solid ducts (They are called solid ducts because they are filled with cells)

3) The ends of these ducts will form the secretory acini

4) Solid ducts and secretory acini will both go through canalization

5) Mesenchyme that surround these glands will condense to form:

a- The capsule of the gland

b- Septa that divide the gland into different lobes and lobules

- Note: The ducts and acini of the parotid gland are both derived from the ectoderm while submandibular and sublingual glands are derived from the endoderm (remember that both are made of epithelial cells)

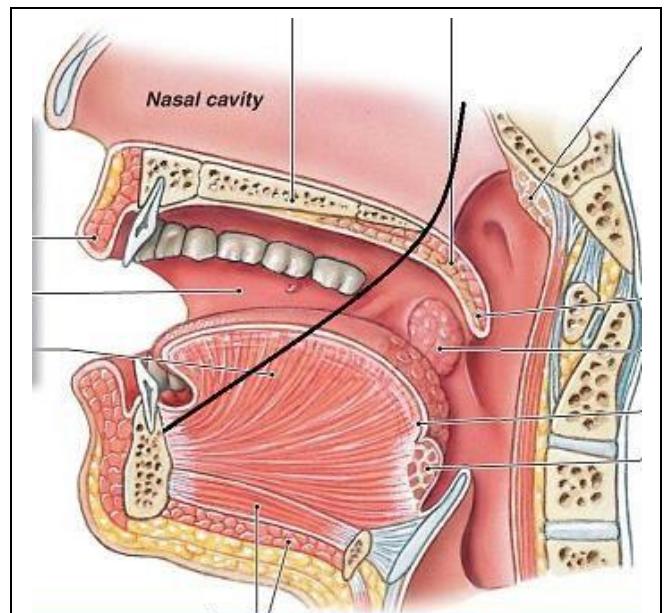
→ Tongue (6:07 - 12:25)

- The tongue appears in embryos of approximately 4 weeks

- Tongue develops when the stomodeum and pharynx meet

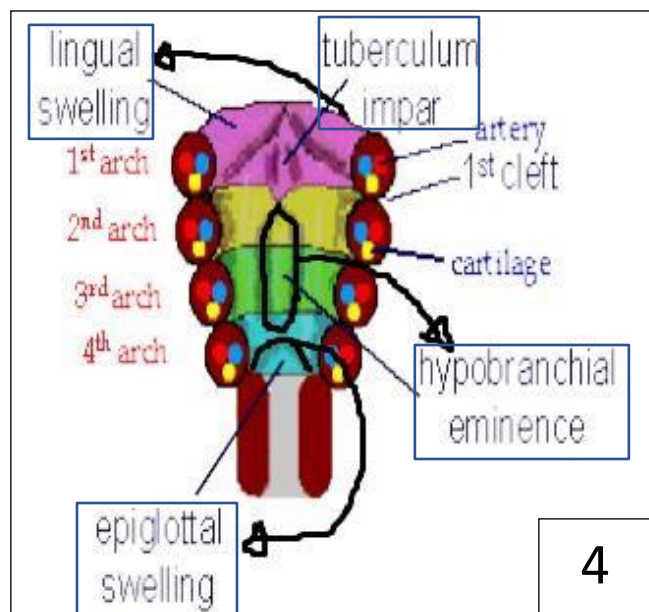
- The tongue forms from two origins: (pic 4)

1) **The anterior 2/3 part of the tongue:** forms from of **two lateral lingual swellings** and **one medial swelling** (the tuberculum impar), these structures form from the first arch



3

The imaginary line



4

2) The posterior 1/3 part of the tongue: forms from the **copula**, or **hypobranchial eminence** (*) **hypobranchial eminence**: median swelling formed by mesoderm of the second, third, and part of the fourth arch. (bordered in black in pic 4)

- Q: What forms the arches?

a) The lateral lining of the arch is formed by **ectoderm**

b) inside the arch is formed by **mesoderm**

c) The medial lining of the arch is formed by **ectoderm**

-Structures form from the arches other than the tongue

1) **Epiglottis**: formed from epiglottal swelling, which is a third median swelling, formed by the posterior part of the fourth arch.

2) **laryngeal orifice** (a connection between the pharynx and the larynx): surrounded by the arytenoids swellings

- **Note**: pic 5 (A) shows the development in the embryo, while pic 5 (B) shows the final structure after developing.

- The growth of the tongue: the lateral

lingual swellings increase in size, they overgrow the tuberculum impar and merge, forming the anterior two thirds, or body, of the tongue, **the line where they merge is called median sulcus**.

- **Innervation of the tongue**:

To understand the innervation of the tongue, we have to keep this golden rule :

ANY PART OF THE TONGUE RECEIVE INNERVATION FROM THE PROCEEDURE ARCH THAT IT HAD FORMED FROM.

(*) each arch contain a nerve:

1st arch contains Trigeminal nerve (CN V)

2nd arch contains facial nerve (CN VII)

3rd arch contains glossopharyngeal nerve (CN IX)

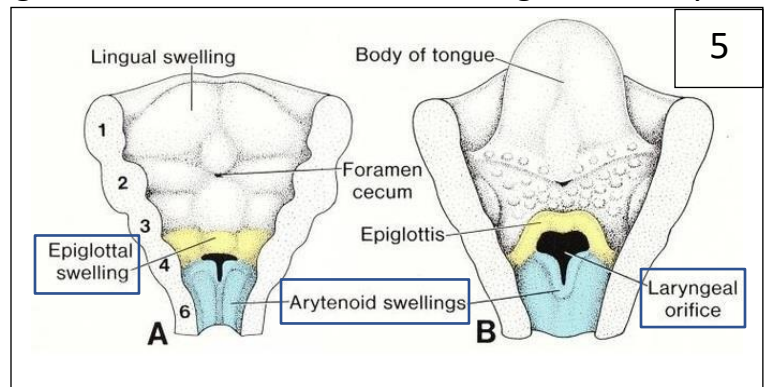
4th arch contains the superior laryngeal branch of the vagus nerve (CN X)

E.g. to understand the golden rule: if there is a part of the tongue that is formed for example from the 1st arch, it will receive innervation from the trigeminal nerve

Now let's speak about the innervation of each part:

1) The anterior 2/3 part of the tongue is formed from the **first arch**, so it receive innervation from the **mandibular branch of the trigeminal nerve**.

2)The posterior 1/3 part of tongue is formed by the second, third and fourth arch, but mostly it's is formed by the **third arch** as it overgrows, so it's innervated by glossopharyngeal nerve



3) The extreme posterior part of the tongue and the epiglottis are formed by the **fourth arch**, so they are innervated by the **superior laryngeal nerve**.

4) Special sensory innervation (taste) to the anterior two thirds of the tongue is provided by the **chorda tympani** which is a branch of the **facial nerve** (taste is an exception to the previous rule as facial nerve is in the second arch)

- Note: The anterior and posterior parts of the tongue are separated by a v-structure called **terminal sulcus** **because they have different origins**.

- Muscles of the tongue:

Some of the tongue muscles probably differentiate in situ, but most are derived from **myoblasts** originating in **occipital somites**, thus, tongue musculature is innervated by the **hypoglossal nerve**.

→ Development of the pharynx (12:25 –14:31) (pic 6)

- We will speak about the pharynx by referring to the three germ layers:

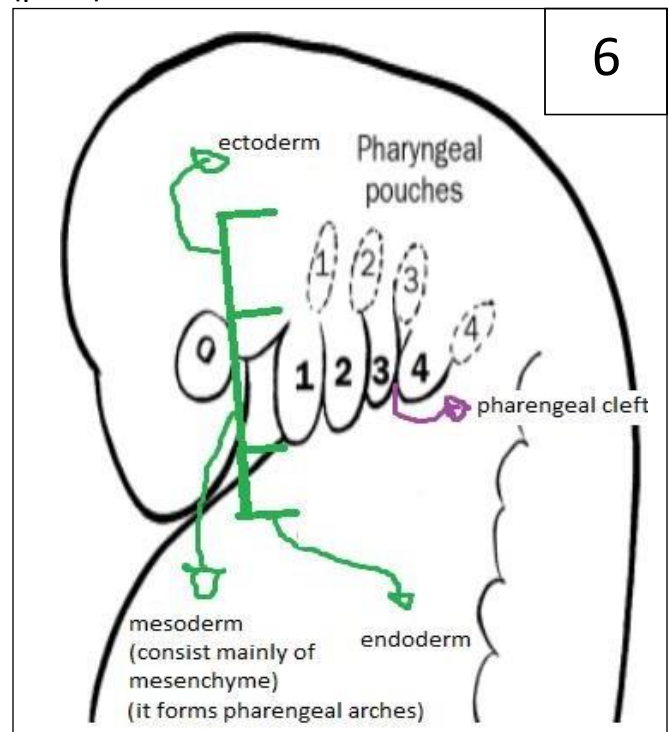
1) endoderm: The pharynx will develop from the endoderm of the foregut in the neck.

2) mesoderm: it lies on the surface of the foregut as pharyngeal arches.

Mesoderm in each side splits up to 5-6 arches. Each arch forms a swelling on the surface of the walls of the foregut, As a result of these swellings a series of clefts are seen between the arches they're called **pharyngeal clefts**.

3) ectoderm: above the mesoderm and the most lateral layer referring to the endoderm it's formed of **pharyngeal pouches** (grooves)

- So, The foregut on this level forms the pharynx



→ Development of the anterior abdominal wall (14:31 – 19:10)

- Remember:

The ectoderm forms the skin and the nervous system

The mesoderm forms the connective tissues, cartilages, bones and muscles

The endoderm forms the GI tract

The anterior abdominal wall is formed mainly from the **mesoderm** (How?)

To understand the previous point clearly, we have to know that the lateral mesoderm is divided into:

1. Somatic layer: outer layer and faces the ectoderm layer
2. Splanchnic layer: inner layer and attached with the endoderm layer, **it faces the viscera.**

(* The somatic layer with the ectoderm is called **Somatopleuric mesoderm**

(* The splanchnic layer with the endoderm is called **Splanchnopleuric mesoderm**

Our focus will be on the **Somatopleuric mesoderm** as it forms the anterior abdominal wall, **Splanchnopleuric mesoderm** is less important

- So the ant. Abdominal wall is derived from the Somatopleuric mesoderm as we said and they

retain their innervation from the ventral rami of the spinal nerves

- The somatopleuric mesoderm then tangentially divides into three layers:

- External oblique
- Internal oblique
- Transversals abdominus

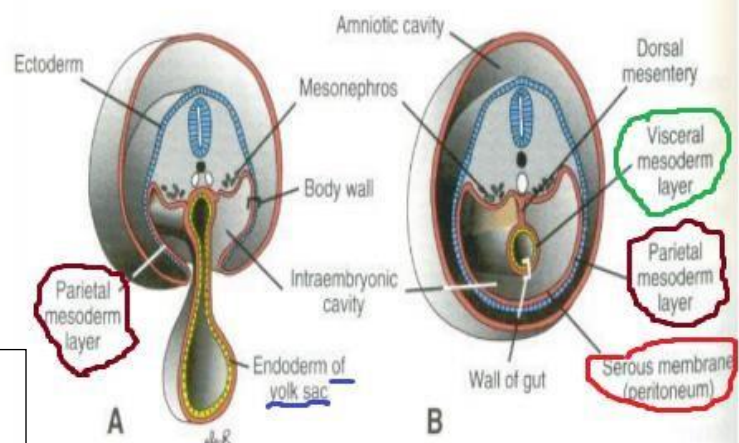
-The rectus abdominus muscle retains the indications of the segmental origin **because it came from the myotome** (the presence of tendinous intersections prove that this muscle came from the myotome)

- Finally after formation of the abdominal Wall, right and left sides of mesenchyme fuses together at the 3rd month into the midline to form the linea alpa.

- On either side of the lina alpa the rectus muscles lies within their rectus sheaths

Somatopleuric mesoderm becomes **parietal mesoderm** which form **serous membranes** that line the peritoneal, pleural, and pericardial cavities.

Splanchnopleuric mesoderm becomes **visceral mesoderm** which form serous membranes that line each organ.



7

Umbilicus = السرة
Umbilical cord = الحبل السري

→ Development of the umbilicus and the umbilical cord (19:10 - 22:53)

Q: How does the umbilical cord develop?

Before we answer this question, we have to know two terms:

1) Chorion, a membrane that surrounds the chorionic cavity (shown in green in pic 8), this membrane will form lastly the placenta

2) amnion, a membrane that surrounds the amniotic cavity (shown in blue in pic)

- What happens that the amniotic cavity enlarge while the baby develop, on the other hand, the chorionic cavity deflate until amnion fuses with the chorion.

The amnion encloses the body stalk and the yolk sac (see the pic) with their blood vessels to form the **tubular umbilical cord** at the **end of the folding**.

Q: What are contents of the umbilical cord?

1) Wharton's jelly: Loose connective tissue (mucoid tissue) formed by the mesenchymal core of the cord that surround other structures in the umbilical cord.

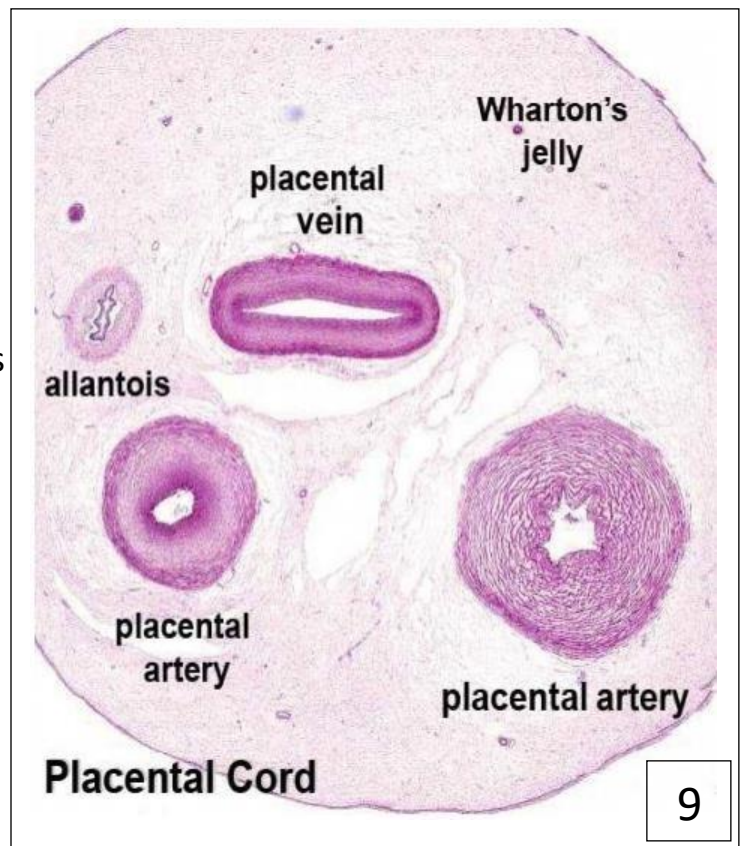
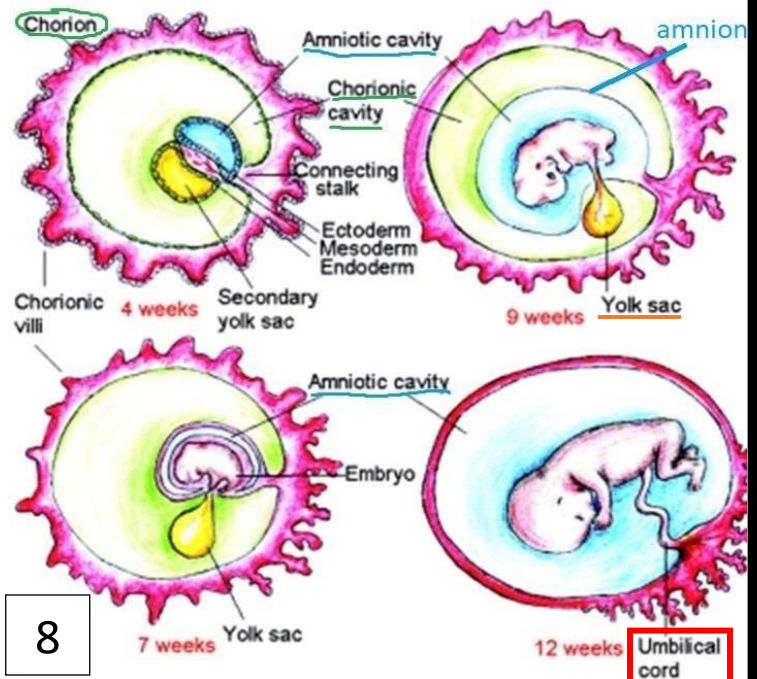
Note: in many hospitals the umbilical cord is kept for further clinical benefits as Wharton's jelly contains stem cell.

2) Remains of yolk sac.

3) Vitelline duct: connection between the umbilicus and the midgut.

4) Remains of allantois: connection between the umbilicus and the urinary bladder

Note: Both vitelline duct and the remains of the yolk sac must obliterate completely, as we don't want feces or urine to be excreted from the umbilicus.



5) Umbilical blood vessels: we have two types of blood vessels:

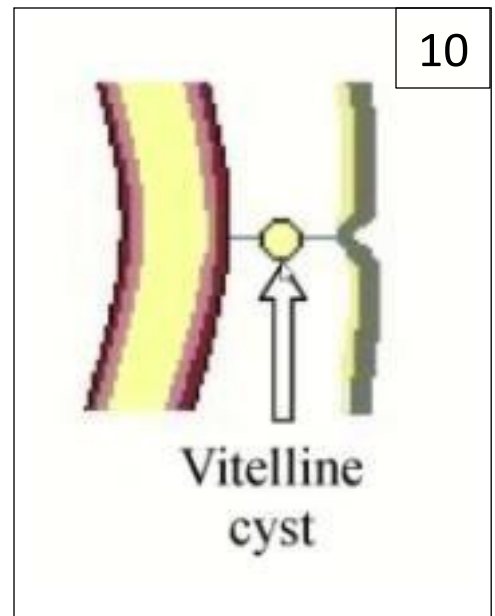
a- Arteries: We have 2 arteries that carries **deoxygenated** blood from the fetus to the chorion (placenta)

b- 2 veins carry **oxygenated** blood from the placenta (the right vein will soon disappear, **so don't be confused if you read that there's only one vein in other medical sources**)

Note: arteries in the umbilical cord are somehow similar to the pulmonary trunk as both carry deoxygenated blood.

→ **Vitelline duct abnormalities** (22:53 – 24:00)

- In 2 to 4% of people, a small portion of the vitelline duct persists, forming an outpocketing of the ileum, Meckel's diverticulum or ileal diverticulum
- In the adult, this diverticulum, approximately 40 to 60 cm from the ileocecal valve on the antimesenteric border of the ileum, does not usually cause any symptoms.
- However, when it contains heterotopic pancreatic tissue or gastric mucosa, it may cause ulceration, bleeding, or even perforation.
- Sometimes both ends of the vitelline duct transform into fibrous cords, and the middle portion forms a large cyst, an enterocystoma, or vitelline cyst (pic 10)



→ **Formation of lung buds** (24:00 – 28:19)

Q: When does the respiratory diverticulum (lung bud) appears?

A: When the embryo is approximately 4 weeks old

Q: what is the origin of the lung bud?

A: The anterior wall of the foregut

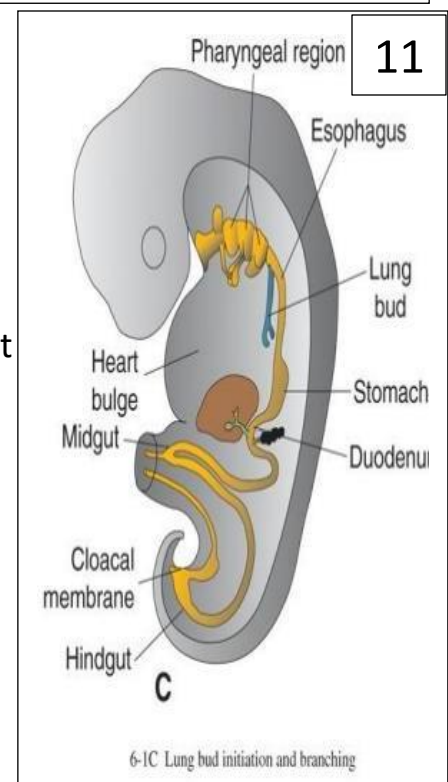
Q: What determine the location of the bud along the gut tube?

A: signals from the surrounding mesenchyme, including fibroblast growth factors (FGFs), they act as guiders

Q: What are the procedures of the different parts of the respiratory tract?

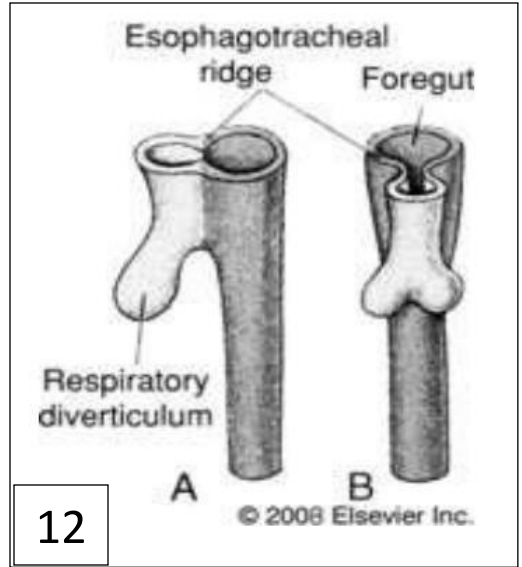
A: There are two origins:

1st origin → endodermal layer: forms the epithelium of the internal lining of the larynx, trachea, and bronchi, as well as that of the lungs.



2nd origin → mesoderm layer: specially the splanchnic mesoderm surrounding the foregut, it forms cartilaginous, muscular, and connective tissue components of the trachea and lungs.

- Initially the lung bud is in open communication with the foregut
- When the diverticulum expands caudally, however, two longitudinal ridges, the tracheoesophageal ridges, separate it from the foregut
- Subsequently, when these ridges fuse to form the tracheoesophageal septum, the foregut is divided into a dorsal portion, the esophagus, and a ventral portion, the trachea and lung buds
- The respiratory primordium maintains its communication with the pharynx through the laryngeal orifice



قال الفريابي:

((كان سفيان الثوري يصلي ثم يلتفت إلى الشباب فيقول: إذا لم تصلّوا

اليوم فمتى؟))

{الحلية (٥٩/٧)}