





ANATOMY / HISTOLOGY

Sheet

OSlide

 \bigcirc Handout

Number

7

Subject

Embryology 1

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- This sheet was written according to the recording that belongs to section 3, And revised according to sec. 2 recording
- The order of ideas is a little bit different.
- Everything in the slides is mentioned here.

Rules you must follow to understand embryology :

- 1. You have to relate the final structure to developmental processes that take place.
- 2. Don't skip any figure
- 3. Use the maximal power of imagination you have \oplus

Origin of the cells according to the embryonic disc:

- A. Anything line the surface is from the **ectoderm**.
- B. Anything lines the inner surface of a tube is from the **endoderm**
- C. Anything forms connective tissue is from the **mesoderm**.



In order to talk about the development of the nose , let's recall what are the parts that we need to end with :

1- The Nares (singular \rightarrow nostril : anterior opening of the nose)

- 2- The choanae (posterior opening)
- 3- Lateral and medial walls
- 4- Palate (floor of nasal cavity)
- 5- The roof 🔨

Development of the nose :

- Embryology is a story, that has time and place, and main characters 🕀
- Our story here begins at the **4**th **week** of development:
- The embryo is starting to achieve its final shape, forming the face, so at the cephalic end (the head) certain features start to appear.
- These features are **growing prominences** (processes) that origin mainly from the first two pharyngeal pouches.
- Initially we have 3 main prominences:
- At the center, an on growing prominence called the **Frontonasal prominence**, hence the name this process is growing from the front toward the future nose.
- Another pair of prominences ,on both right and left sides called the Maxillary prominence.
- Between these two, a local thickening of actively growing cells on each side is formed called the **Nasal (olfactory) placode** (these will be the future Nares).

Don't you dare skip this figure



Frontonasal prominence:

 Extends from the frontal bone down toward the nose, so the growth of the Frontonasal prominence from up → <u>downward</u> and will form the main part of the nasal septum.

Maxillary prominence:

• It will form the maxilla and participate in forming the upper lip, also it will participate in the formation of the nose. (it grows <u>medially</u>)

And the story continues:

- The nasal placodes start growing and invaginating to the inside (backward growth forming nasal pits on each side,
- As a result of that, they create two new prominences around them:
- Medial nasal prominence. (helps in the formation of the nasal septum)
- Lateral nasal prominence. (helps in the formation of the lateral wall of the nose)

يعني لو جبنا معجون و عملنا فيه حفرة, رح يصير حوالين الحفرة حواف جديدة . (بصوت المحتسب) Frontonasal prominence Lateral nasal process Medial nasal process Maxillary prominence Mandibular prominence Intermaxillary process

So the future Nostril will be surrounded by three prominences:

- 1- Medial nasal.(inner edge of the pit)
- 2- Lateral nasal.(outer edge of the pit)
- 3- Maxillary.(inferiorly)

And the story continues:

• The maxillary prominence start to grow toward the midline (medially) during the following two weeks ,as they do so they compress the medial nasal prominences toward the midline ,and fuse together (the cleft between them is now lost) and eventually meet with the growing frontonasal prominence and form the <u>septum</u>.

Clinical correlate :

- The fusion of the prominences is essential to prevent future clefts, of these the so called <u>cleft lip</u> "الشفة الارنبية" which happens due to failure of fusion between the medial nasal prominence and maxillary prominence or between medial nasal prom. and lateral nasal prom..
- If this occurs at one side, we call it <u>unilateral</u> cleft lip
- If on both sides, we call it <u>bilateral</u> cleft lip.





Conclusion: the nose is formed from *five* facial prominences:

- 1- Frontonasal prominence: which forms the nasal septum
- 2- Medial nasal prominences: which forms the <u>tip</u> of the nose (and part of the septum).
- **3- Lateral nasal prominence**: which forms the <u>ala</u> of the nose and the lateral <u>wall</u> of the nose.
- 4- Olfactory pit: forms the <u>nostril</u> and then becomes deeper to form a blind sac (the <u>vestibule</u>)
- 5- Maxillary prominence

- The cells of the nasal pits will proliferate backwards and invaginate inside forming the <u>vestibule</u>, so the vestibule will be formed <u>after</u> the formation of the nostril.
- The development of the vestibule is of great importance, because here the origin of the cell is ectodermal, remember that the vestibule is lined by a <u>modified skin</u>.

✤ Summary ☺

- ✓ The <u>frontonasal</u> mainly participates in forming the **septum** which is the bridge of the nose.
- Maxillary will give cheeks and lateral portion of upper lip "the lateral portion only, because the medial portion comes from the medial nasal prominence.
- ✓ <u>The medial nasal</u> will form the **Philtrum** and the **upper lip** and will reach the **tip of the nose**
- ✓ <u>The Lateral nasal</u> will give rise to the lateral wall of the nose plus the <u>ala</u> of the nose
- ✓ <u>Mandibular</u> will give rise to **lower lip**.

Nasal cavities :

- Our story here starts at the **6th week** of development:
- As the nasal pits invaginate backwards and upwards into the mesenchyme, because of their proliferation and because of the growing prominences outside.
- After proliferation, canalization and death of cells in the center occurs (to form a cavity), the lining epithelium of the nasal cavity will be endodermal in origin .
- The underlying mesenchyme will form connective tissue, glands and ducts.
- The embryo by now has two cavities: developing <u>nasal cavity</u> and developing <u>oral cavity</u> below it.

- These are initially separated by **Oronasal Membrane**.
- This membrane will break down, and will be replaced by the hard palate (floor of the nose).
- The hard palate is of two parts (discussed later):
 - 1- Primary palate.
 - 2- Secondary palate.



X The choanae: (the Posterior Nares):

- There is a primitive choanae, results from the <u>backward</u> growth of the Mesenchyme initially.
- The nasal pits grow backward as we know by now the Nares are formed, the nasal cavities, what we have left is the choanae.
- The <u>primitive choanae</u> lies between the septum and the hard palate, on each side of the midline (the septum), it lies <u>posterior</u> to the primary palate.
- Afterward, when the secondary palate is formed, the hard palate is complete, then we have full separation between the oral and nasal cavities.
- The primitive choanae will mature to become the definitive choanae and open into the nasopharynx
- So there is primitive choanae, and definitive choanae which is resulted from the development of the primary and secondary palate reaching the nasopharynx.



& Paranasal sinuses:

- Paranasal sinus are cavities inside the skull bone lined by thin mucosa (this mucosa is endodermal in origin.) ن الله
- Paranasal air sinuses develop as diverticula "due to proliferation" from mesenchyme of the lateral nasal wall and extend into the maxilla, ethmoid, frontal, and sphenoid bones: ? شو يعنى ->



• These cavities are formed from the lateral wall of the nose, the cell will proliferate towards the skull bone, so the maxillary air sinus will result from

the growth of cells from lateral wall of the nose at the same level of the maxilla, and proliferation is going inside the maxilla.

- Then after that <u>canalization</u> will occur, so the cavity will be formed inside the maxilla to form the maxillary air sinus "proliferation + canalization"
- As the proliferation occurs, ducts will also be

Lacrimal anlage Nasal cartilage Conjunctival sac Inferior turbinate Palate
Nasal cartilage
Conjunctival sac Inferior meatus
Conjunctival sac Inferior meatus
Conjunctival sac

formed (and each will open into the part of the lateral wall that corresponds to it) this would be the middle meatus for the maxillary in our example.

- This implies for all Paranasal air sinuses.
- So the Paranasal sinuses is proliferation from the <u>mesenchyme</u> on the lateral wall going toward skull bone then <u>canalization</u> will occur.
- They reach their maximum size during <u>puberty</u> and contribute to the definitive shape of the face.

& Hard palate :

1) Primary palate :

• Arise from the medial nasal prominence and maxillary prominence deep within the face (As a result of medial growth of the maxillary prominences,



the two medial nasal prominences merge not only at the surface but also at a deeper level.)

- As a result of the fusion of the medial nasal prominences an intermaxillary segment is formed.
- This Development has the following components (parts):
- 1. Labial component: which forms the philtrum of the upper lip. (from intermaxillary segment)
- 2. **Upper jaw component** : which carries the four incisor teeth (from the maxillary prominence)
- 3. **Palatal component** : which forms the triangular primary palate (from 2 medial nasal + maxillary prominences)
- The intermaxillary segment continue developing rostrally and forms part of the <u>nasal septum</u>, which is also formed by the frontal prominence, and thus it completes the septum.
- The primary palate will give rise to palatal shelf that participate in the formation of the secondary palate.
- Incisive foramen is the meeting point between the primary and the secondary palate, and remains open in embryo so that the greater palatine nerve and vessel can pass through it.

2) Secondary palate :

- Two shelf like growth from the <u>maxillary</u> prominence *"medially and backward"* make the secondary palate, these are called palatine shelves and appear at 6th week of development.
- During the 6th week these two palatine shelves direct obliquely downward on each side and participate in forming the tongue, however by reaching the 7th week they become horizontal and fuse forming the secondary palate.

Remember:

The incisive foramen is the entry point of the greater palatine nerve The union of the 2 folds of the soft palate occurs during the 8th week.

Oral cavi

- Anteriorly, the shelves fuse with the triangular primary palate, and the <u>incisive</u> <u>foramen</u> is the midline landmark between the primary and secondary palates.
- At the same time as the palatine shelves fuse, the nasal septum grows down and joins with the cephalic aspect of the newly formed palate
- 2 folds grow posteriorly from the edge of the palatine process to form <u>the soft</u> <u>palate and the uvula</u>.
- The 2 parts of the uvula fuse in the midline during the 11th week

Clinical correlate : <u>Cleft Palate</u>

- ✓ Defects in **FUSION** of the palatine shelves "coming from the maxillary prominences" could lead to cleft palate.
 Incisive Nostril _______
- This also could be unilateral or bilateral.
- ✓ <u>Unilateral cleft lip & palate</u> can extend to the nose. (because maxillary prominences participate in the formation of the two)
- Cleft soft palate we can see cleft <u>uvula</u> also.



Cleft palate

Bilateral cleft lip & jaw

Cleft palate with unilateral cleft lip & jaw

7 weeks

8 weeks

10 weeks

Uvula

Cleft Lip & Palate is dangerous in babies because it makes it hard for them to be fed because feeding material could pass to the respiratory system and suffocates the baby

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Doctors may have to place Nasogastric tube until surgery takes place...



• The development of the respiratory system is somehow related to the primitive gut :

As the primitive gut (GI tract) develop, it is further divided into four sections:

- 1- The pharyngeal gut, or pharynx, extends from the buccopharyngeal membrane to the tracheobronchial diverticulum
- 2- The foregut lies caudal to the pharyngeal tube and extends as far caudally as the liver outgrowth.
- 3- The midgut begins caudal to the liver bud and extends to the junction of the right two-thirds and left third of the transverse colon in the adult.
- 4- The hindgut extends from the left third of the transverse colon to the cloacal membrane

Our story begins at the 4^{th} week :

- From the anterior wall of the foregut, a so called lung bud برعم or respiratory <u>diverticulum</u> appears.
- The cells from this bud proliferate pulling the structure downwards.
- The location of the bud along the gut-tube is determined by signals from the surrounding mesenchyme, including fibroblast growth factors (FGFs) that instruct the endoderm, what does that mean??



• These are set like alarms that fire only at certain points of development.



- Of these we have FGFs that activate cells and lead them only when the time for them is needed.
- These factors could be blocked and higher the risks for <u>anomalies</u>, if the carrier female smokes, or takes any drug that cause anomalies, the development could be cut off at any point.
- The most common anomaly is remaining connection between esophagus and trachea (discussed later).
- The lining epithelium for the whole system is endodermal in origin
- All cartilage, muscle, Connective Tissue from splanchnic mesoderm
- Splanchnic Vs Somatic جداري "Somatic is parietal "peripheral While splanchnic is inside حشوي

- On surface ectodermal
- after the proliferation of cells, canalization occurs to form tracts and bronchi, at the end of each bronchi we have lung buds
- The respiratory primordium maintains its communication with the pharynx through the <u>laryngeal orifice</u>



So... 🕄

- We have to lose the connection between the trachea and esophagus ;this separation is initially by means of forming ridges (<u>tracheoesophageal</u> <u>ridges</u>) "constriction until separation"
- Growth of this ridge between esophagus and trachea until forming a septum (tracheoesophageal septum).
- The oesophagus :
 - The oesophagus start short in the chest, afterwards it elongates and descends downwards due to the growing heart and respiratory system (as if they pull it down).
 - Certain anomalies can lead to shortening of the esophagus, and this higher the risk for Hiatus hernia.
 - The muscular coat, which is formed by surrounding splanchnic mesenchyme, is striated in its upper two-thirds and innervated by the <u>vagus</u> the muscle coat is smooth in the lower third and is innervated by the splanchnic plexus.

Anomalies of the trachea and esophagus

☆ Tracheoesophageal fistula (TEF) :

Abnormalities in partitioning of the esophagus and trachea by the tracheoesophageal septum result in esophageal atresia with or without tracheoesophageal fistulas



- Fistula is a tract between two cavities
- <u>Atresia</u> "blind end" of esophagus : which could be proximal or/ and distal

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- TEF is the most common anomaly in the lower respiratory tract
- These defects occur in approximately in 1/3000 births
- These abnormalities are associated with other birth defects, including cardiac abnormalities, which occur in 33% of these cases.
- In this regard TEFs are a component of the VACTERL association (Vertebral anomalies, Anal atresia, Cardiac defects, Tracheoesophageal fistula, Esophageal atresia, Renal anomalies, and Limb defects)

* Esophageal atresia (proximal) and tracheoesophageal fistula:

- 90% of the cases
- We have : proximal esophageal atresia , distal fistula
- Complications :
 - **Poly-hydraminose :**increase in the amniotic fluid in the amniotic sac around the embryo, normally this fluid enter the esophagus and circulate within the embryo, but since the proximal end of esophagus is blind, this fluid move backward and <u>remain in the sac</u>.
 - After birth :
 - Vomiting and regurgitation of anything the infant swallow
 - **Pneumonia and pneumonitis:** because of the fistula that connects the respiratory system to the GI tract.
 - Infants with common type TEF and esophageal atresia cough and choke because of <u>excessive amounts of saliva</u> in the mouth
 - When the infant try to swallow milk it rapidly fills the esophageal pouch and is regurgitated
 - **Distention of the abdomen:** as the baby cries, the air enters through the fistula and fills the stomach.

It is essential to diagnose this case as soon as possible, within two days, surgical interventions and fixing the esophagus save the infant.



- ✤ Other types "less common":
 - two atresia ~ 1%
 - H-shaped fistula (in the figure, atresia with double fistula)
 - → Isolated esophageal atresia and H-type TEF without esophageal Atresia each accounts for 4% of these defects.

☆ Tracheal atresia and stenosis :

- Are uncommon anomalies and usually associated with one of the varities of TEF
- In some case a web tissue may obstructs the airflow (incomplete tracheal atresia)

*In the figure it is referred to as: atresia with distal fistula

Development of the larynx: (briefly)

- The internal lining of the larynx originates from endoderm, but the cartilages and muscles originate from mesenchyme of the 4th and 6th pharyngeal arches
- As a result of rapid proliferation of this mesenchyme, the laryngeal orifice changes in appearance from a <u>sagittal slit to a T-shaped</u> <u>opening</u>

Foramen Cecum:

Separates anterior two thirds of the tongue from the posterior third,

Lies at the bottom of pharynx

It's where the thyroid gland start formation ...

- This orifice is the only connection between the respiratory and GI system
- Subsequently, when <u>mesenchyme of the two arches</u> transforms into the thyroid, cricoid, and arytenoid cartilages, the characteristic adult shape of the laryngeal orifice can be recognized



- At about the time that the cartilages are formed, the laryngeal epithelium also proliferates rapidly resulting in a temporary occlusion of the lumen.
- Subsequently, vacuolization and recanalization produce a pair of lateral recesses, the laryngeal ventricles (sacules)
- True vocal cords and false vocal cords are related to formation of ventricles

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- Since musculature of the larynx is derived from mesenchyme of the fourth and sixth pharyngeal arches, all laryngeal muscles are innervated by branches of the tenth cranial nerve, the vagus nerve
- **The superior laryngeal** nerve innervates derivatives of the **fourth** pharyngeal arch, and the **recurrent laryngeal** nerve innervates derivatives of the **sixth pharyngeal arch**





"Words will be just words till you bring them to life"

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