**Events during first week of development**

- Post pronuclei fusion: Zygote is formed
- Male and female pronuclei formed: Duplicate their DNA
- Fertilization: ~12-24 hours after ovulation
- 1st mitosis
- 2 cell stage: ~2 days
- Early Morula: 16 cells, 3 days
- Late morula: 32 cell, ~4 days
- Endometrium in the secretory phase
- Blastocyst: ~5 days
- Blastocyst cavity
- Inner cell mass
- Outer cell mass
- Early implantation of blastocyst: ~6 days
- Trophoblast cells
- Trophoblast
- Embryoblast
- Fimbria
- Zygote
- Blastomere
- Oocyte after ovulation
The embryo is a blastocyst.
The embryo is a trilaminar disc.
Folding of the embryo …… the embryo is becoming a tube like structure
Stage 13 Human Embryo
(roughly 28 days)
0.5 mm
The bones of the baby is completing its development by clothed with flesh during this stage.
Eleventh Week to Full Term
WEEK 4 EMBRYO

**General features**

- Primordia of the brain
- Primordia of the heart
- Primordia of the eye
- Primordia of the nose
- Somites
- Upper limbs bud
- Lower limbs bud
- Branchial arches
The most important feature in the development of the head and neck is the Formation of THE PHARYNGEAL OR BRANCHIAL ARCHES
development of pharyngeal arches resembles formation of gills in fish.

However, in the human embryo, real gills (branchia) are never formed. Therefore, the term pharyngeal arches has been adopted for the human embryo.

Is it branchial or is it pharyngeal arch?
THE PHARYNGEAL ARCHES appear in the fourth and fifth weeks of development.
In a cross section of the embryo in the area of the head and neck, the following can be noticed:

**The Pharyngeal Arches**

The pharyngeal pouches appear with development of the arches and clefts, a number of outpocketings.

**The Pharyngeal Clefts**

**The Pharyngeal Arches** are separated by deep clefts known as **Pharyngeal Clefts**.
Why the appear?

Migration of cells from

1- PARAXIAL MESODERM
2- LATERAL PLATE MESODERM
3- NEURAL CREST

What are 1, 2, and 3?
Paraxial mesoderm

It develops into two peripheral masses and a constriction in the middle

1-Medial mesoderm
2-Intermediate
3-lateral mesoderm
Medial mesoderm

• The medial mesoderm enlarges pushing the ectoderm upwards to give
  the **somites**
Migration of the cells from the occipital Myotomes into the future mouth to form the tongue

This is an explanation to how the arches appear as a result of migration of the cells from the medial mesoderm (somites) into the regions of the future head and neck.

As we mentioned there are other reasons...
1-PHARYNGEAL ARCHES
During the fifth week, the second pharyngeal arch enlarges and overgrows the third and fourth arches, forming the ectodermal depression called cervical sinus.
Each pharyngeal arch consists of:

1. **Surface ECTODERM**
2. A core of MESENCHYMAL tissue
3. Epithelium of ENDODERMAL origin

Each pharyngeal arch contains:

1. **An artery** that arises from the primordial heart
2. A cartilaginous rod, forms the skeleton of the arch
3. **Muscular component** gives the muscles in the head and neck (each arch has its own cranial nerve and wherever the muscle cells migrate, they carry their nerve component with them)
4. **Nerve**, supplies the mucosa and muscles derived from the arch
What are the bones and cartilages of the head and neck?

- Spine of sphenoid bone
- Anterior ligament of malleus
- Malleus
- Incus
- Stapes
- Auditory ossicles
- Sphenomandibular ligament
- Styloid process
- Stylohyoid ligament
- Greater cornu (horn) of hyoid bone
- Thyroid cartilage
- Cricoid cartilage
- Former site of 1st arch (Meckel) cartilage
- Lesser cornu of hyoid bone
- Body of hyoid bone
1- Muscles of facial expression
2- Muscles of mastication
Nerves of the head and neck?
What are the organs of the head and neck?
The first pharyngeal arch consists of

1- A DORSAL PORTION
THE MAXILLARY PROCESS

and

2- A VENTRAL PORTION
THE MANDIBULAR PROCESS

which contains Meckel’s cartilage
Cartilaginous derivatives of the first pharyngeal arch

1. The dorsal end of first arch cartilage (Meckel cartilage) ossifies to form malleus and incus.

2. The middle part of cartilage forms anterior ligament of malleus, sphenomandibular ligament.

3. Ventral part of the first arch cartilages form primordium of the mandible. The cartilage disappears as mandible develops around it.
1- The **muscles of mastication** (temporalis, masseter, and pterygoids),
2- **Anterior belly of the digastric**
3- **mylohyoid**
4- **tensor tympani**, and **tensor palatini**
The nerve supply to the muscles of the first arch is provided by the **mandibular branch of the trigeminal nerve**

Since mesenchyme from the first arch also contributes to the dermis of the face, **sensory supply** to the skin of the face is provided by **ophthalmic, maxillary, and mandibular branches of the trigeminal nerve**.
The cartilage of the second or hyoid arch (Reichert’s cartilage) gives rise to:

1. The stapes
2. Styloid process of the temporal bone
3. Stylohyoid ligament
4. The lesser horn and the upper part of the body of the hyoid bone

Muscles of the hyoid arch are:
1. The stapedius
2. Stylohyoid
3. Posterior belly of the digastric
4. Auricular, and
5. Muscles of facial expression

The nerve of the second arch is the facial nerve, which supplies all of these muscles.
The cartilage of the third pharyngeal arch produces:

1. The lower part of the body and greater horn of the hyoid bone

2. The musculature is limited to the *stylopharyngeus* muscles

These muscles are innervated by the **GLOSSOPHARYNGEAL NERVE**

the nerve of the third arch
FOURTH AND SIXTH PHARYNGEAL ARCHES
Cartilaginous components of the fourth and sixth pharyngeal arches fuse to form
1-THE THYROID
2-CRICOID
3-ARYTENOID
4-CORNICULATE
5- CUNEIFORM

The cartilages of the LARYNX

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Figure 15.9 Definitive structures formed by the cartilaginous components of the various pharyngeal arches.

of the larynx (Fig. 15.9). Muscles of the fourth arch (cricothyroid, levator palatini, and constrictors of the pharynx) are innervated by the superior laryngeal branch of the vagus, the nerve of the fourth arch. Intrinsic muscles
2-PHARYNGEAL POUCHES
The human embryo has **FIVE PAIRS** of pharyngeal pouches.

- The last one of these is atypical and often considered as part of the fourth

**FIRST PHARYNGEAL POUCH** forms a diverticulum called the *tubotympanic recess*

The **FIRST PHARYNGEAL POUCH** comes in contact with the epithelial lining of the first pharyngeal cleft, the future **EXTERNAL AUDITORY MEATUS**

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*Figure 15.10 A. Development of the pharyngeal clefts and pouches. The second arch grows over the third and fourth arches, burying the second, third, and fourth pharyngeal clefts. B. Remnants of the second, third, and fourth pharyngeal clefts form the cervical sinus, which is normally obliterated. Note the structures formed by the various pharyngeal pouches.*
The **distal** portion of the diverticulum widens into a saclike structure
the primitive tympanic or **MIDDLE EAR CAVITY**
and the **proximal** part remains narrow, forming **THE AUDITORY**
(eustachian) tube

The lining of the tympanic cavity later aids in formation of
the tympanic membrane or eardrum

*Figure 15.11* Migration of the thymus, parathyroid glands, and ultimobranchial body. The thyroid gland originates in the midline at the level of the foramen cecum and descends to the level of the first tracheal rings.
SECOND PHARYNGEAL POUCH
The epithelial lining of the second pharyngeal pouch proliferates and forms

THE PRIMORDIUM OF THE PALATINE TONSIL

During the third and fifth months, the tonsil is infiltrated by lymphatic tissue

Part of the pouch remains and is found in the adult as the TONSILLAR FOSSA
THIRD PHARYNGEAL POUCH

In the fifth week, epithelium of the dorsal wing of the third pouch differentiates into INFERIOR PARATHYROID GLAND while the ventral wing forms THE THYMUS

Both gland primordia lose their connection with the pharyngeal wall, and the thymus then migrates in a caudal and a medial direction, pulling the inferior parathyroid with it

- Growth and development of the thymus continue until puberty
- In the young child, the thymus occupies considerable space in the thorax and lies behind the sternum and anterior to the pericardium and great vessels
- In older it is atrophied and replaced by fatty tissue

Figure 15.11 Migration of the thymus, parathyroid glands, and ultimobranchial body. The thyroid gland originates in the midline at the level of the foramen cecum and descends to the level of the first tracheal rings.
FOURTH PHARYNGEAL POUCH
Epithelium of the dorsal wing of the fourth pharyngeal pouch forms THE SUPERIOR PARATHYROID GLAND

When the parathyroid gland loses contact with the wall of the pharynx, it attaches itself to the dorsal surface of the caudally migrating thyroid as the superior parathyroid gland.

FIFTH PHARYNGEAL POUCH
the last to develop, is usually considered to be a part of the fourth pouch.
It gives rise to the ultimobranchial body which is later incorporated into the thyroid gland. Cells of the ultimobranchial body give rise to the parafollicular, or C, cells of the thyroid gland. These cells secrete calcitonin, a hormone involved in regulation of the calcium level in the blood.
3-PHARYNGEAL CLEFTS
3-Pharyngeal Clefts

The 5-week embryo is characterized by the presence of four pharyngeal clefts of which only one contributes to the definitive structure of the embryo.

- The dorsal part of the first cleft penetrates the underlying mesenchyme and gives rise to the **external auditory meatus**.
- The epithelial lining at the bottom of the meatus participates in formation of the **eardrum**.
- Active proliferation of mesenchymal tissue in the second arch causes it to overlap the third and fourth arches. Finally, it merges with the **epicardial ridge** in the lower part of the neck and the second, third, and fourth clefts lose contact with the outside.

*The clefts form a cavity lined with ectodermal epithelium, the **cervical sinus**, but with further development this sinus disappears.*

Figure 15.10 A. Development of the pharyngeal clefts and pouches. The second arch grows over the third and fourth arches, burying the second, third, and fourth pharyngeal clefts. B. Remnants of the second, third, and fourth pharyngeal clefts form the cervical sinus, which is normally obliterated. Note the structures formed by the various pharyngeal pouches.
DEVELOPMENT OF THE FACE
At the end of the fourth week, facial prominences consisting primarily of neural crest-derived mesenchyme and formed mainly by the first pair of pharyngeal arches.

The frontonasal prominence formed by proliferation of mesenchyme ventral to the brain vesicles, constitutes the upper border of the stomodeum.

Maxillary prominences can be distinguished lateral to the stomodeum.

MANDIBULAR prominences can be distinguished caudal to the stomodeum.

On both sides of the frontonasal prominence, local thickenings of the surface ectoderm, the nasal placodes.
During the fifth week, the nasal placodes invaginate to form **NASAL PITS**. In so doing, they create a ridge of tissue that surrounds each pit and forms **THE NASAL PROMINENCES**.

The prominences on the outer edge of the pits are:
- **THE MEDIAL NASAL PROMINENCES**
- **THE LATERAL NASAL PROMINENCES**

During the following 2 weeks, the **maxillary prominences** continue to increase in size. Simultaneously, they **grow medially**, compressing the medial nasal prominences toward the midline. Subsequently, the cleft between the medial nasal prominence and the maxillary prominence is lost, and the two fuse.

**Figure 15.23** Frontal aspect of the face. A. 7-week embryo. Maxillary prominences have fused with the medial nasal prominences. B. 10-week embryo. C. Scanning electron micrograph of a human embryo at a stage similar to that of A.
Therefore, the upper lip is formed by **THE TWO MEDIAL NASAL** prominences
And
**THE TWO MAXILLARY PROMINENCES**

The lateral nasal prominences do not participate in formation of the upper lip

The lower lip and jaw form from the mandibular prominences that merge across the midline

*Figure 15.22* Frontal aspect of the face. A. 5-week embryo. B. 6-week embryo. The nasal prominences are gradually separated from the maxillary prominence by deep furrows. C. Scanning electron micrograph of a mouse embryo at a stage similar to that of B.*
As a result of medial growth of the maxillary prominences
And the two medial nasal prominences merge **not only at the surface but also at a deeper level**
The structure formed by the two merged prominences is the INTERMAXILLARY SEGMENT

It is composed of:

1. (a) a labial component, which forms the philtrum of the upper lip
2. (b) an upper jaw component, which carries the four incisor teeth
3. (c) a palatal component, which forms the triangular primary palate

The intermaxillary segment is continuous with the rostral portion of the nasal septum, which is formed by the frontal prominence

Figure 15.23 Frontal aspect of the face. A. 7-week embryo. Maxillary prominences have fused with the medial nasal prominences. B. 10-week embryo. C. Scanning electron micrograph of a human embryo at a stage similar to that of A.
Secondary Palate

Although the primary palate is derived from the intermaxillary segment, the main part of the definitive palate is formed by two shelflike outgrowths from the maxillary prominences. These outgrowths, the palatine shelves, appear in the sixth week of development and are directed obliquely downward on each side of the tongue. In the seventh week, however, the palatine shelves ascend to attain a horizontal position above the tongue and fuse, forming the secondary palate.

Anteriorly, the shelves fuse with the triangular primary palate, and the incisive foramen 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.

Figure 15.24 A. Intermaxillary segment and maxillary processes. B. The intermaxillary segment giving rise to the philtrum of the upper lip, the median part of the maxillary bone with its four incisor teeth, and the triangular primary palate.
Facial Clefts
Cleft lip and cleft palate are common defects that result in abnormal facial appearance and defective speech

1. Cleft lip
2. Cleft palate

A. Normal.
A. **Unilateral cleft lip**: results from failure of the maxillary prominence to merge with medial nasal prominence on the effected side.

B. **Bilateral cleft lip**: results from failure of the maxillary prominences to merge with medial nasal prominence on both sides.
C. **Median cleft lip**: results from failure of the medial nasal prominences to merge and form the intermaxillary segment.

D. **Oblique facial cleft**: failure of fusion between the maxillary prominence and the lateral nasal prominence. The nasolacrimal duct persist opened, usually associated with cleft lip on the same side.
Cleft palate

The **incisive foramen** is considered the dividing landmark between the anterior and posterior cleft deformities.

A- Cleft of the primary palate

Results from failure of the palatine shelves to fuse with the primary palate which takes place anterior to the incisive foramen therefore this type is **anterior cleft palate**

Note that **Cleft of the primary palate is always anterior** and can be **unilateral and bilateral**

Primary Bilateral cleft (involving the lip and jaw)

Note : It is anterior to the incisive foramen

Primary Unilateral Cleft palate (combined with unilateral cleft lip)
B. Cleft of the secondary palate

Results from failure of the palatine shelves to fuse with each other and with the primary palate which takes place **posterior to the incisive foramen therefore this type is**

*Posterior cleft palate*

Note that **Cleft of the secondary palate is always posterior**

Note it is located posterior to the **incisive foramen**
Cleft of the primary and secondary palate

Results from failure of the palatine shelves to fuse with each other and with the primary palate which takes place *anterior and posterior to the incisive foramen*

therefore this type is *mixed anterior and posterior cleft palates*

Primary and secondary Cleft palates combined with unilateral cleft lip