Pharyngeal Apparatus

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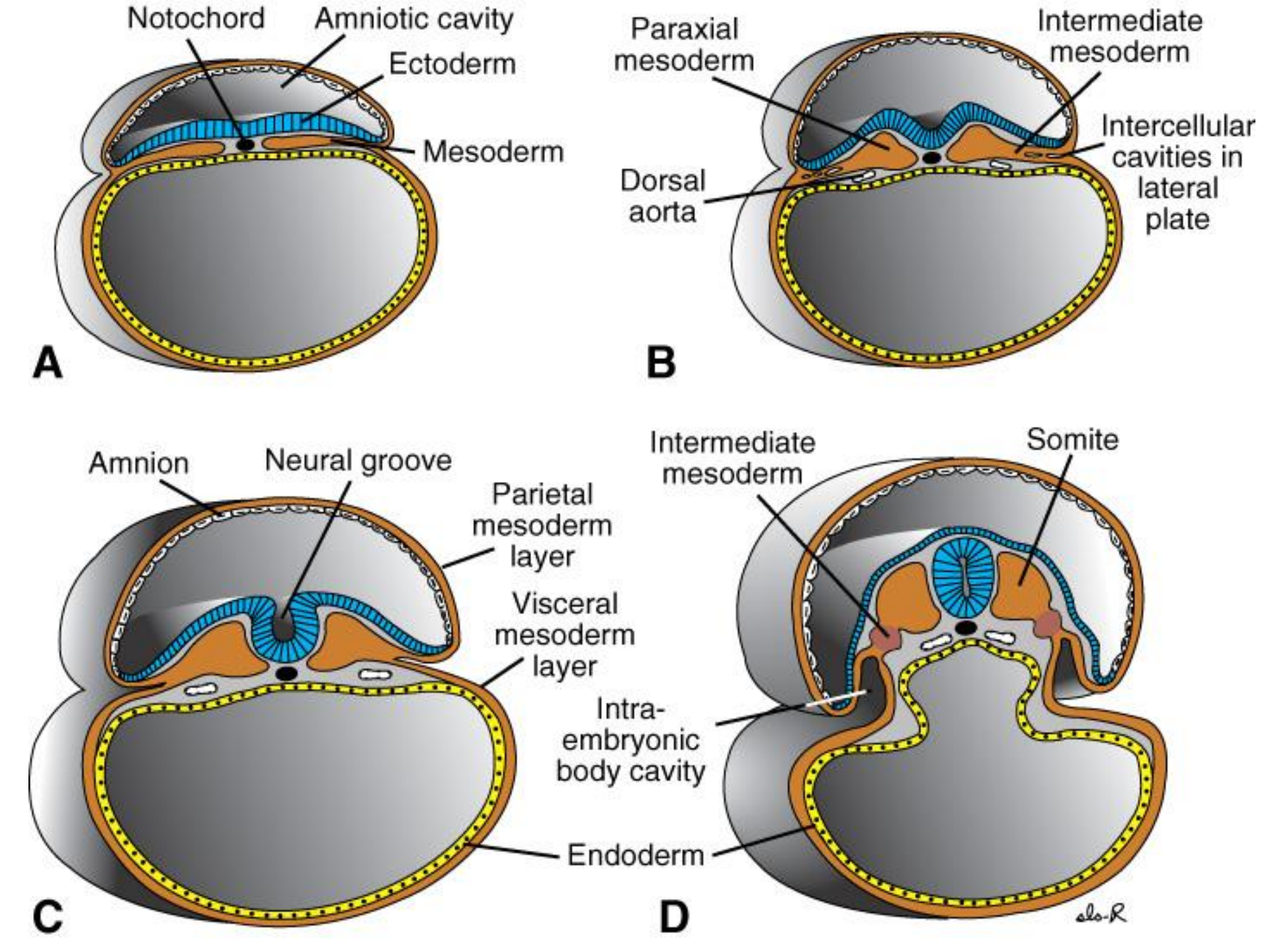
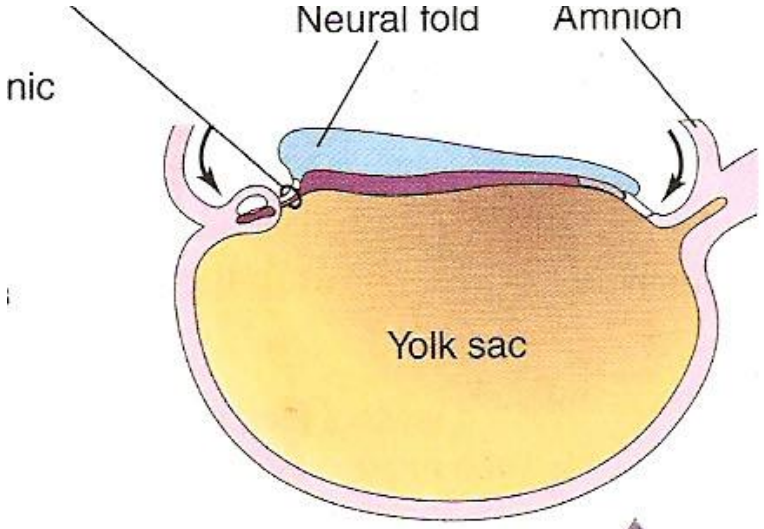
Embryonic folding

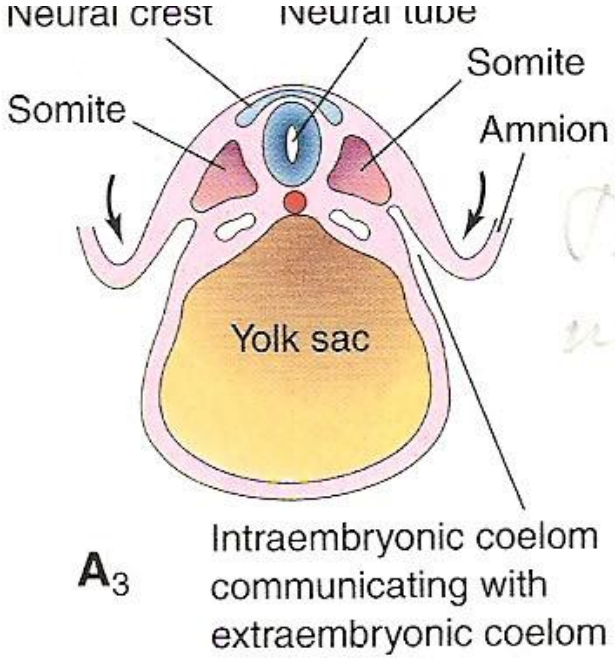
- 4th week
- Cephalocaudal folding
- Lateral folding
- Flat germ disc ➡ 3-D vertebrate body form

http://www.indiana.edu/~anat550/genanim/latfold/latfold.swf

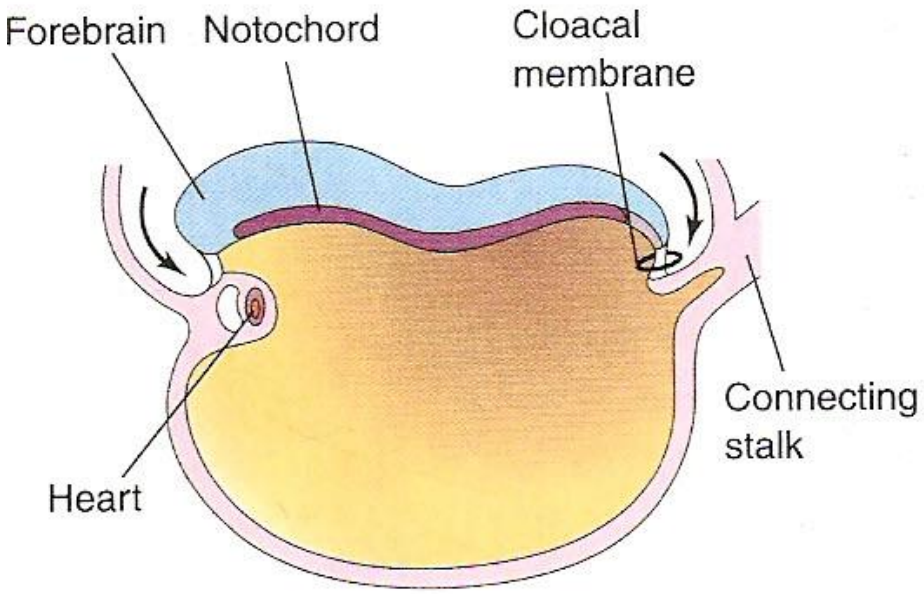

Notochord
Amniotic cavity
Ectoderm
Mesoderm
A
Paraxial mesoderm
Intermediate mesoderm
Intercellular cavities in lateral plate
Dorsal aorta
B
Amnion
Neural groove
Parietal mesoderm layer
Visceral mesoderm layer
Endoderm
C
Intermediate mesoderm
Somite
Intra-embryonic body cavity
D


nic
Neural fold
Amnion
Yolk sac

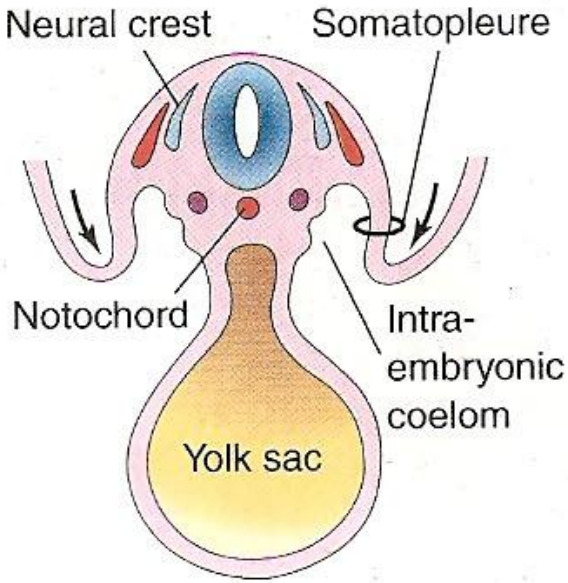
A_2


Neural crest
Neural tube
Somite
Somite
Amnion
Yolk sac
Intraembryonic coelom
communicating with
extraembryonic coelom

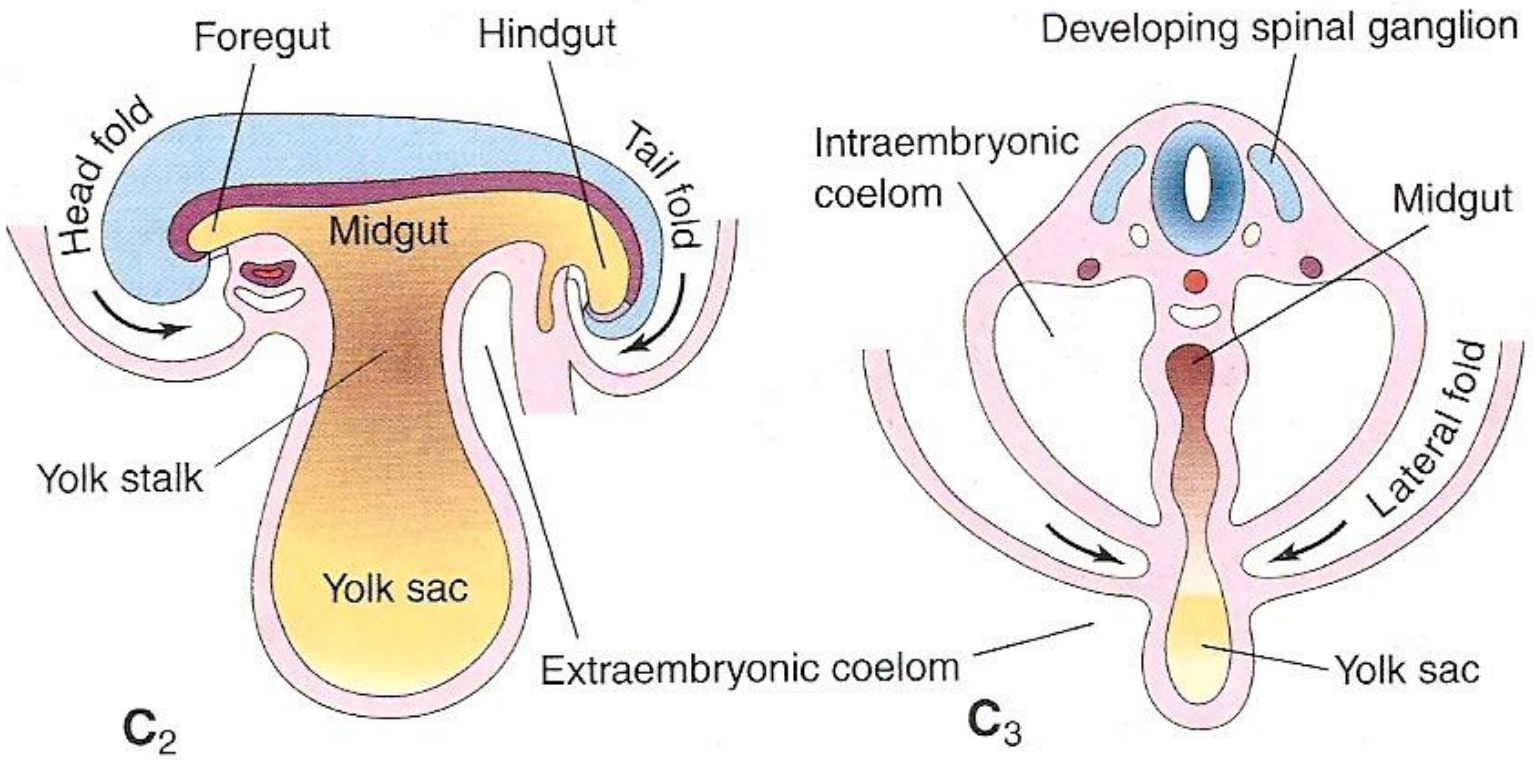
A_3

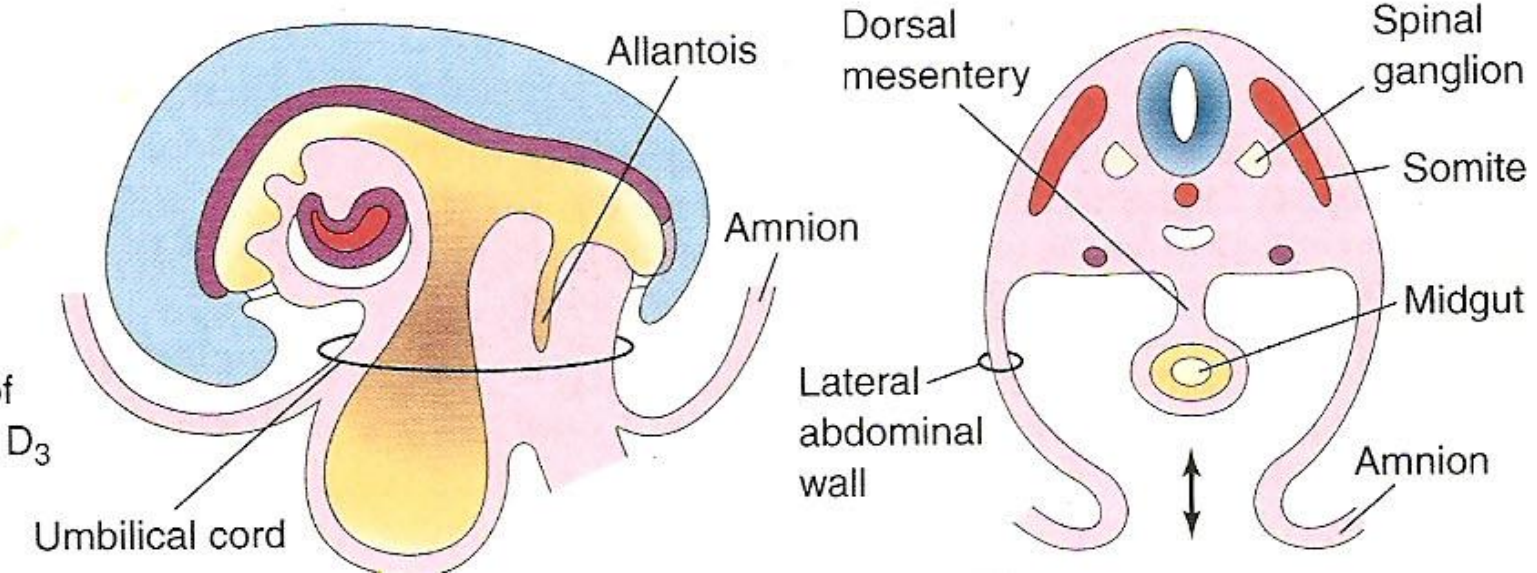

Forebrain
Notochord
Cloacal
membrane
Connecting
stalk
Heart

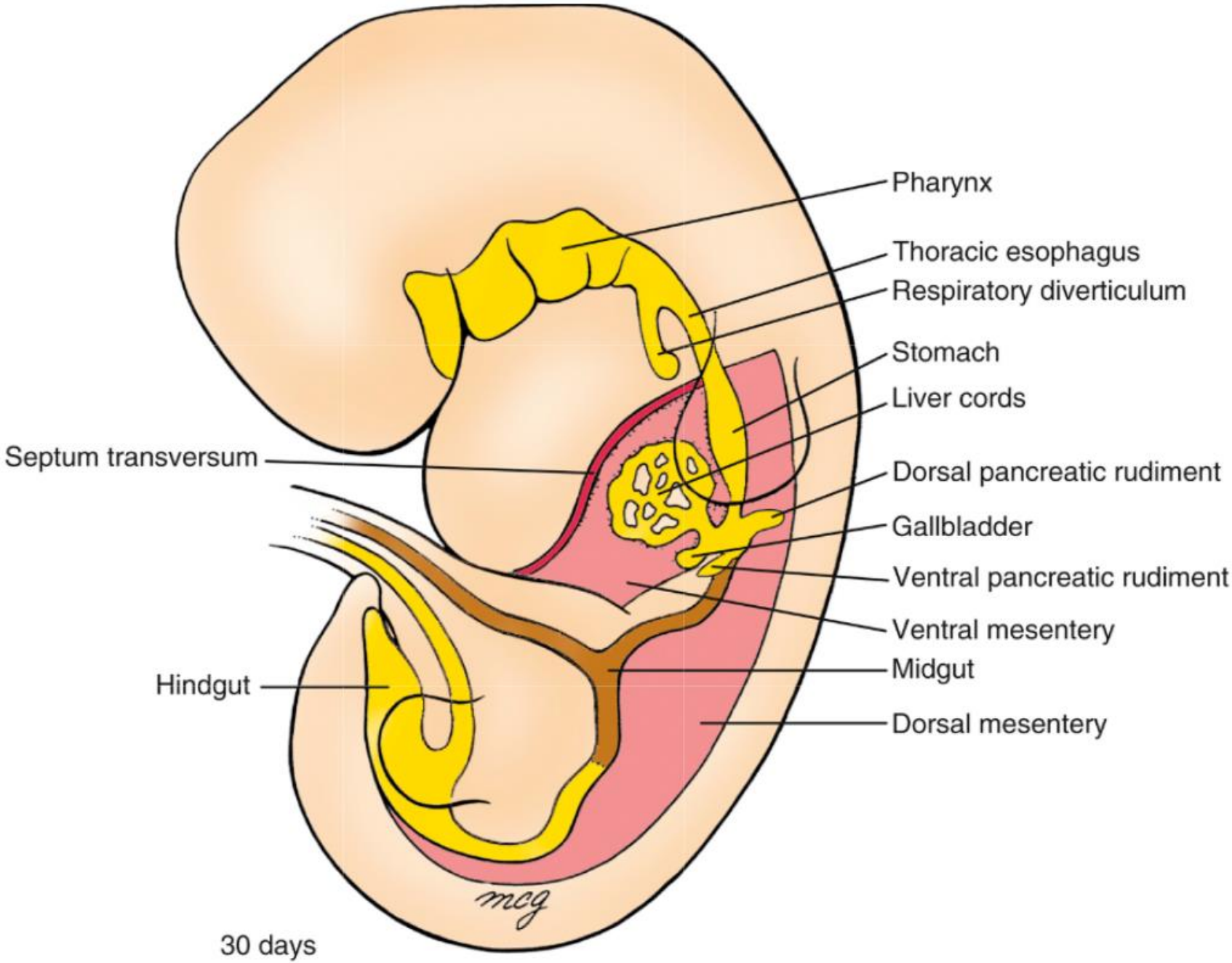
B_2

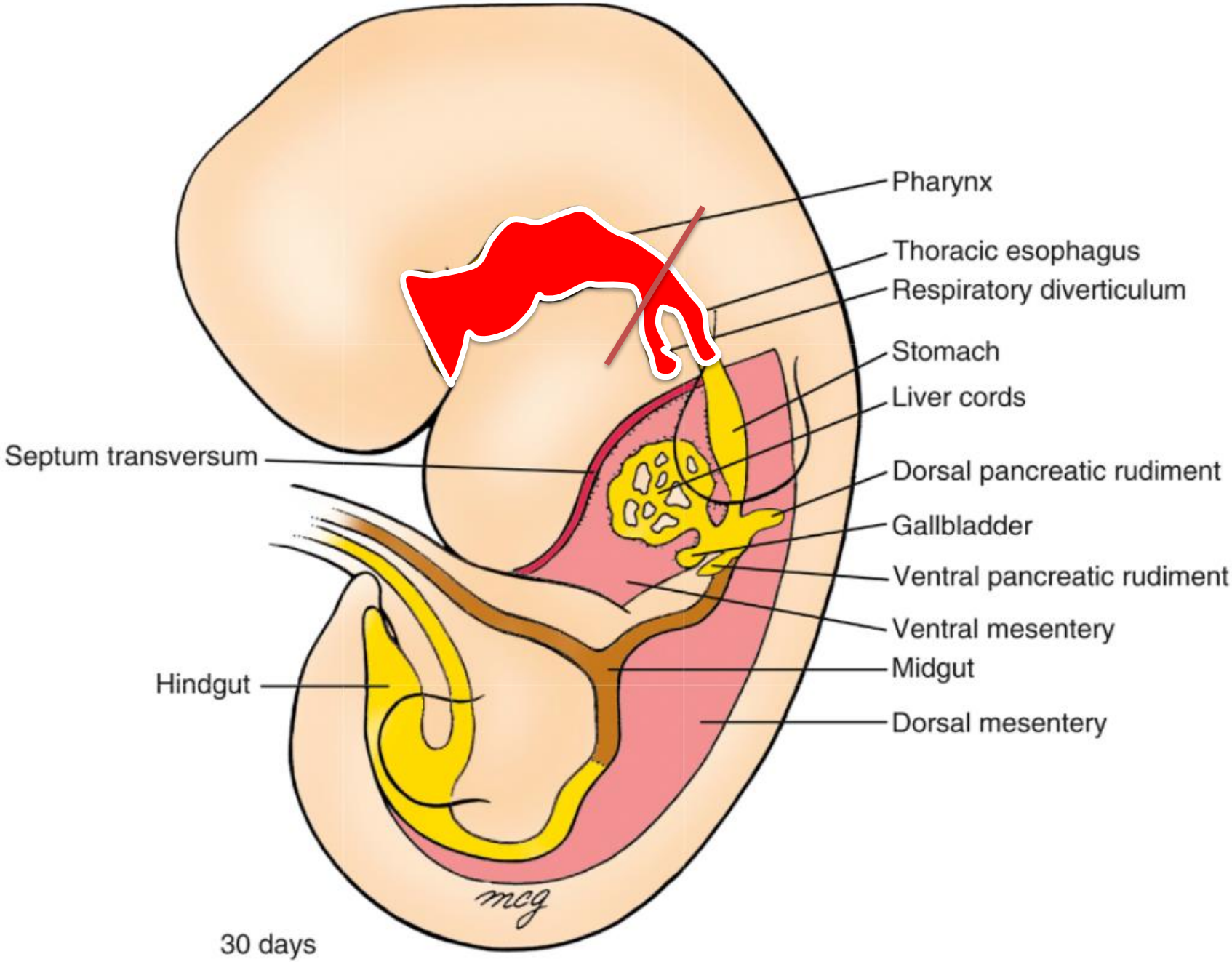

Neural crest
Somatopleure
Notochord
Intra-
embryonic
coelom
Yolk sac

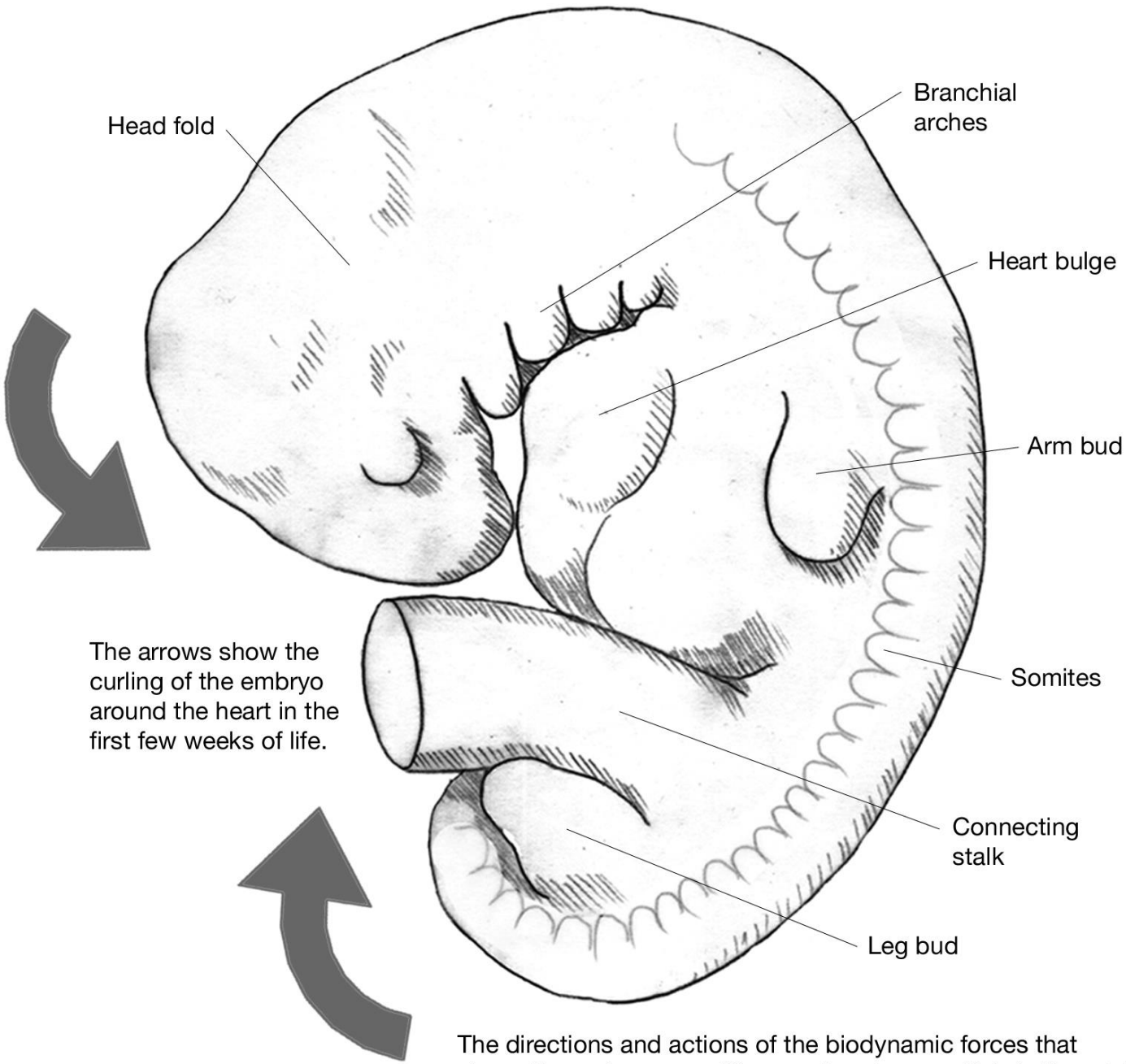
B_3


Foregut
Hindgut
Head fold
Tail fold
Midgut
Yolk stalk
Yolk sac
Extraembryonic coelom
C2
Developing spinal ganglion
Intraembryonic coelom
Midgut
Lateral fold
Yolk sac
C3


Allantois
Amnion
Umbilical cord
Dorsal mesentery
Spinal ganglion
Somite
Midgut
Lateral abdominal wall
Amnion


Pharynx
Thoracic esophagus
Respiratory diverticulum
Stomach
Liver cords
Septum transversum
Dorsal pancreatic rudiment
Gallbladder
Ventral pancreatic rudiment
Ventral mesentery
Midgut
Hindgut
Dorsal mesentery
mcg
30 days


Pharynx
Thoracic esophagus
Respiratory diverticulum
Stomach
Liver cords
Septum transversum
Dorsal pancreatic rudiment
Gallbladder
Ventral pancreatic rudiment
Ventral mesentery
Hindgut
Midgut
Dorsal mesentery
mcg
30 days



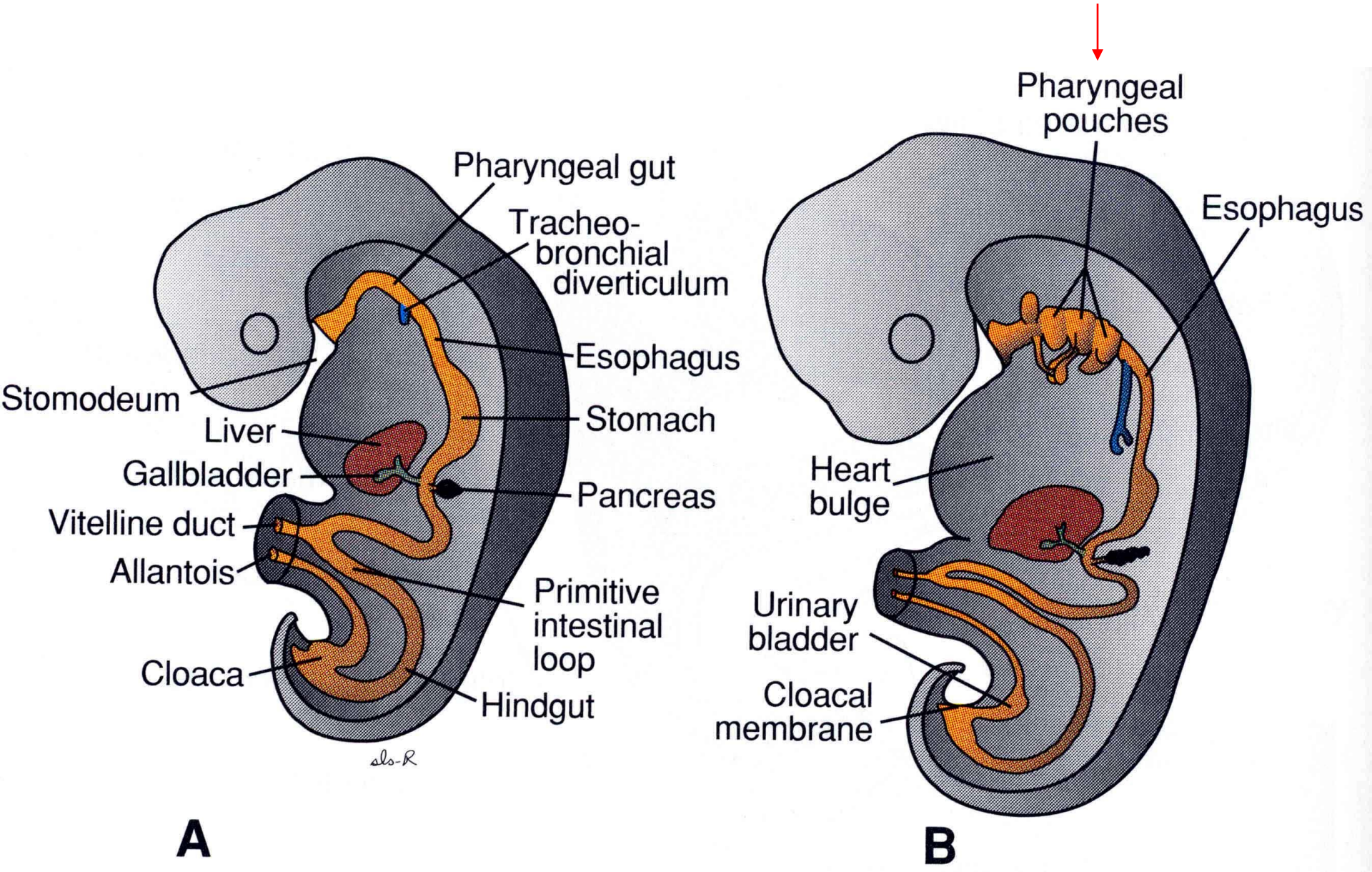
The arrows show the curling of the embryo around the heart in the first few weeks of life.

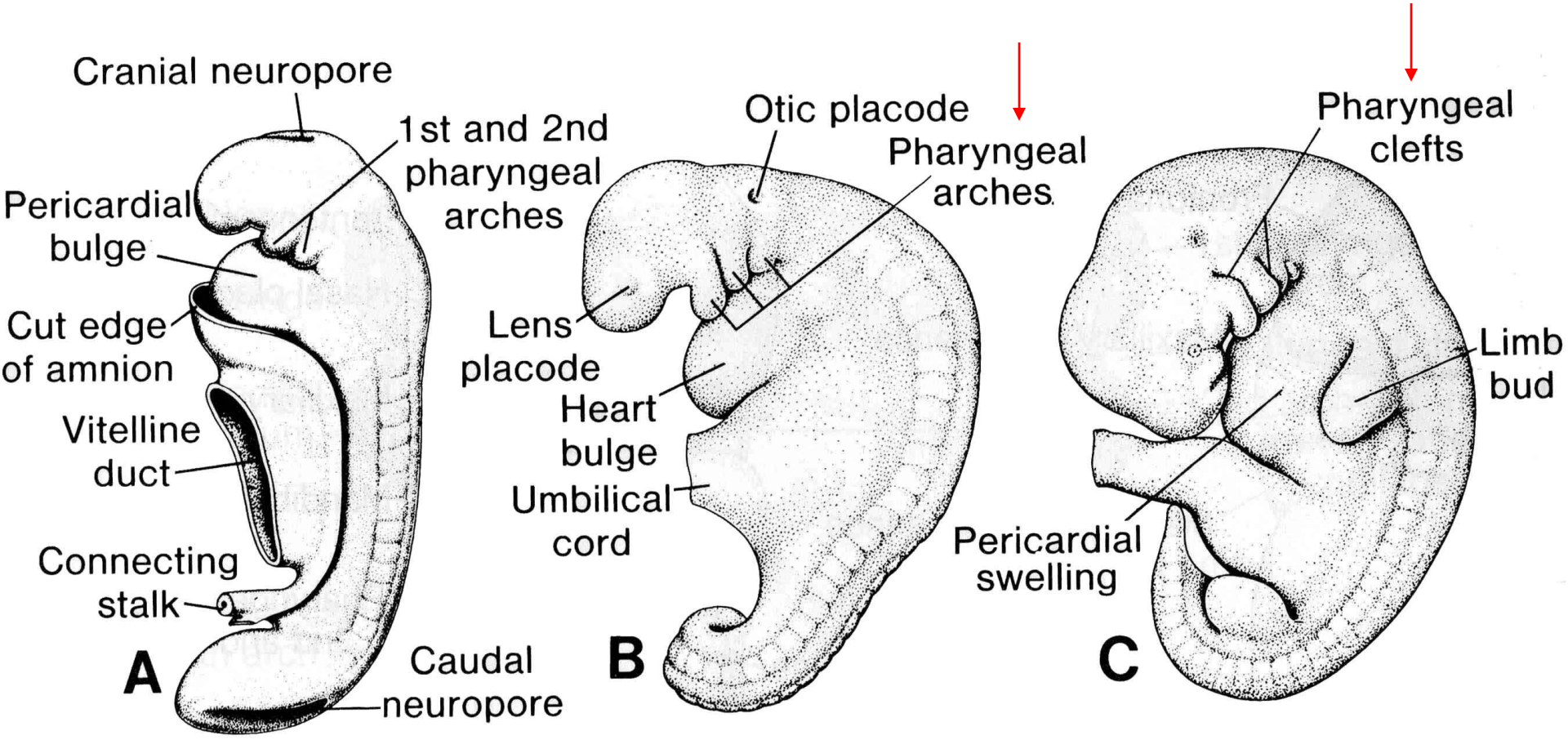
The directions and actions of the biodynamic forces that shape the embryo are still present and perceptible in the adult.

Pharyngeal apparatus

- 4 pairs of pharyngeal arches are well defined
- 5th pair never forms in humans
- 6th pair questioned / not visible externally

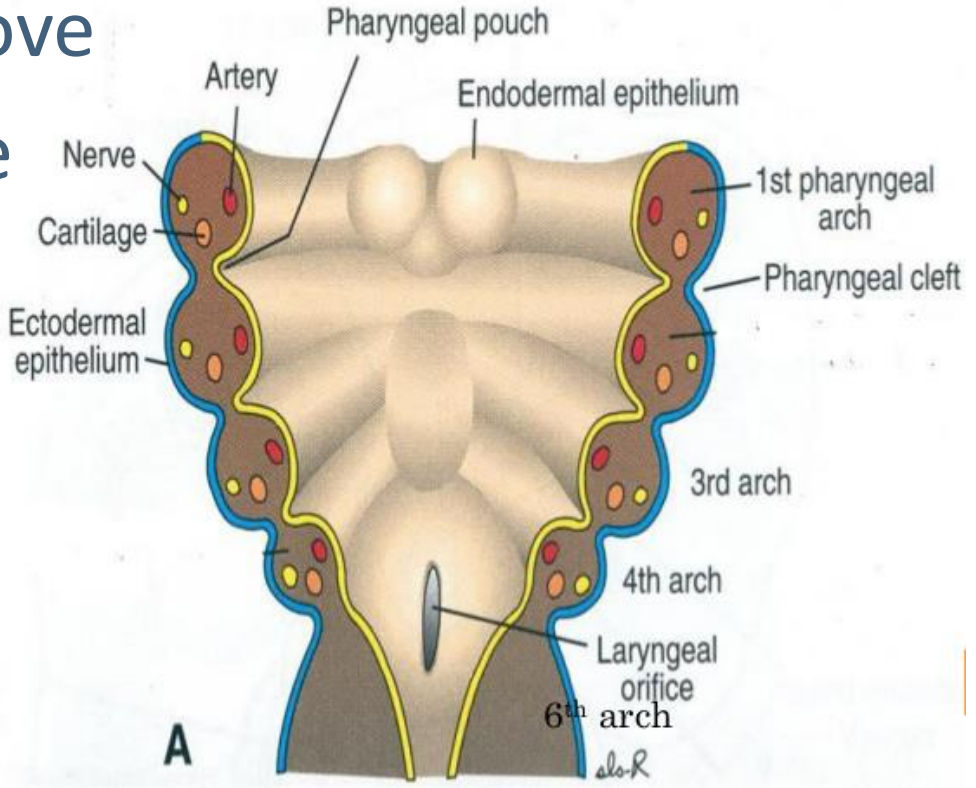
- Day 22 – 29


Pharyngeal gut
Tracheo-
bronchial
diverticulum
Esophagus
Stomodeum
Liver
Stomach
Gallbladder
Pancreas
Vitelline duct
Allantois
Primitive
intestinal
loop
Cloaca
Hindgut
A
Pharyngeal
pouches
Esophagus
Heart
bulge
Urinary
bladder
Cloacal
membrane
B


Cranial neuropore
1st and 2nd pharyngeal arches
Pericardial bulge
Cut edge of amnion
Vitelline duct
Connecting stalk
A
Caudal neuropore
Otic placode
Pharyngeal arches
Lens placode
Heart bulge
Umbilical cord
B
Pharyngeal clefts
Limb bud
Pericardial swelling
C

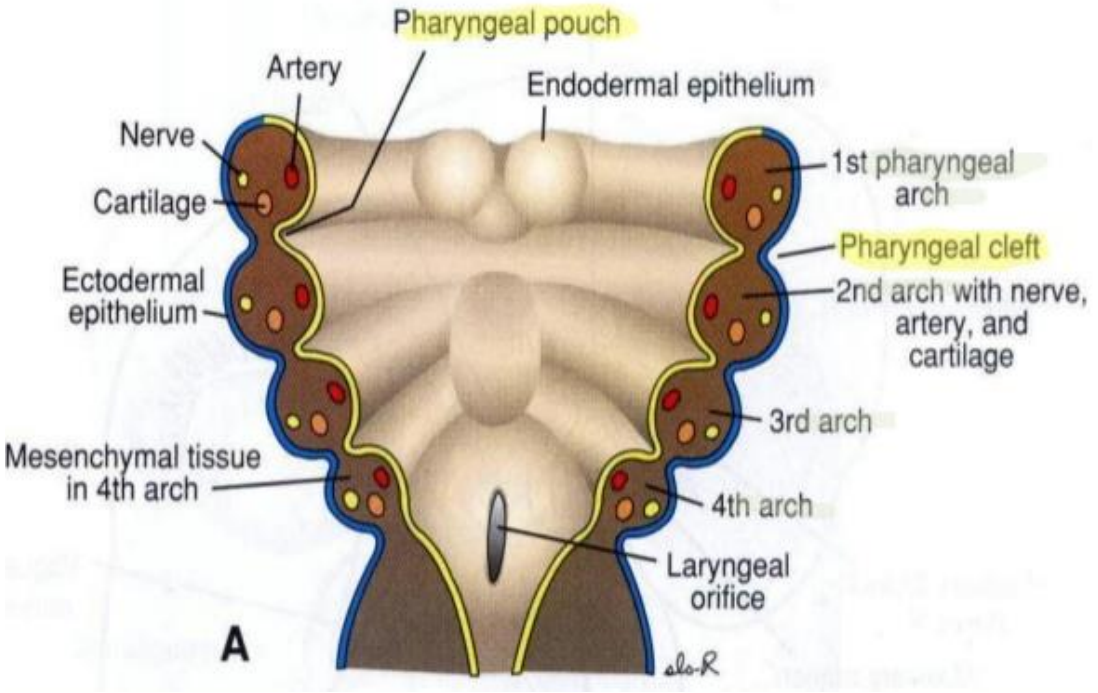
Pharyngeal apparatus

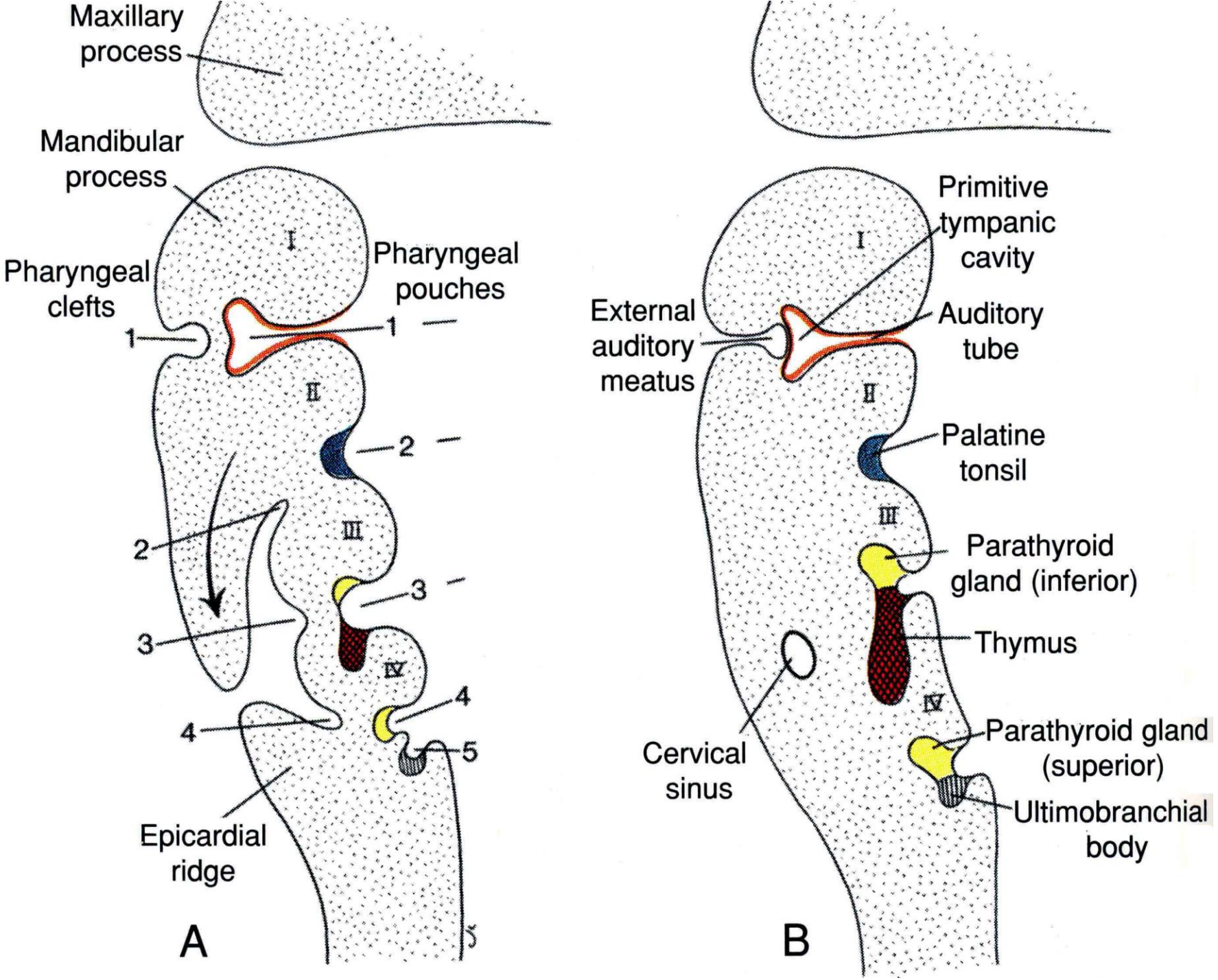
- Pharyngeal arch
- Pharyngeal pouch
- Pharyngeal cleft / groove
- Pharyngeal membrane

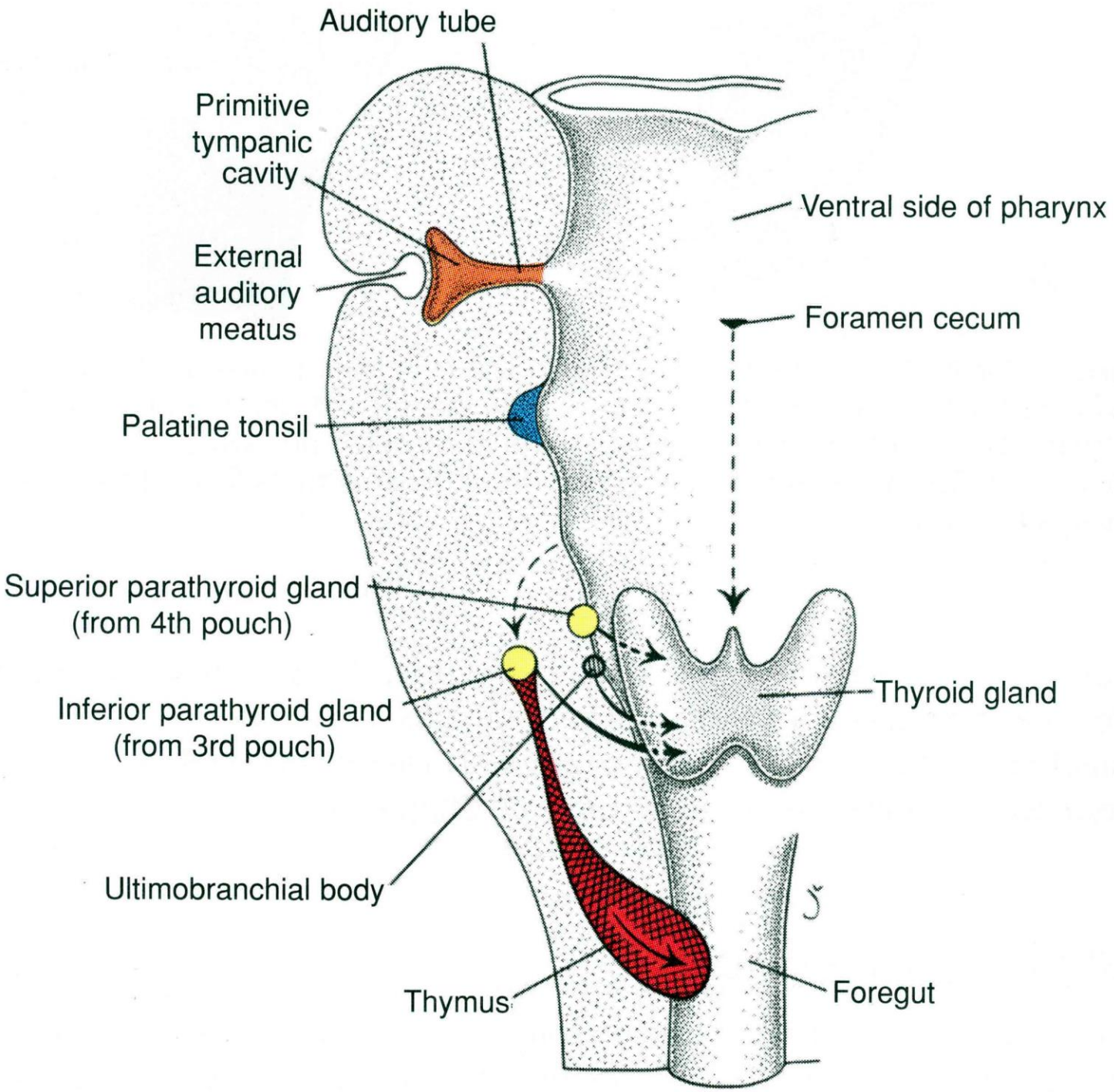


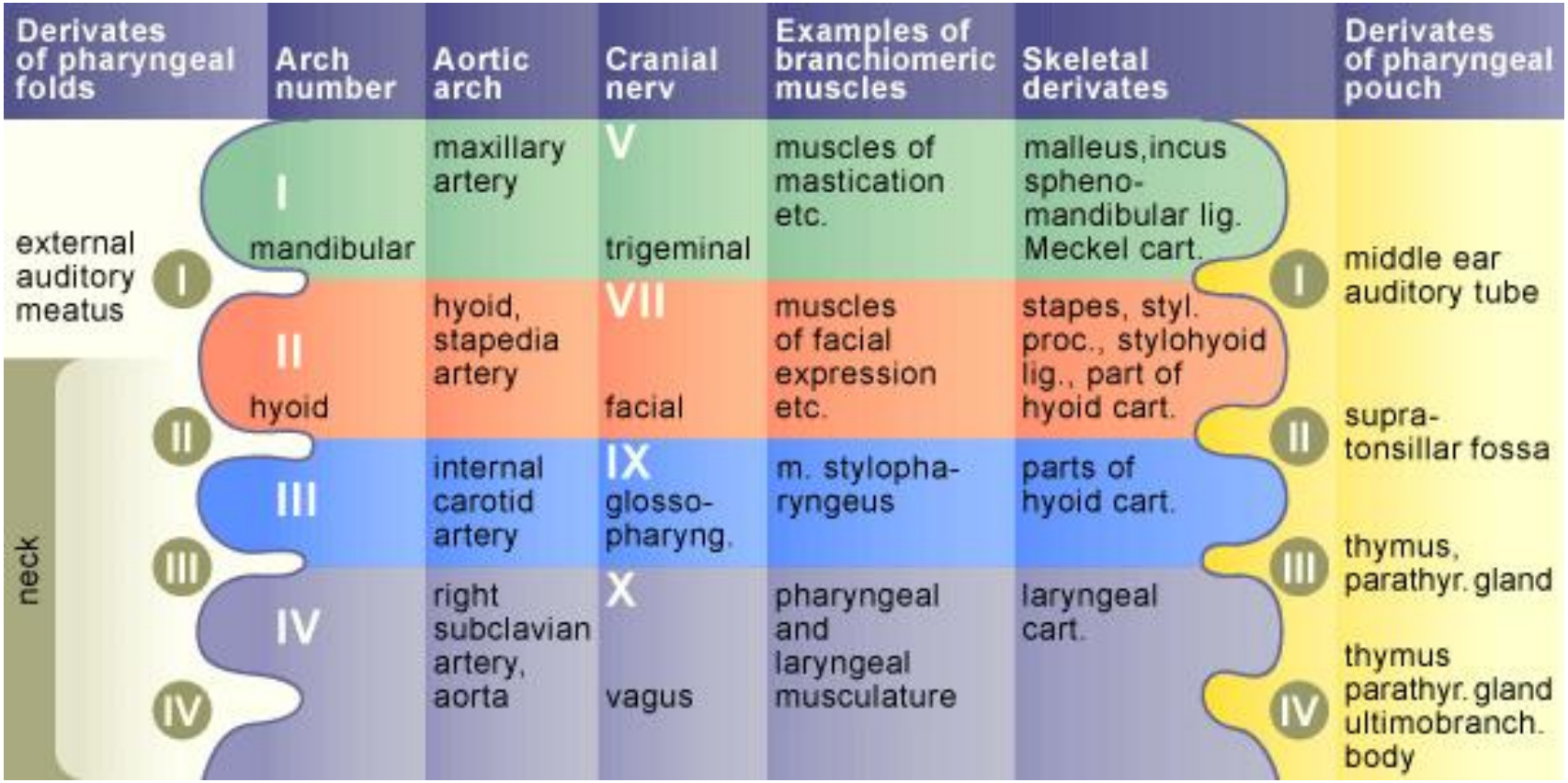
Pharyngeal apparatus

- Ectodermal surface
- Mesenchymal core (mesoderm + **neural crest cells**)
  - **Aortic arch artery**
  - **Cartilagineous element**
  - **Striated muscle elements** innervated by specific **cranial nerve**
- Endodermal lining




Maxillary process
Mandibular process
Pharyngeal clefts
Pharyngeal pouches
I
II
III
IV
1
2
3
4
5
Epicardial ridge
A
Primitive tympanic cavity
External auditory meatus
Auditory tube
Palatine tonsil
Parathyroid gland (inferior)
Thymus
Parathyroid gland (superior)
Ultimobranchial body
Cervical sinus
B

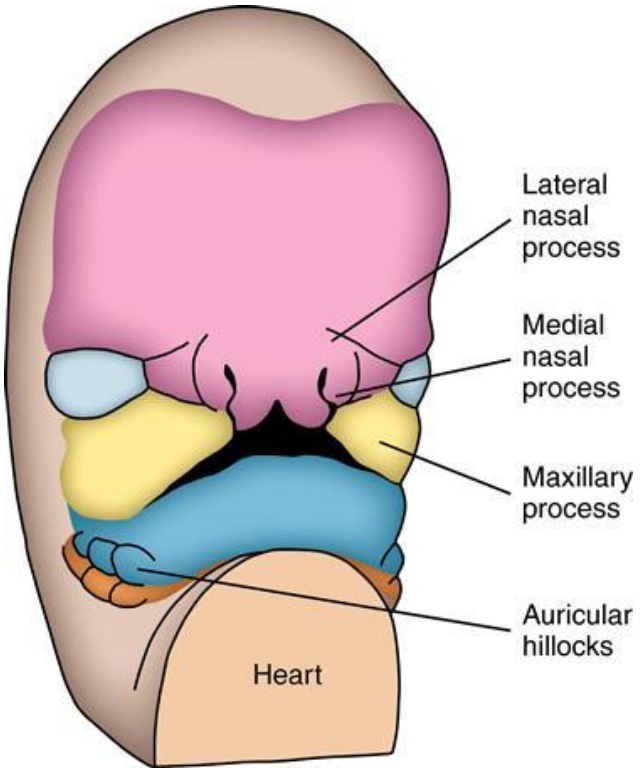

Auditory tube
Primitive tympanic cavity
External auditory meatus
Ventral side of pharynx
Foramen cecum
Palatine tonsil
Superior parathyroid gland (from 4th pouch)
Inferior parathyroid gland (from 3rd pouch)
Thyroid gland
Ultimobranchial body
Thymus
Foregut

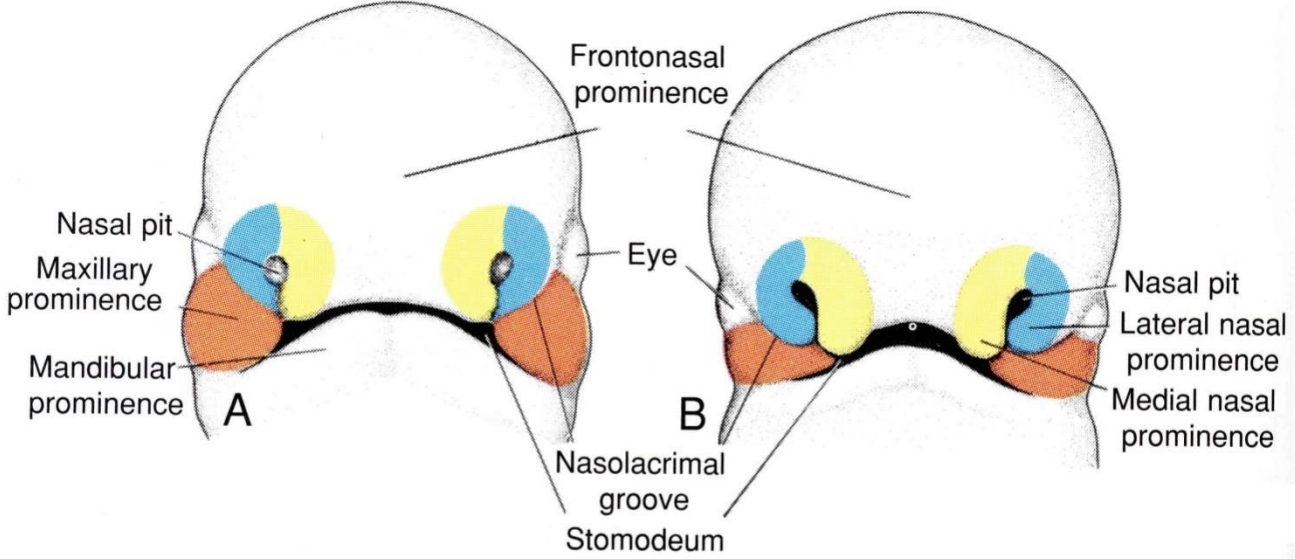

Derivates of pharyngeal folds
Arch number
Aortic arch
Cranial nerv
Examples of branchiomeric muscles
Skeletal derivates
Derivates of pharyngeal pouch
external auditory meatus
neck
I
mandibular
maxillary artery
V
trigeminal
muscles of mastication etc.
malleus, incus spheno-mandibular lig. Meckel cart.
middle ear auditory tube
II
hyoid
hyoid, stapedia artery
VII
facial
muscles of facial expression etc.
stapes, styl. proc., stylohyoid lig., part of hyoid cart.
supra-tonsillar fossa
III
internal carotid artery
IX
glosso-pharyng.
m. stylopha-ryngeus
parts of hyoid cart.
thymus, parathyr. gland
IV
right subclavian artery, aorta
X
vagus
pharyngeal and laryngeal musculature
laryngeal cart.
thymus parathyr. gland ultimobranch. body

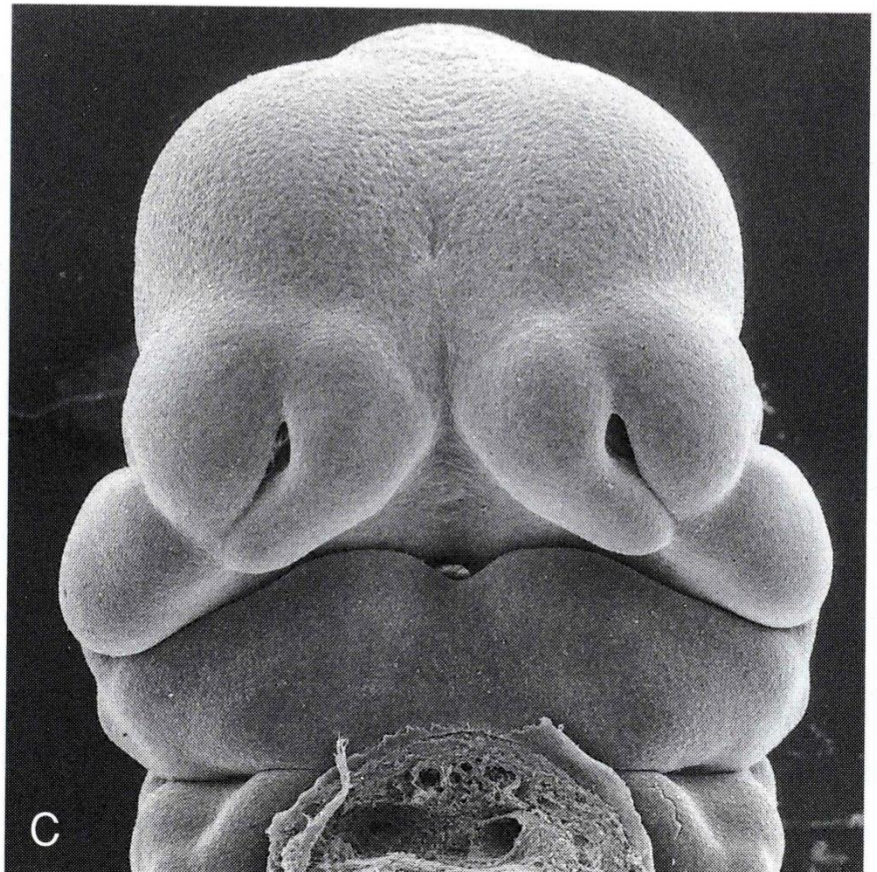
Development of Face

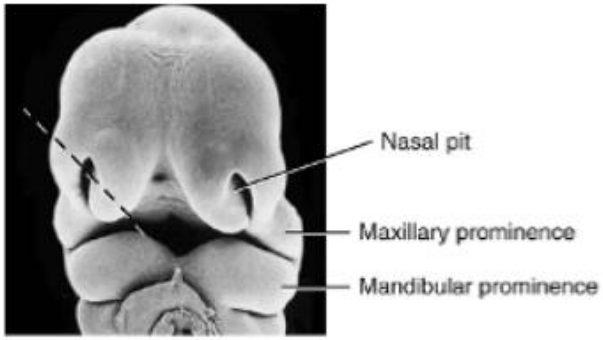
- 4th – 10th week

- Frontonasal prominence
- Paired maxillary prominence
- Paired mandibular prominence

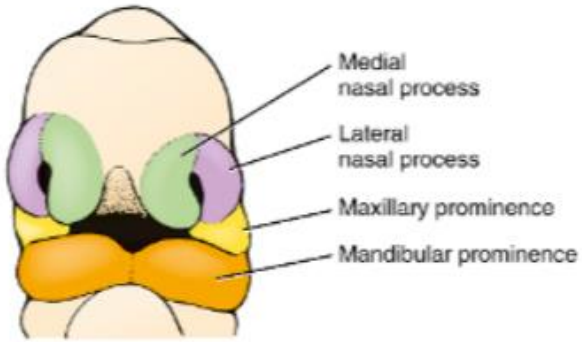



Frontonasal prominence
Nasal pit
Maxillary prominence
Mandibular prominence
A
Eye
B
Nasal pit
Lateral nasal prominence
Medial nasal prominence
Nasolacrimal groove
Stomodeum

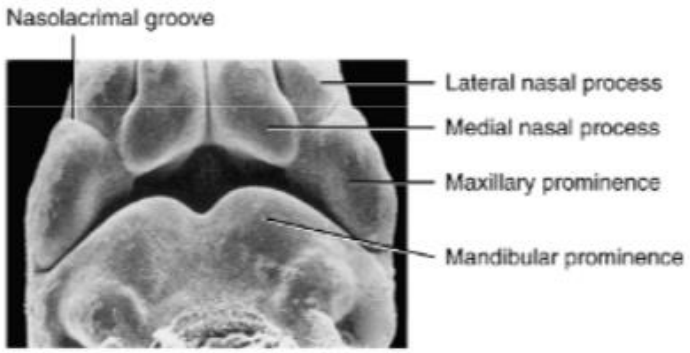

C



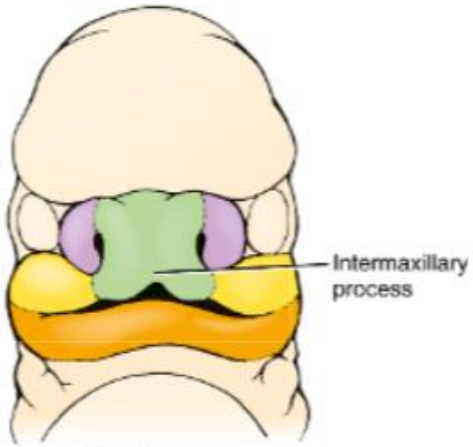
A Early 6th week



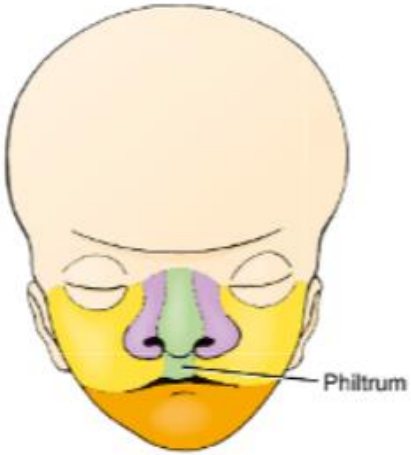
B Early 6th week



C Early 7th week

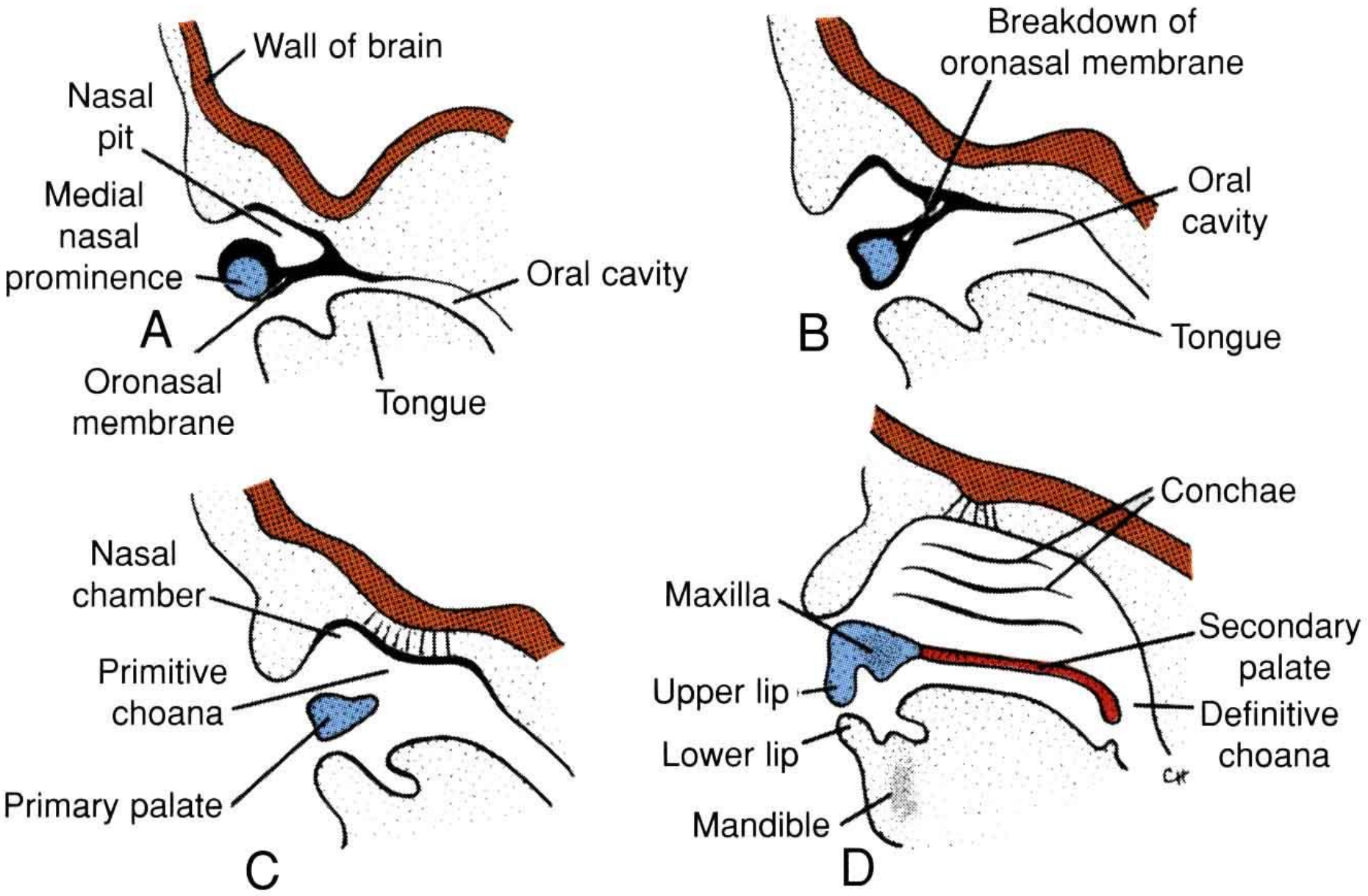


D Late 7th week



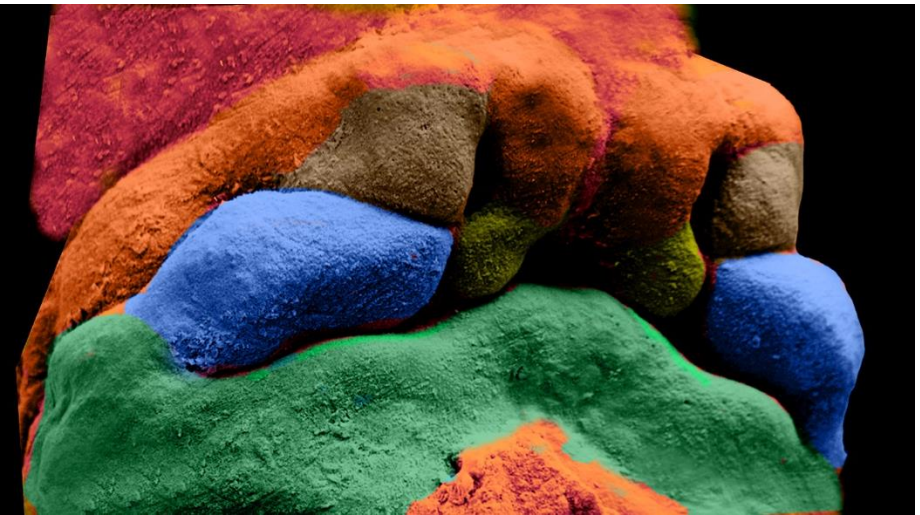
E 10th week

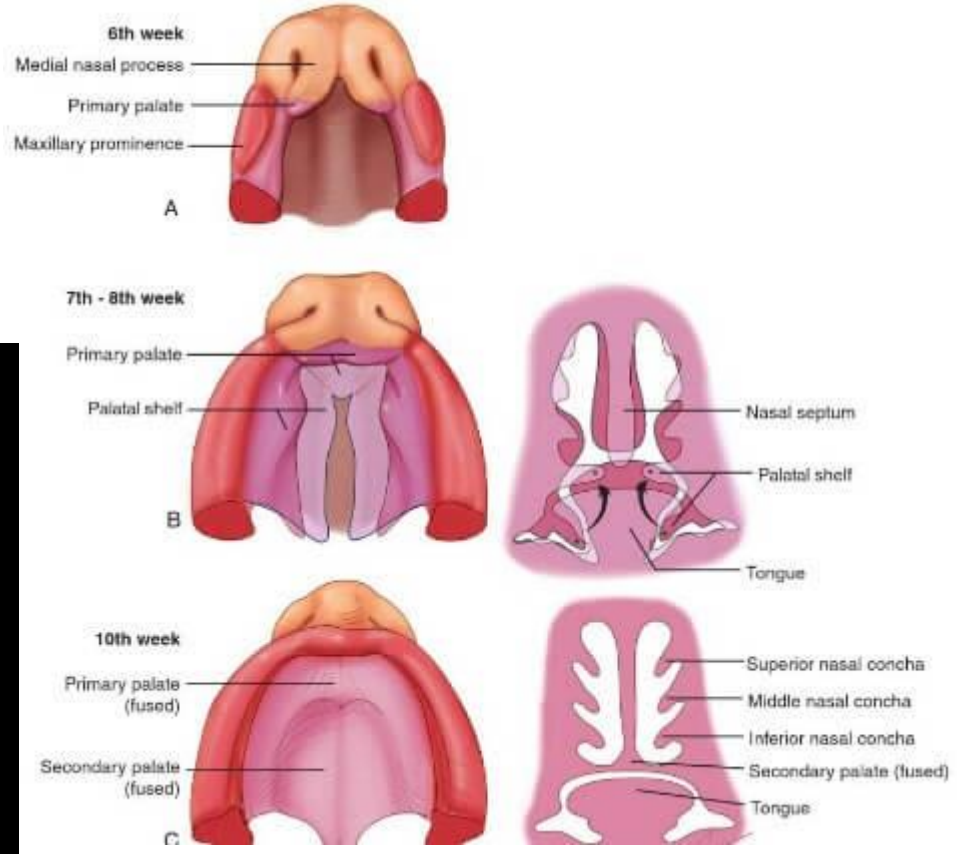
Development of nasal cavity



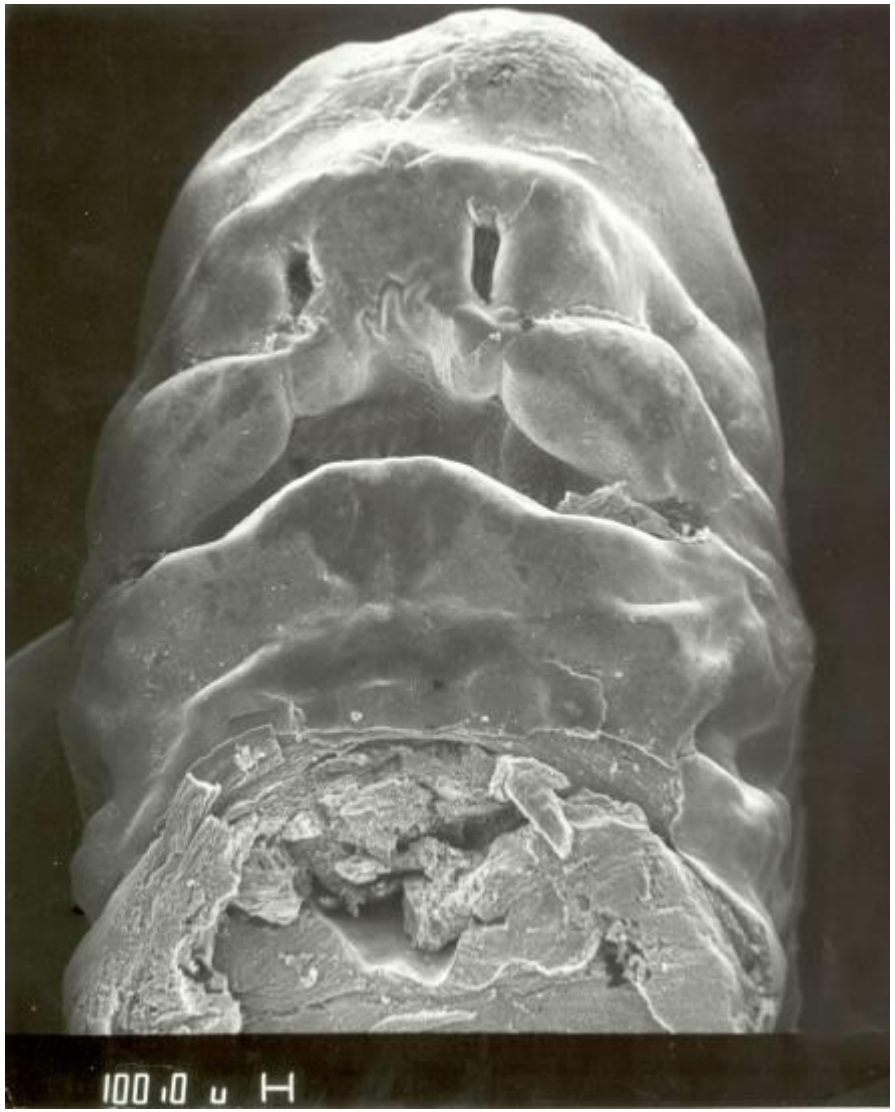
Primary palate

- 6th week
- Posterior extension of intermaxillary proces



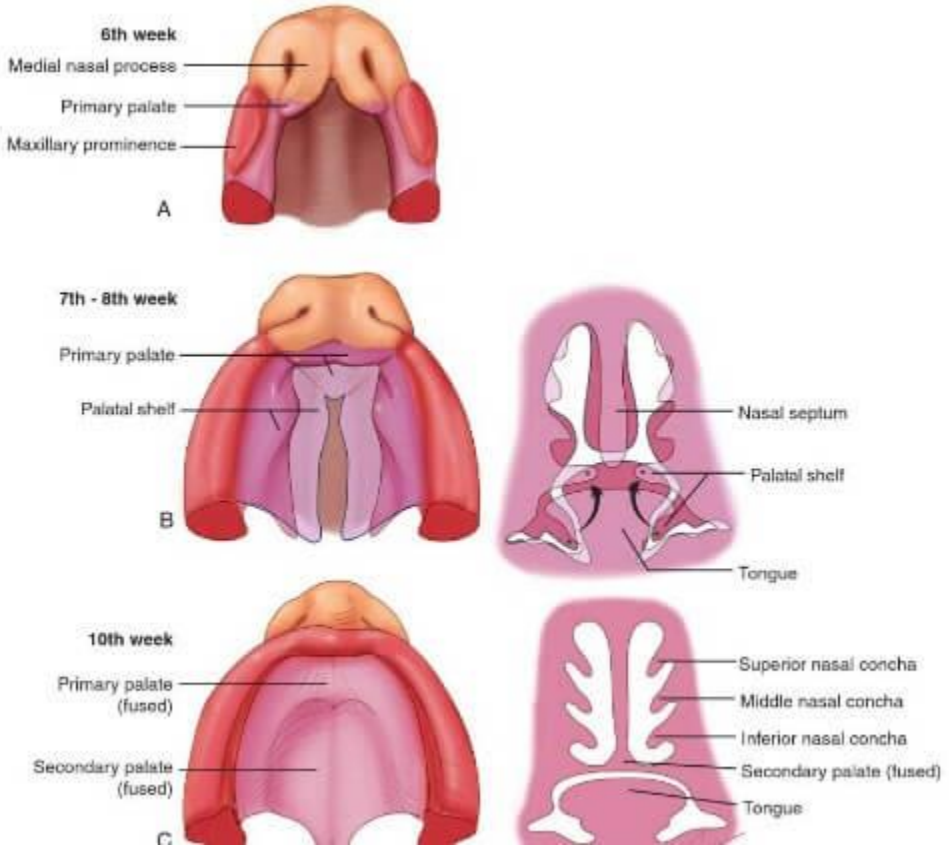


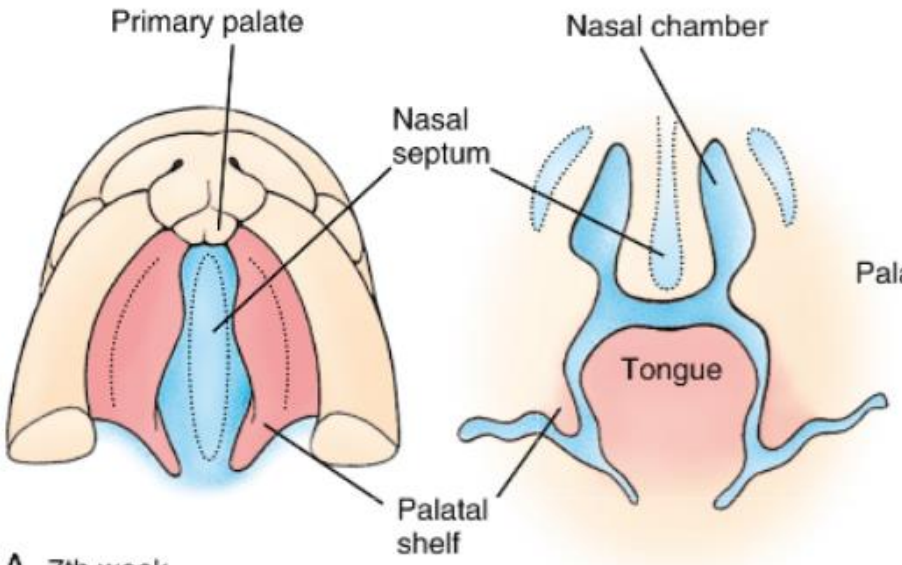
closure of primary palate



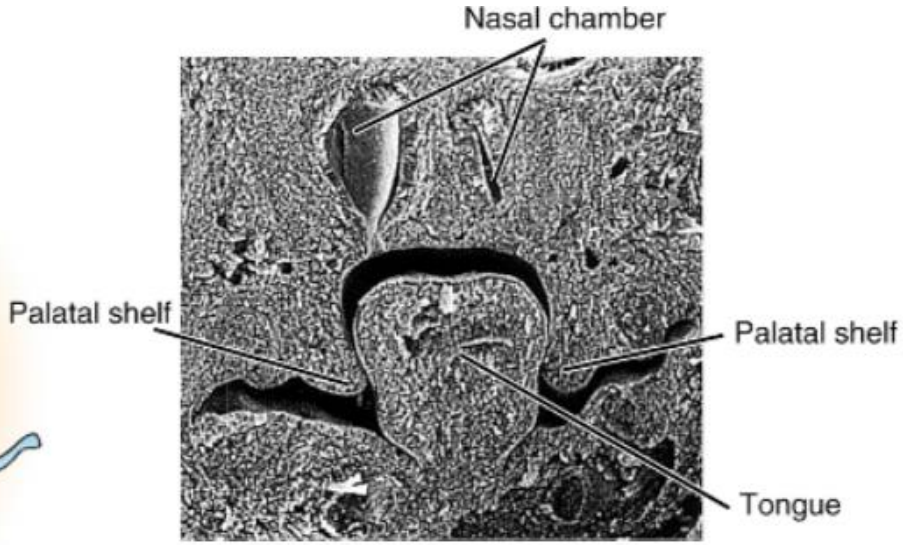
Secomdary palate

- 7th week
- Palatal shelves
  - – Extensions from medial walls of maxillary prominences

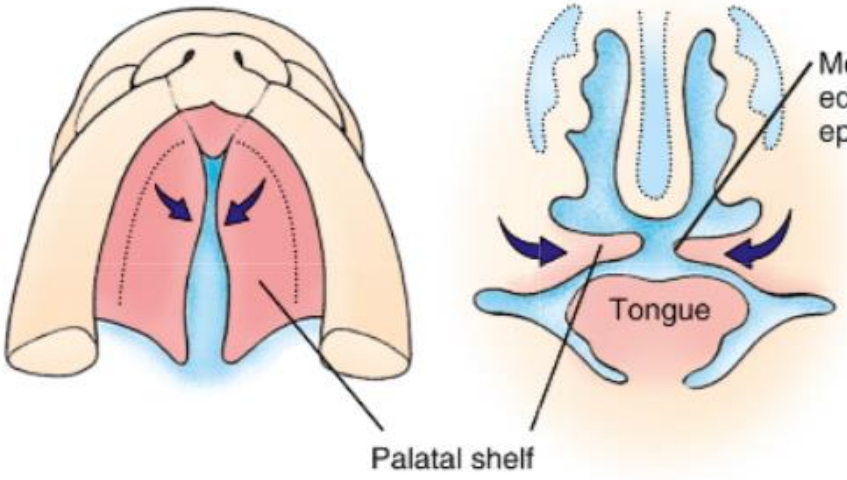




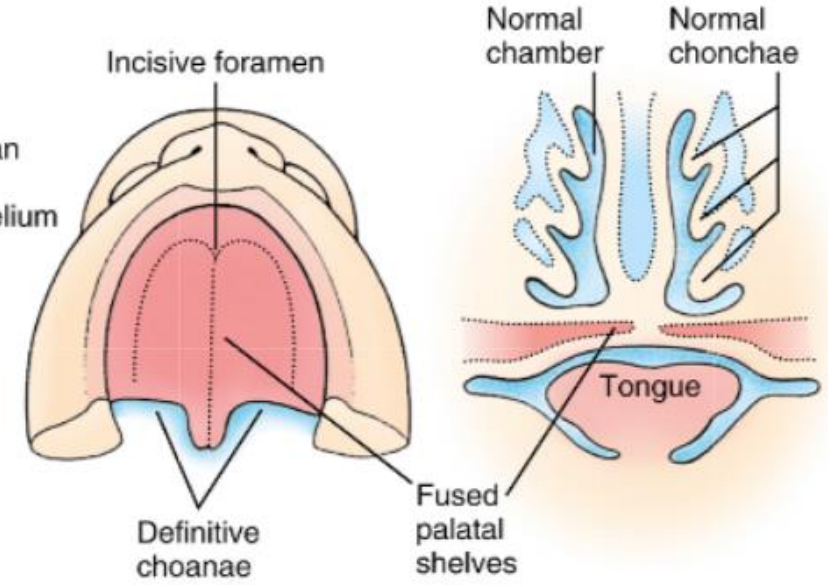
A 7th week



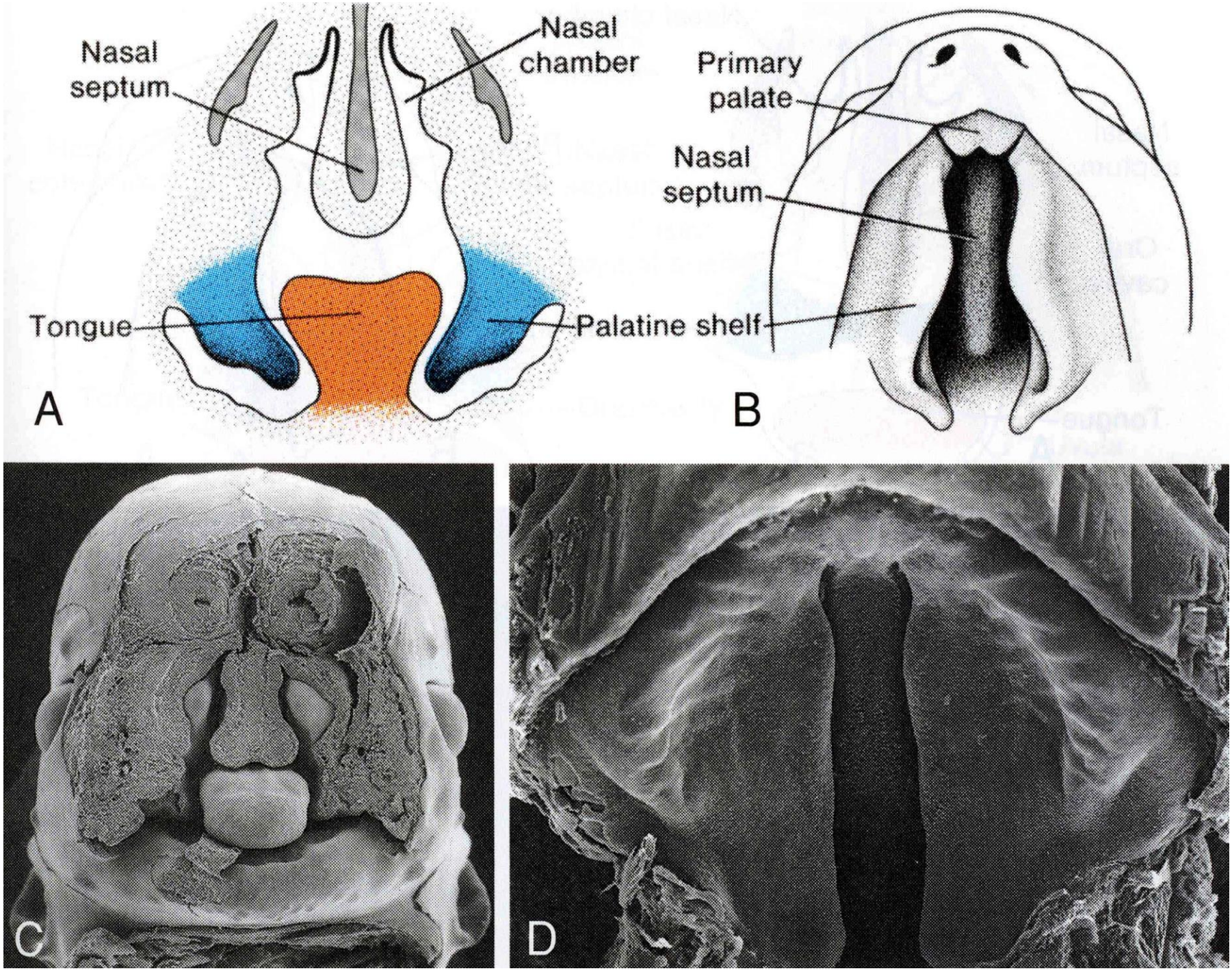
B 7th week



C Late 7th/8th week



D 10th week

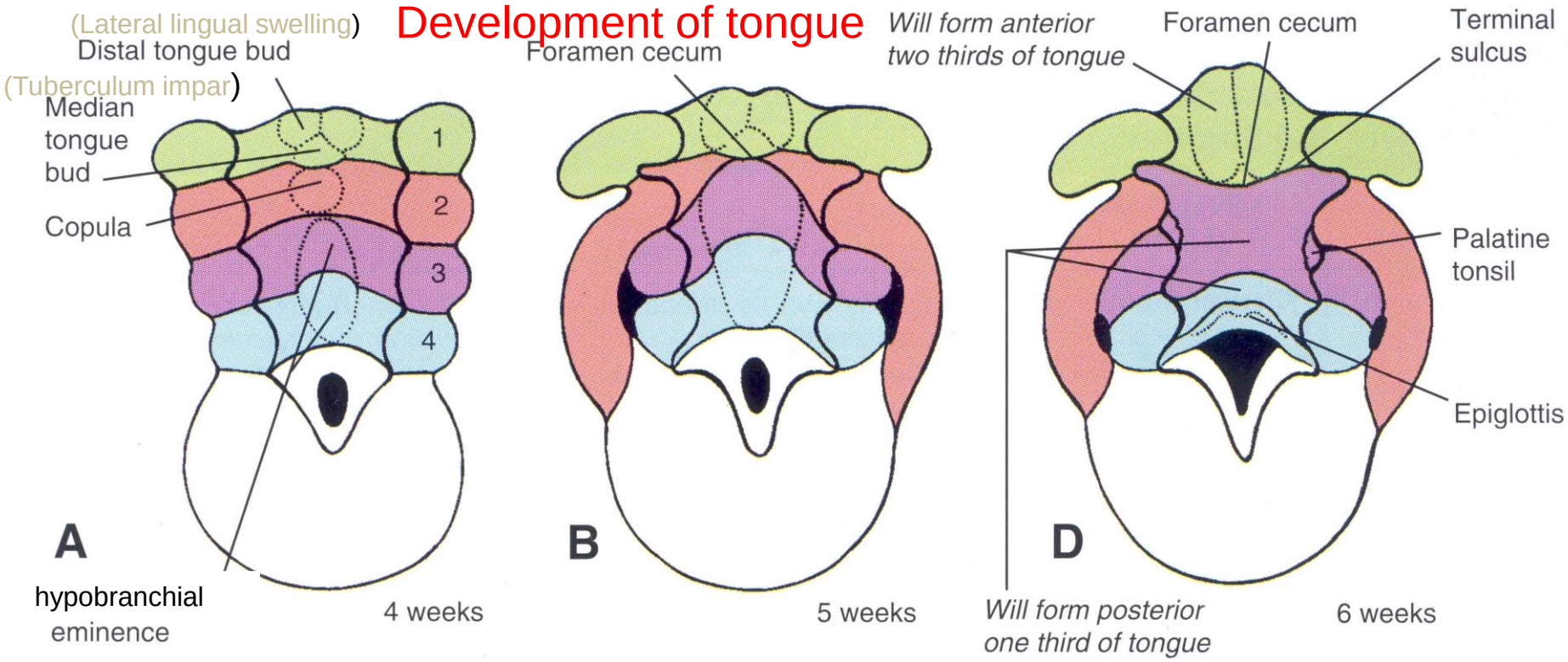

Nasal septum
Nasal chamber
Tongue
Palatine shelf
A
Primary palate
Nasal septum
B
C
D

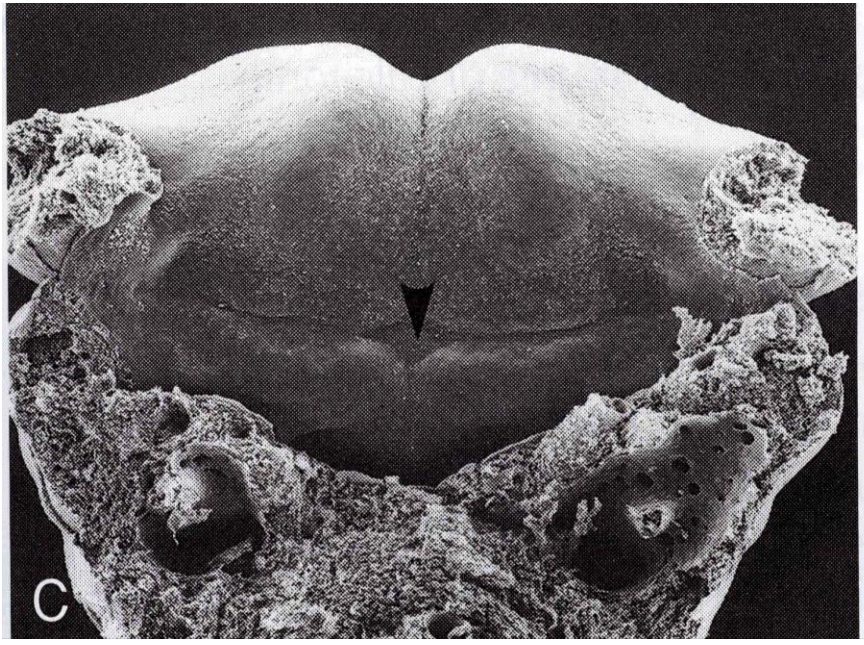
Development of Tongue

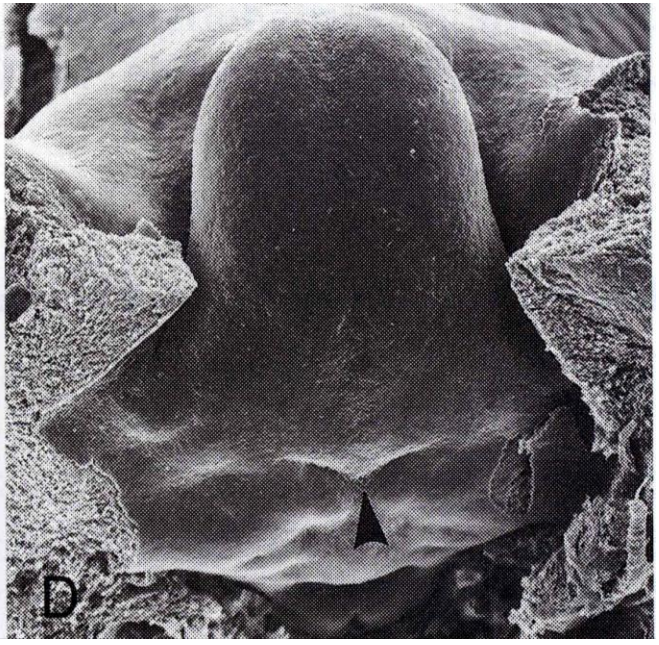
- Late 4th week

- Median tongue bud = median swelling of 1st FA
- Paired distal tongue buds = lateral swellings of 1st FA
- Copula = midline swelling of 2nd FA
- Hypobranchial eminence = midline swelling of 3th and 4th FA

Development of tongue







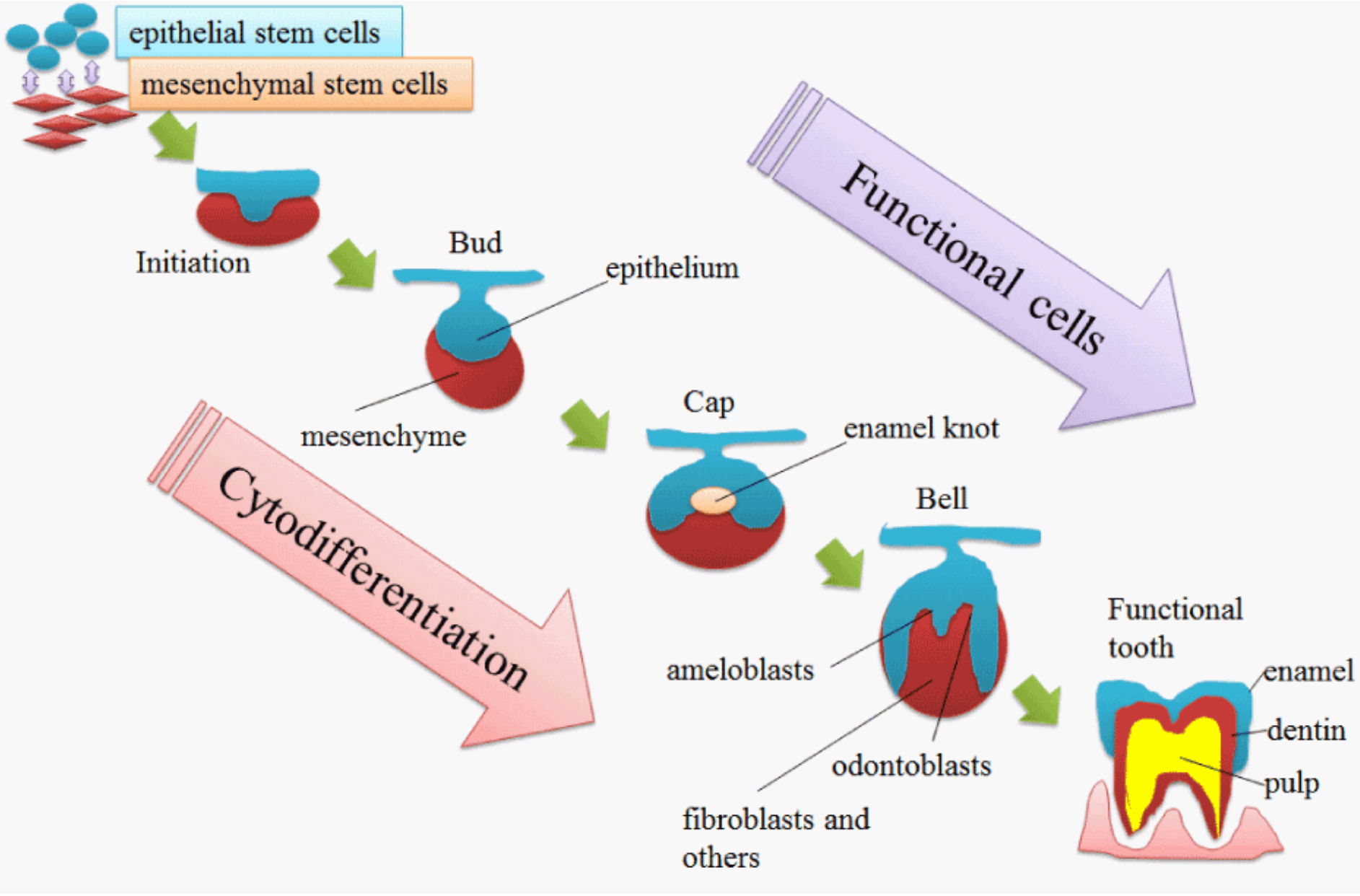
Development of Teeth

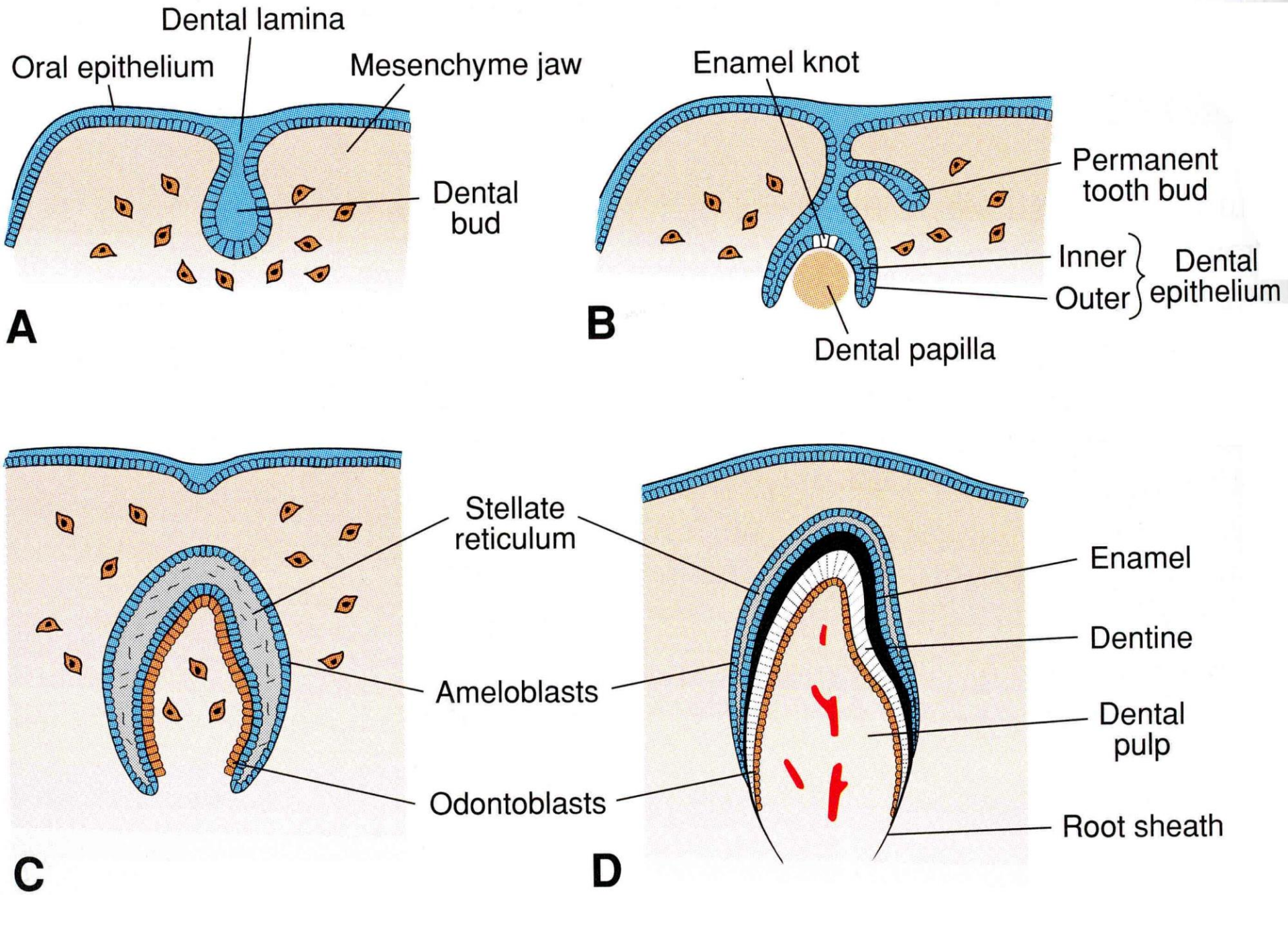
- Primary (deciduous) teeth = milk teeth (4x5)
- Secondary teeth = permanent teeth (4x8)
- Development from:
  - Oral ectoderm
  - Mesoderm
  - Cells of neural crest
- 6th week – superior and inferior dental lamina = thickening of epithelium of primitive oral cavity

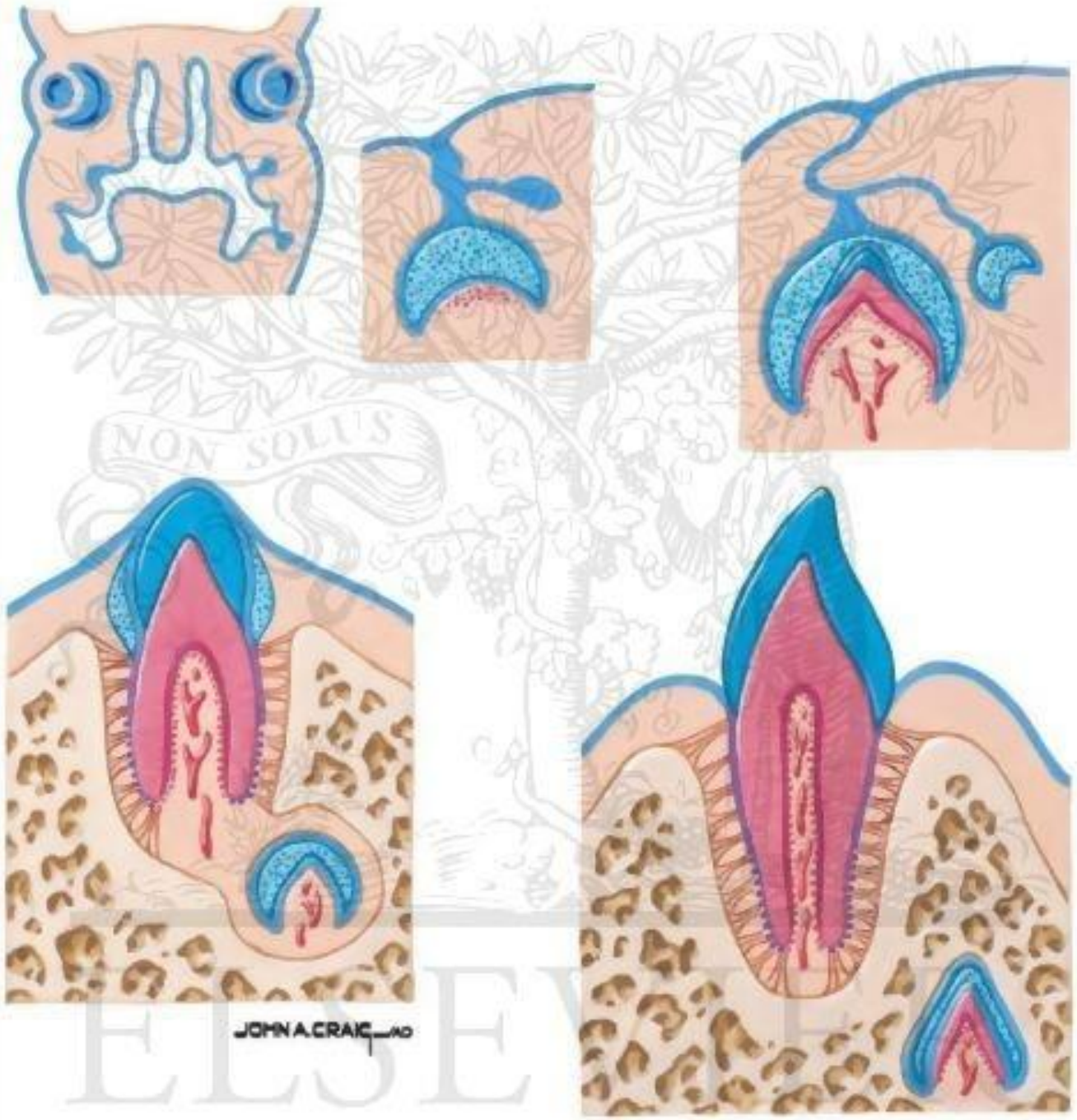
- Bud stage (8th week)
- Cap stage (9th week)
- Bell stage (3th month)

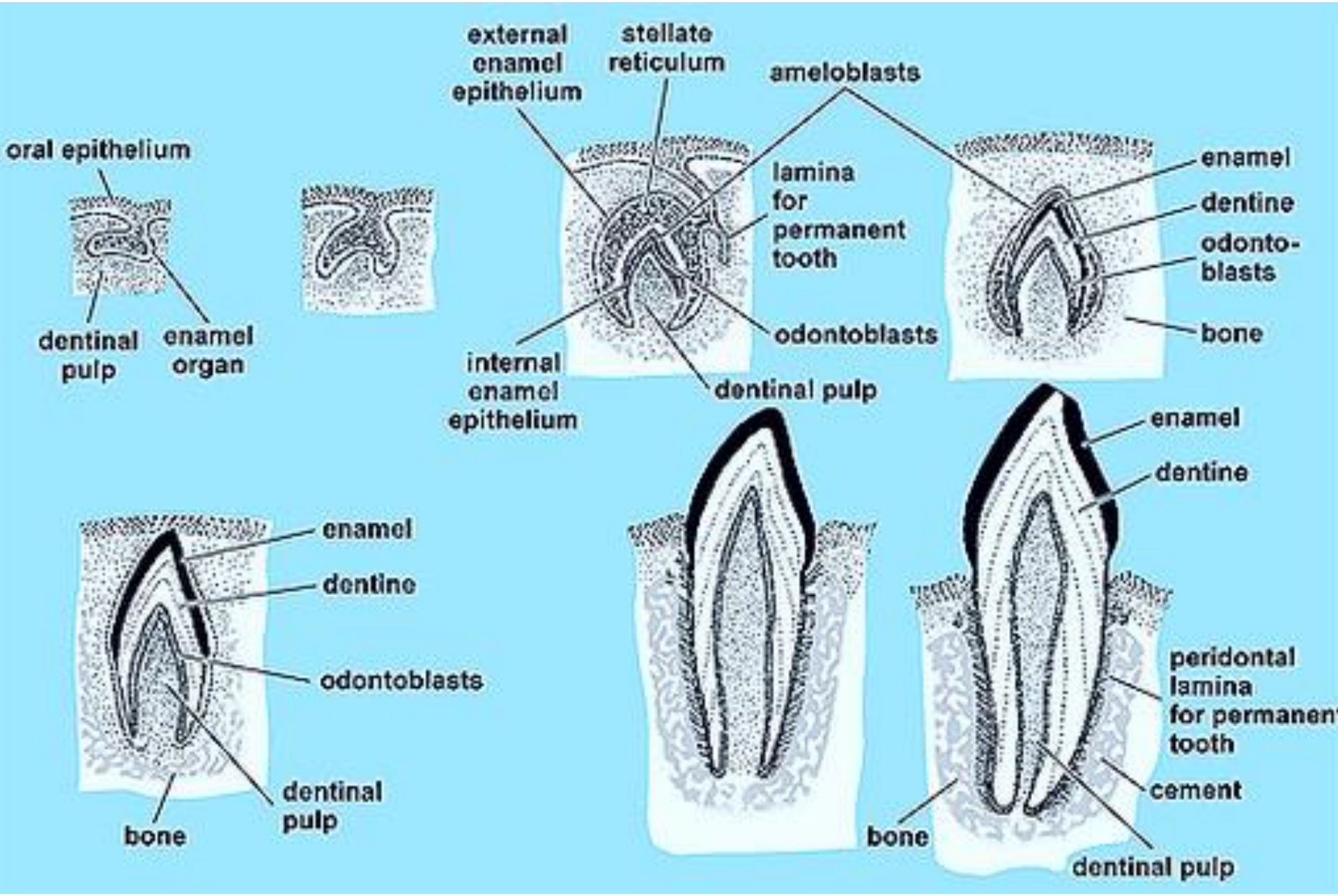
- Each ridge has 10 proliferative centers = local thickening – dental buds = origin of ectodermal part of teeth
- Buds grow into adjacent mesodermal tissue

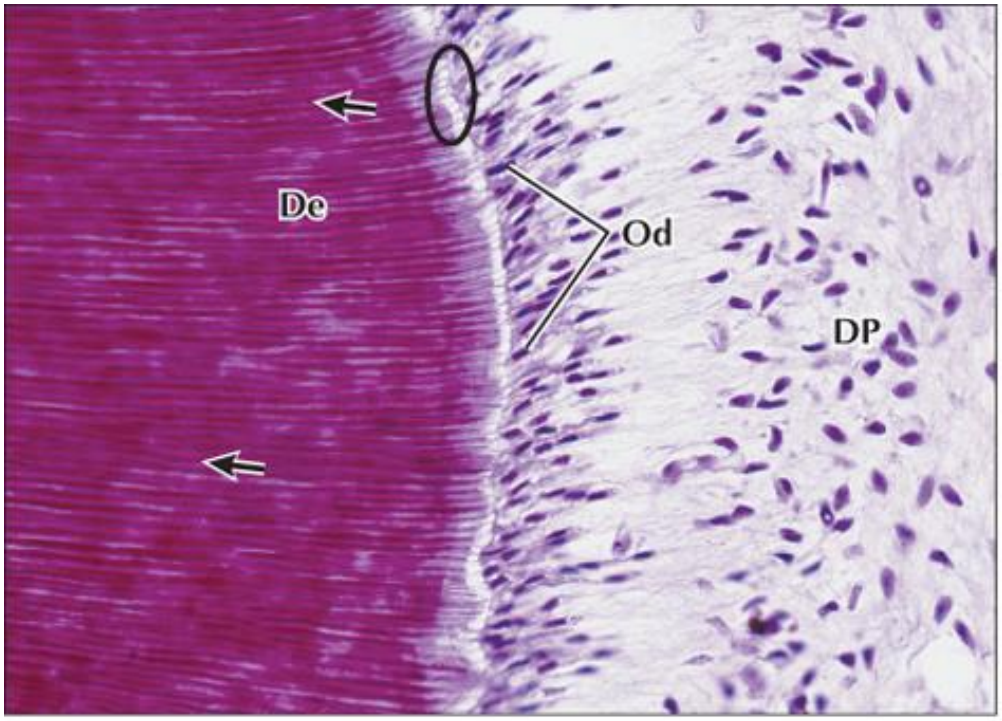
- Buds for deciduous teeth
- Buds for permanent teeth are settled during 10th week lingualy from deciduous teeth and they stay in latency until 6th postnatal year


epithelial stem cells
mesenchymal stem cells
Initiation
Bud
epithelium
mesenchyme
Cap
enamel knot
Bell
ameloblasts
odontoblasts
fibroblasts and
others
Functional
tooth
enamel
dentin
pulp
Functional cells
Cytodifferentiation


Dental lamina
Oral epithelium
Mesenchyme jaw
Dental bud
A
Enamel knot
Permanent tooth bud
Inner
Outer
Dental epithelium
Dental papilla
B
Stellate reticulum
Ameloblasts
Odontoblasts
C
Enamel
Dentine
Dental pulp
Root sheath
D

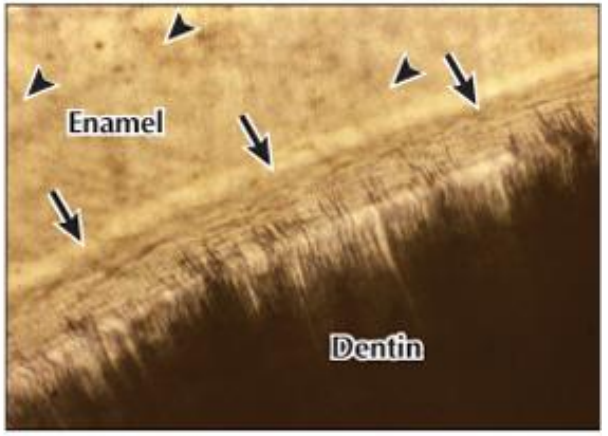

JOHN A. CRAIG, MD

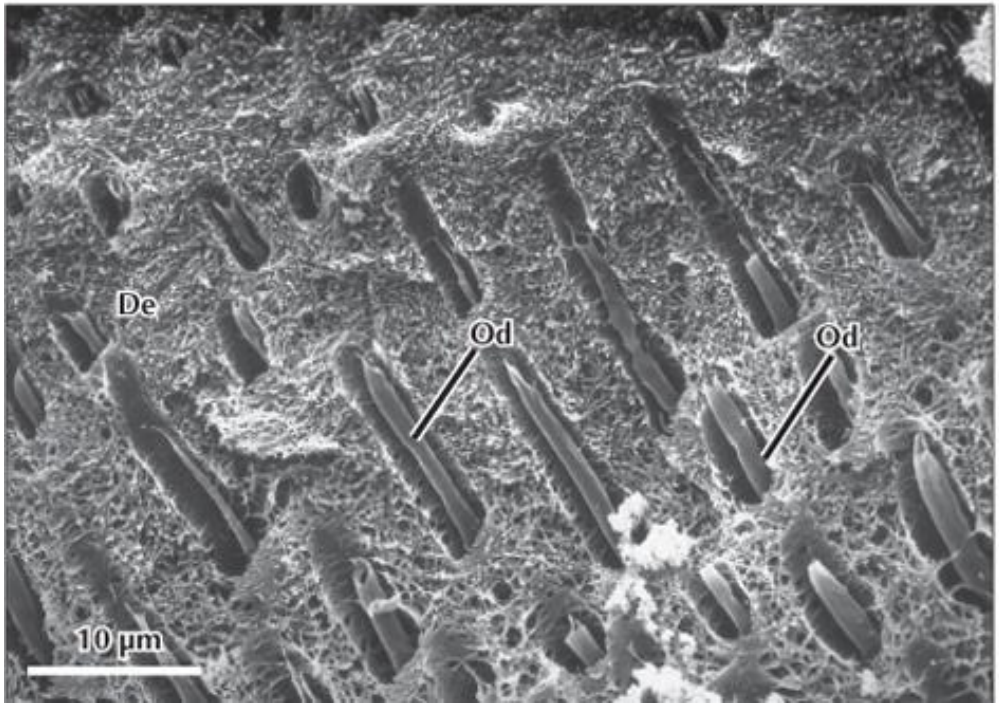

oral epithelium
dentinal pulp
enamel organ
external enamel epithelium
stellate reticulum
ameloblasts
lamina for permanent tooth
odontoblasts
internal enamel epithelium
dentinal pulp
enamel
dentine
odonto-blasts
bone
enamel
dentine
odontoblasts
dentinal pulp
bone
enamel
dentine
peridontal lamina for permanent tooth
cement
bone
dentinal pulp



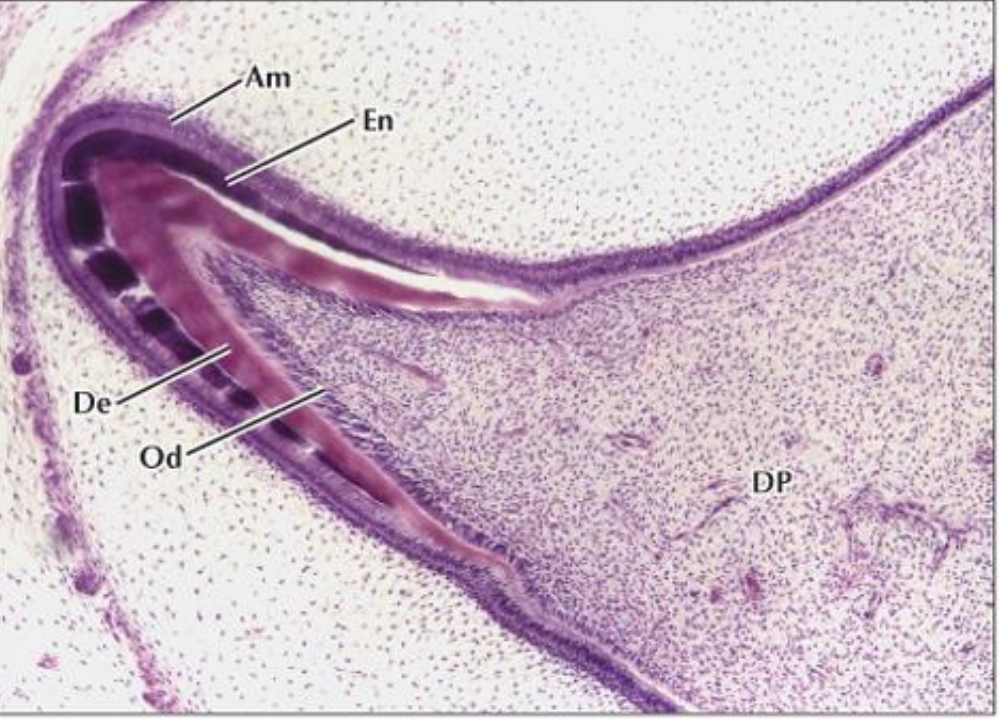
◀ **LM of part of a developing tooth showing details of dentin.** Odontoblasts (**Od**) are close to dentin (**De**), which is intensely eosinophilic because of collagen in its matrix. These cells have thin apical processes (**encircled**) that enter dentin in dentinal tubules (**arrows**), which appear as linear strands running through the dentin. Mesenchymal cells in the dental papilla (**DP**) will later form dental pulp. 340×. *H&E.*

▼ **Part of a mature human tooth.** Enamel covers dentin at the crown of the tooth. The dentinoenamel junction (**arrows**) looks scalloped, and firm attachment of enamel to dentin at this interface is required for tooth function in mastication. Obliquely oriented, ill-defined lines (**arrowheads**) in enamel are enamel rods. Their arrangement contrasts with relatively dark, parallel dentinal tubules in dentin. 300×. *Ground unstained section.*





◀ **High-resolution SEM of dentinal tubules.** Many dentinal tubules run through the dentin (**De**) matrix. The 3- to 4-µm-diameter processes of odontoblasts (**Od**) are in the tubules. 2000×. *(Courtesy of Dr. P. R. Dow)*



◀ **LM of an enamel organ at the bell stage of odontogenesis.** Outside, one layer of ameloblasts (**Am**) is closely apposed to newly formed, darker enamel (**En**). Deeper in the organ, odontoblasts (**Od**), which are differentiated from mesenchymal cells, are at the outer margin of the dental papilla (**DP**). They form one row of cells, next to newly formed dentin (**De**). At this stage of tooth development, the papilla is a mass of primitive mesenchymal cells, which later become dental pulp. 90×. *H&E.*

▶ **LM of part of an enamel organ with details of the dentinoenamel junction.** Tall columnar ameloblasts (**Am**) form one row on the outer aspect of the enamel organ. They have basally located nuclei and thin apical projections called Tomes' processes (**TP**) that extend toward a thin layer of lightly stained preenamel (**PE**), which is the organic matrix of newly formed enamel. A thicker layer of fully mineralized enamel (**En**), more darkly stained, borders the preenamel. On the opposite side, a layer of differentiating odontoblasts (**Od**) is apposed to a thin, lightly stained layer of predentin (**PD**). Thin apical processes of odontoblasts project across predentin into dentin (**De**), which appears darker and radially striate. A thin, clear artifactual space (**arrows**) marks the dentinoenamel junction. 250×. *H&E.*

Thank you for your attention