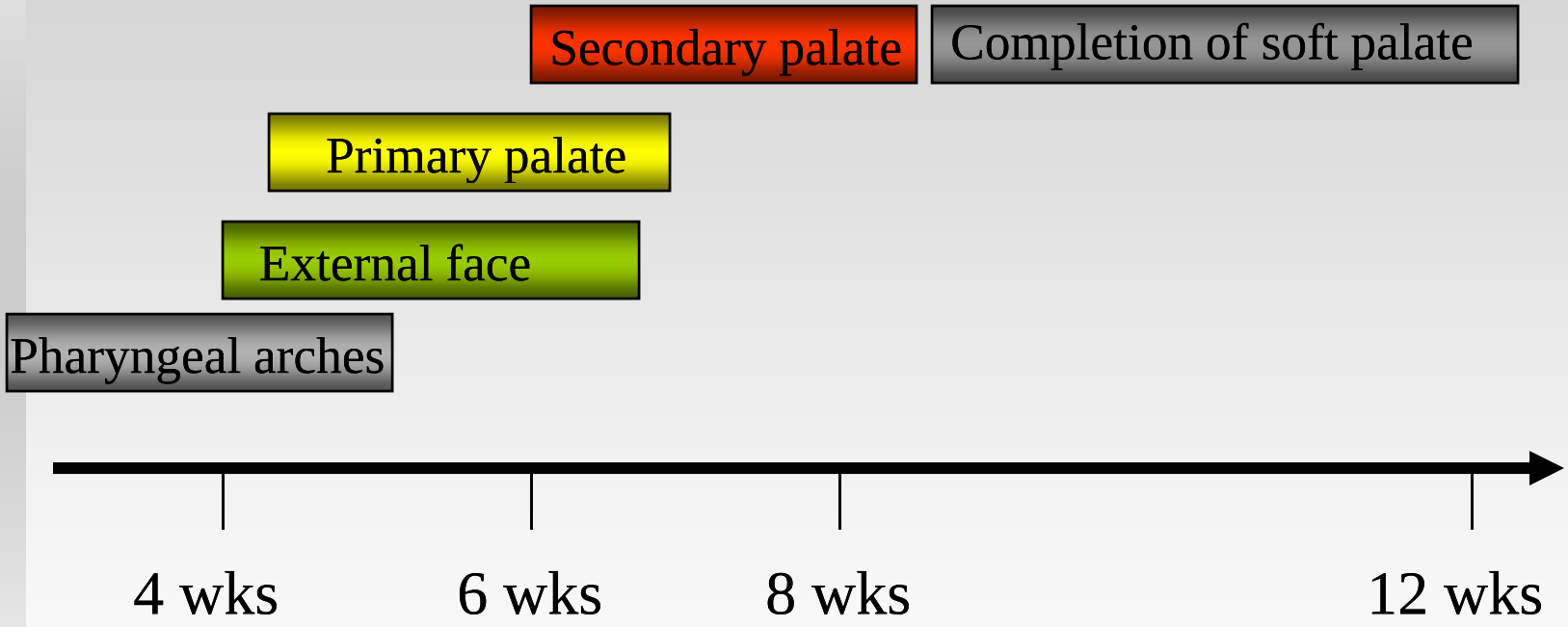
Facial and palatal development

L.Moss-Salentijn

Craniofacial malformations are involved in three quarters of all congenital birth defects in humans.

Chai Y & Maxson RE (2006) Develop Dynamics 235: 2353-2375

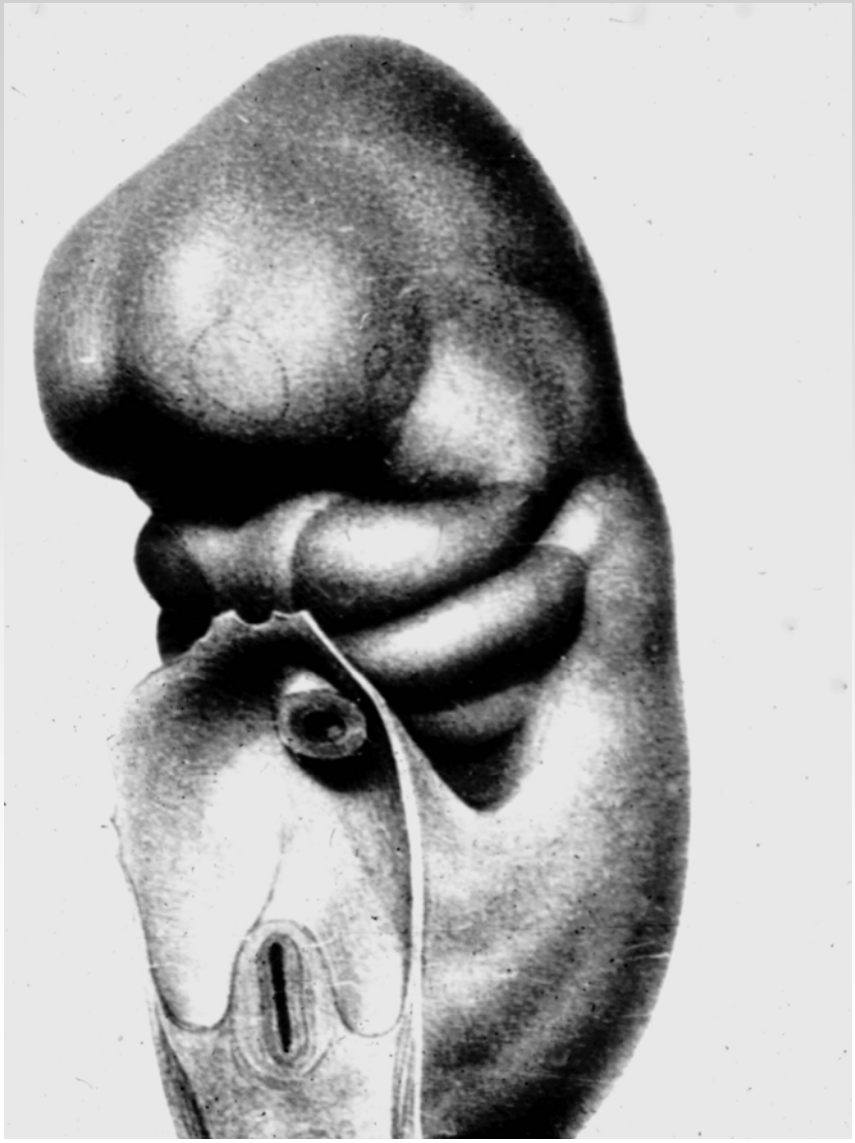
Timeline for development



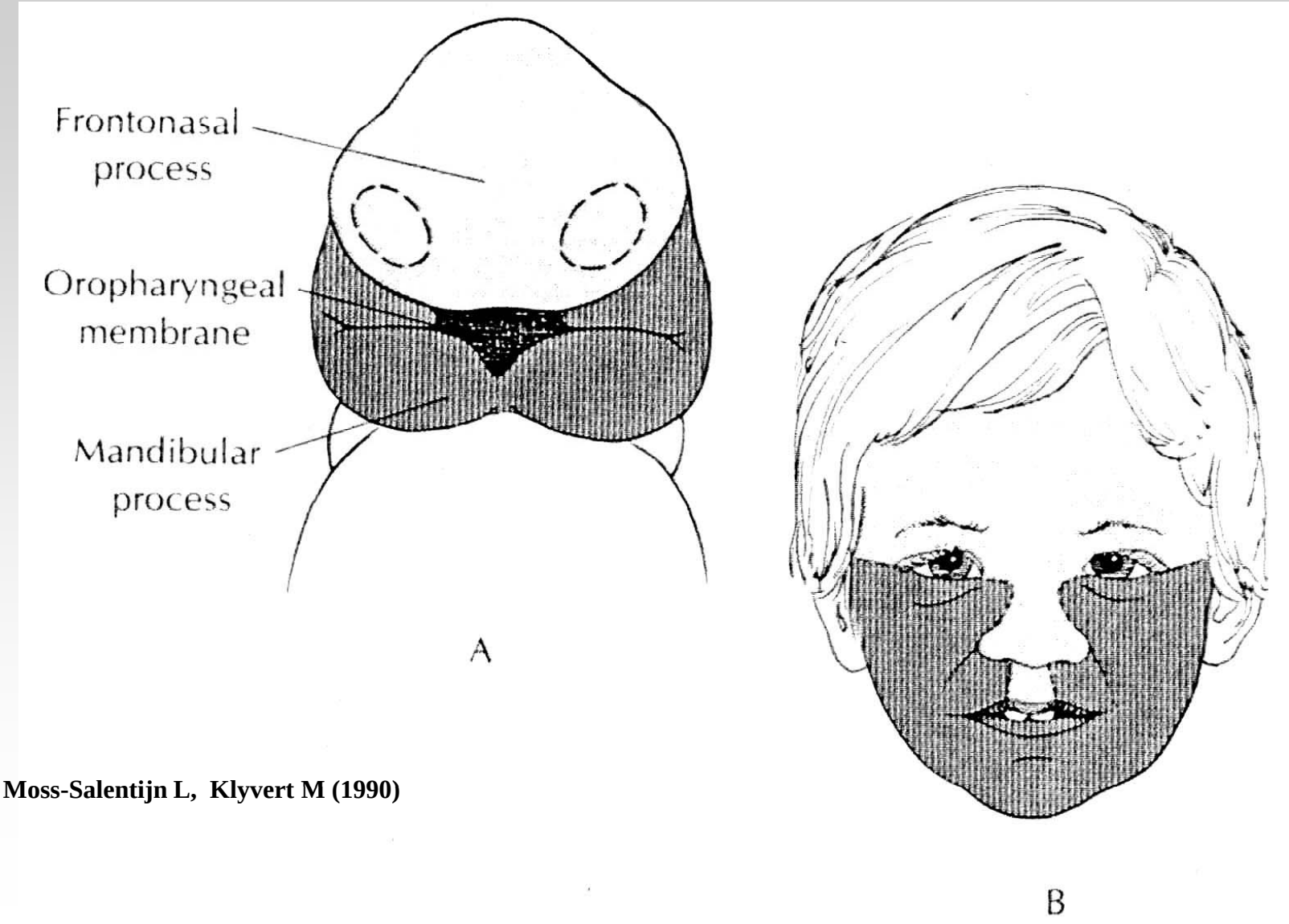
Decrease of severity of potential congenital malformations

Contributions to the external face

- **Periprosencephalon: ectoderm and mostly nc-derived mesenchyme surrounding the forebrain. Frontonasal process.**
- **First pharyngeal (mandibular) arch. Mandibular and maxillary processes.**

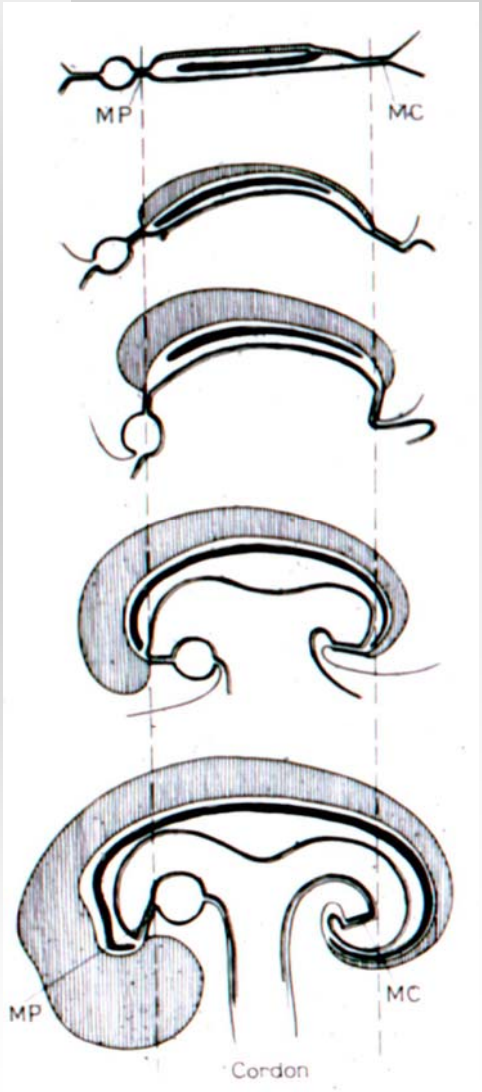


Contributions to external face



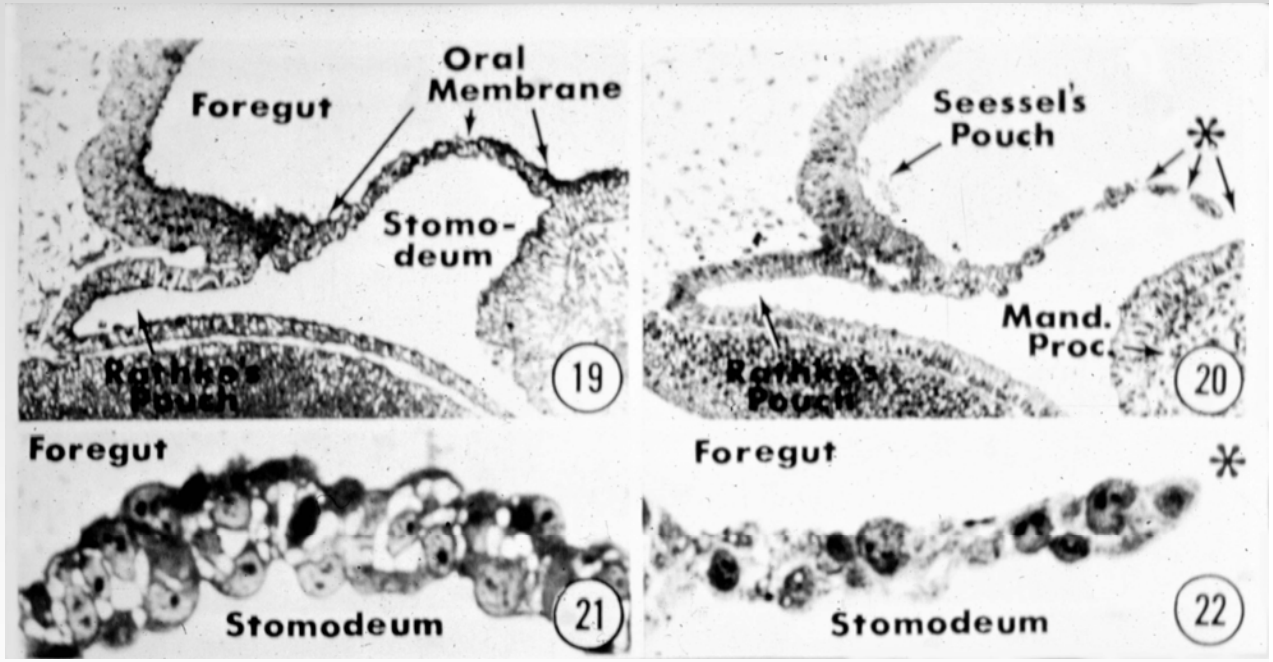
Moss-Salentijn L, Klyvert M (1990)

Oropharyngeal membrane (buccopharyngeal, oral)



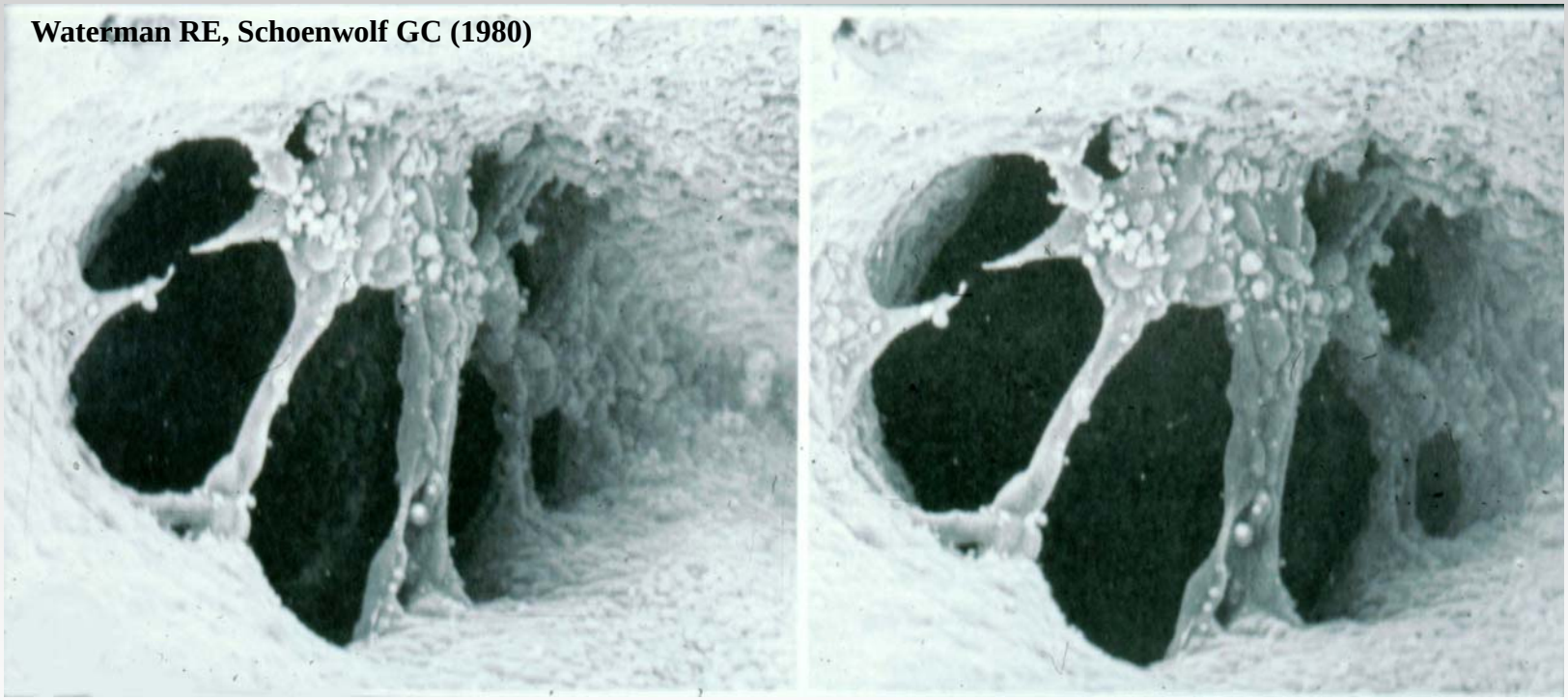
Tuchmann-Duplessis H, David G, Haegel P (1975)

Waterman RE, Schoenwolf GC (1980)



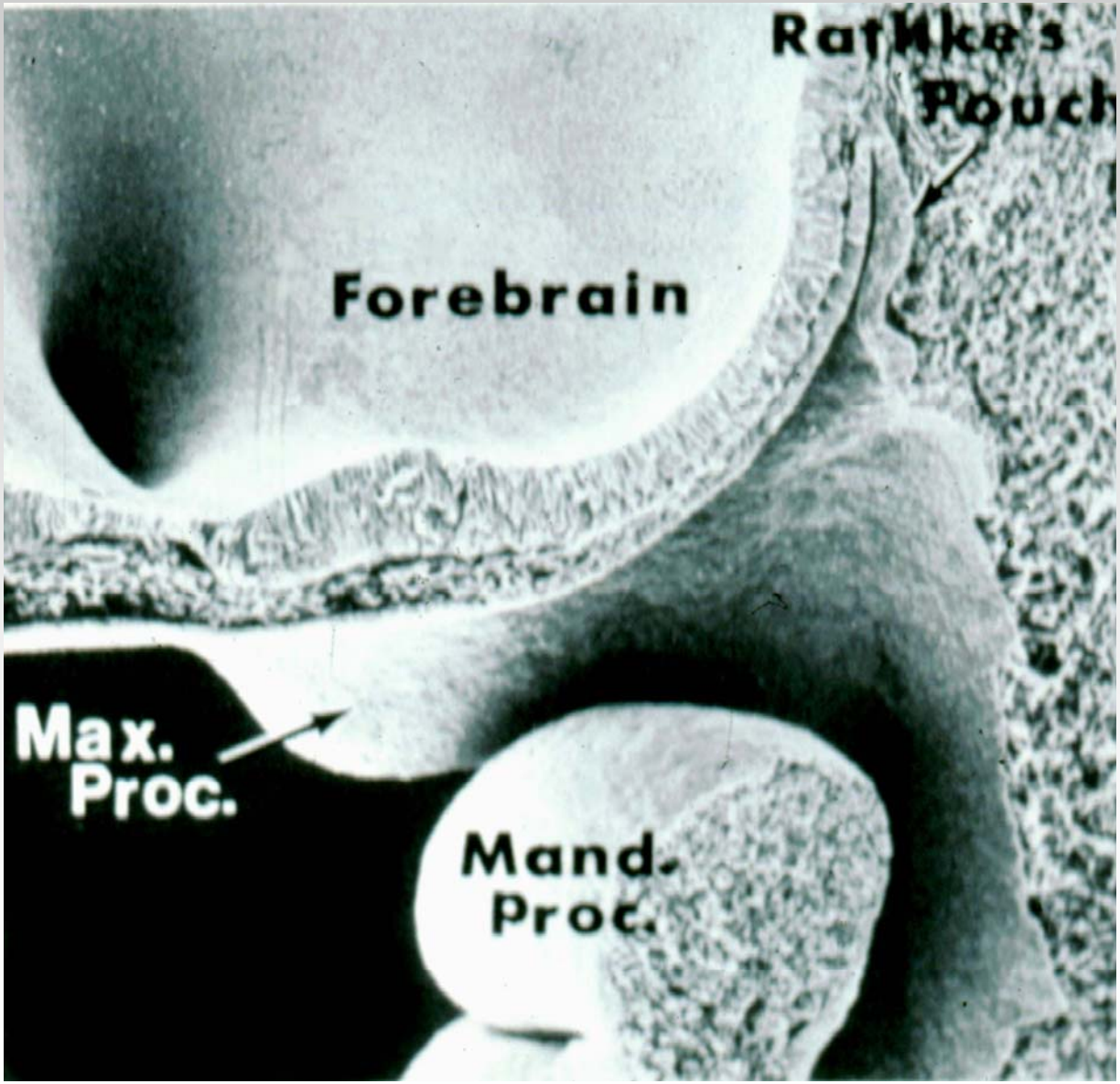
Membrane is composed of ectoderm and endoderm

Disintegration of oropharyngeal membrane



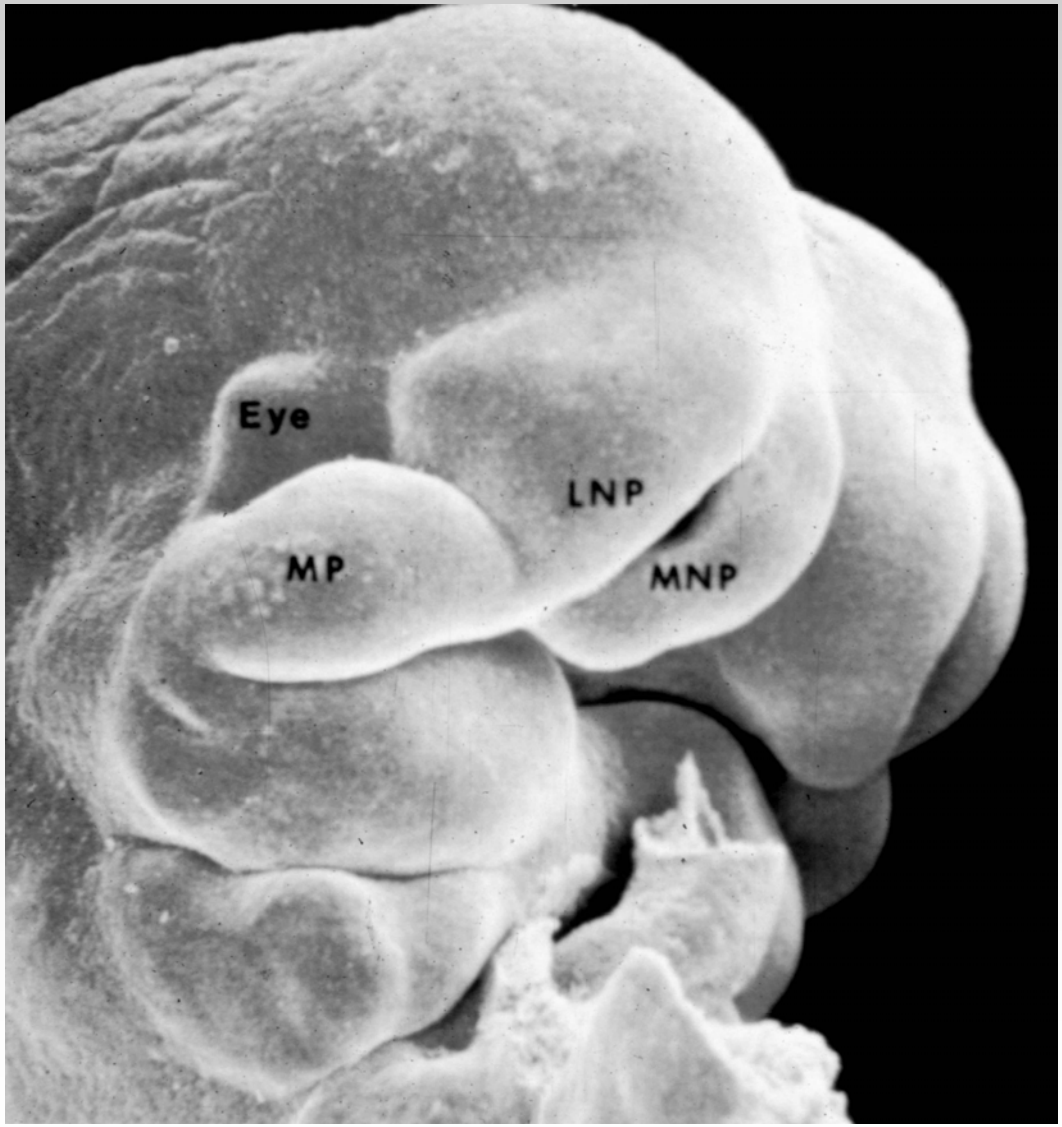
Communication between foregut and amniotic cavity at approximately 4 weeks of development

Stomodeum at 4 weeks



Waterman RE, Schoenwolf GC (1980)

Facial processes (prominences)



Sulik K, Johnston M et al (1980)

Bilaterally:

Lateral nasal

Medial nasal

Maxillary

Mandibular

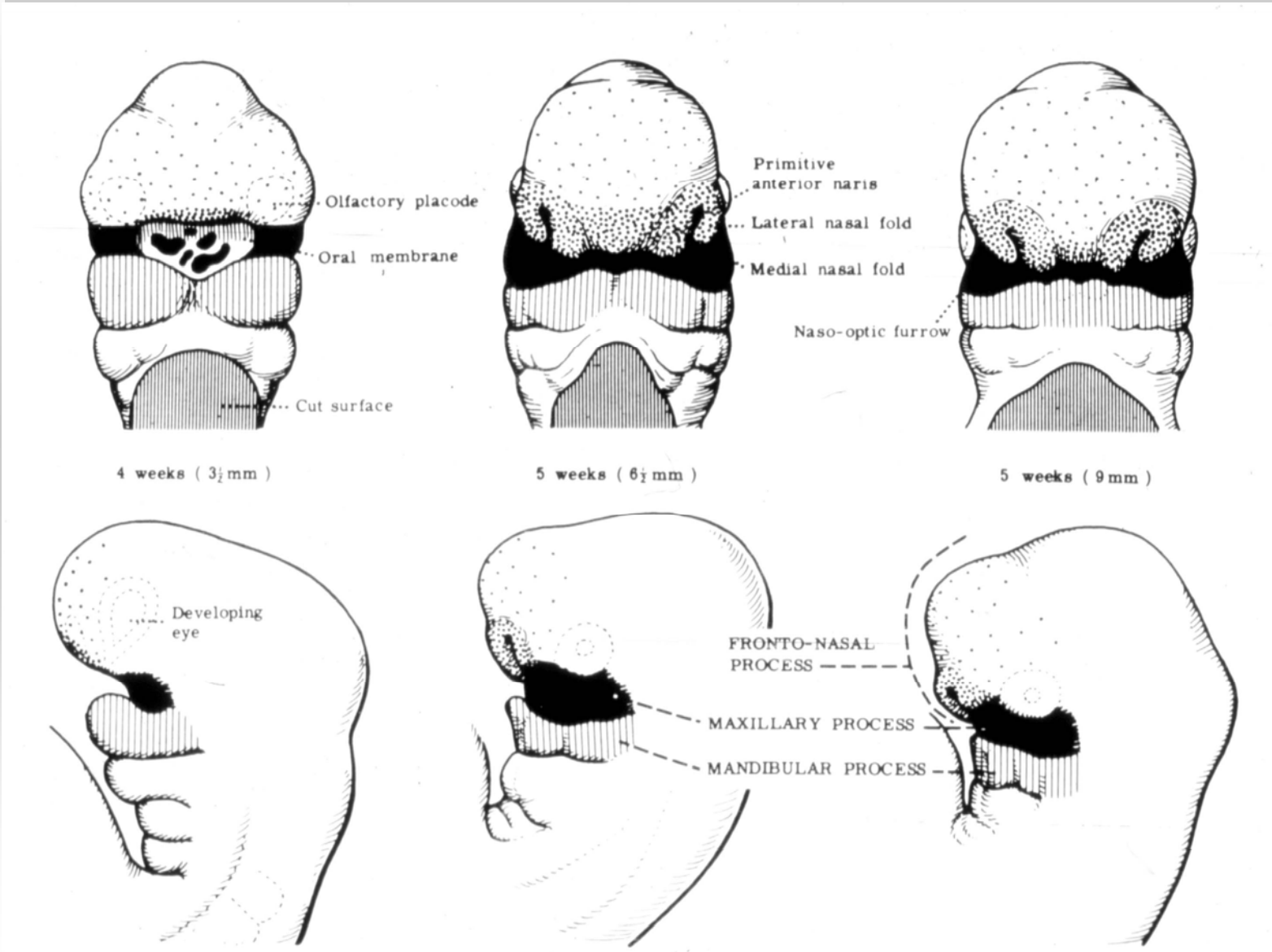
Face development animation 1

Watt, Marie A, and Sanders, Colin

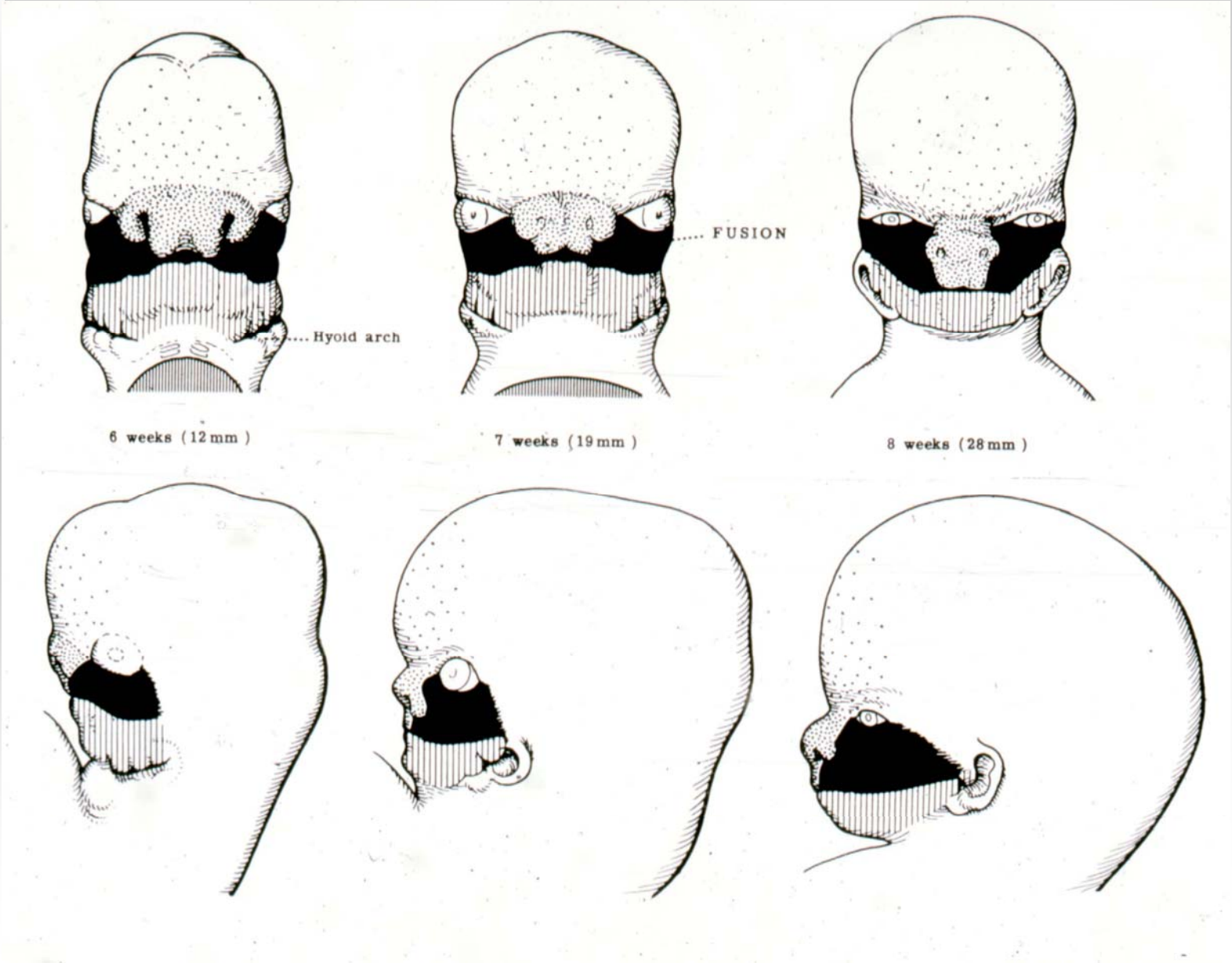
Face development – animation 2

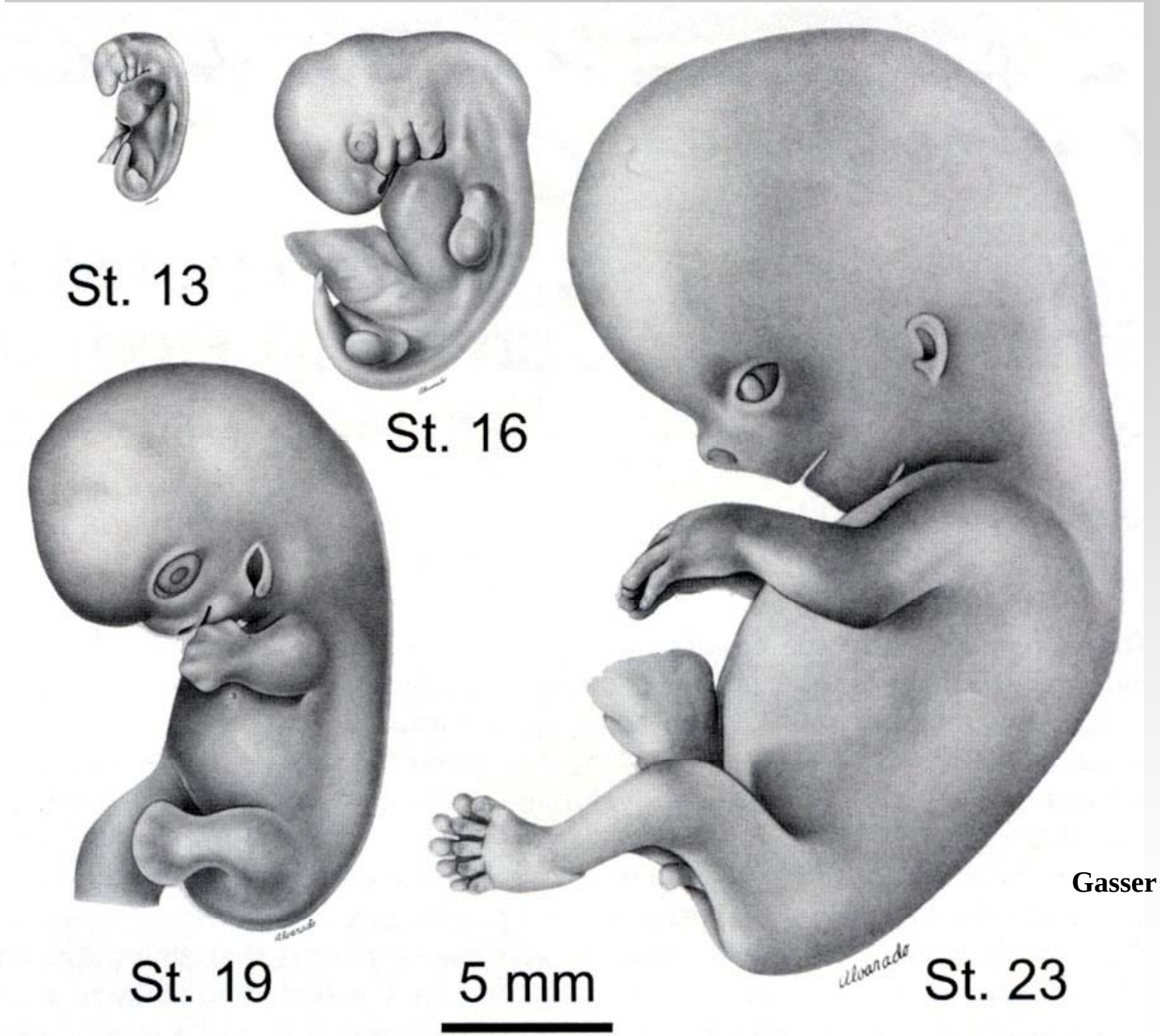
Watt, Marie A, and Sanders, Colin

Development external face (4-5 wks)



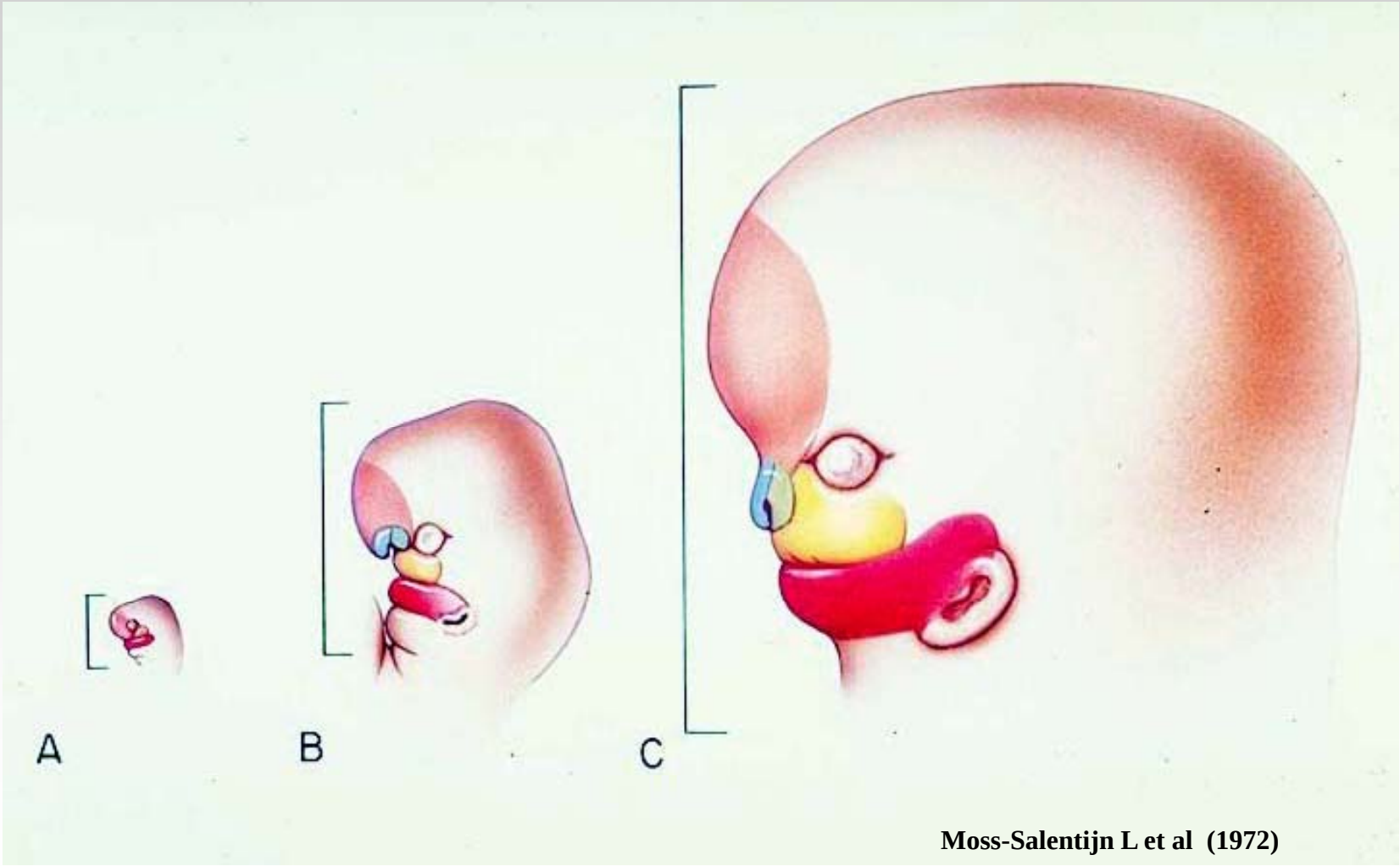
Development external face (6-8 wks)





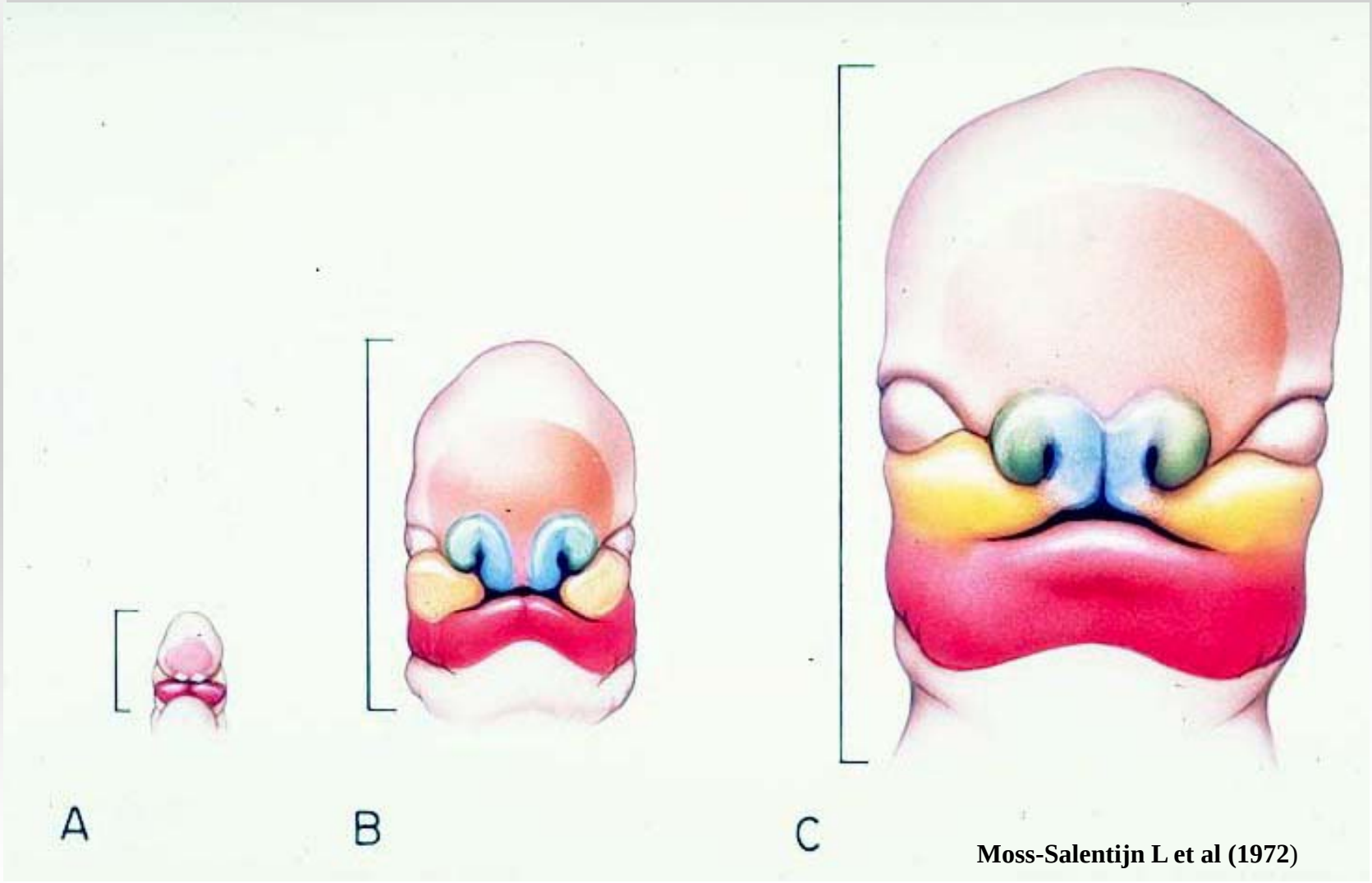
Gasser R (2006)

Dimensional changes (4-6 wks)



Moss-Salentijn L et al (1972)

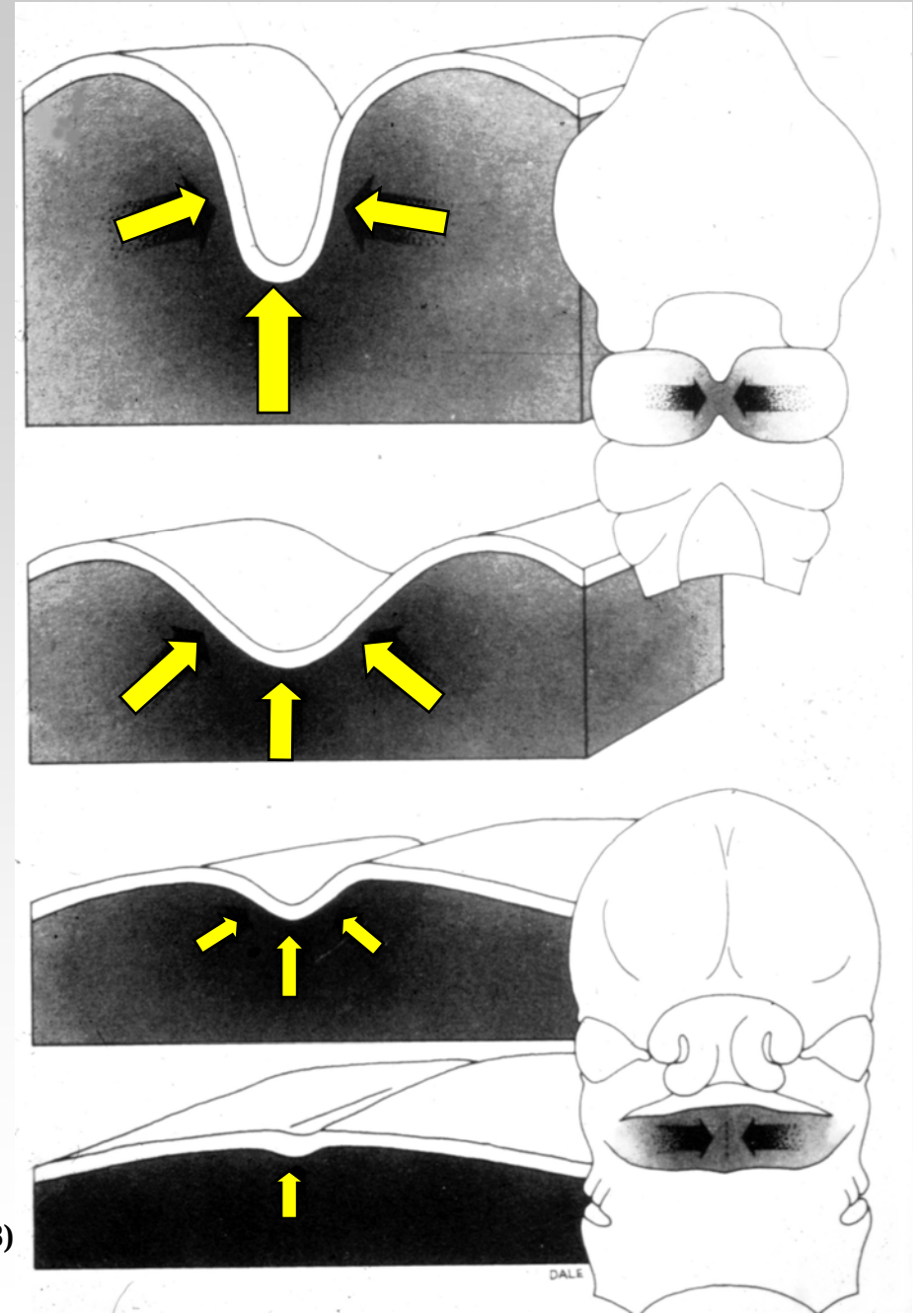
10-fold linear increase in size !



Moss-Salentijn L et al (1972)

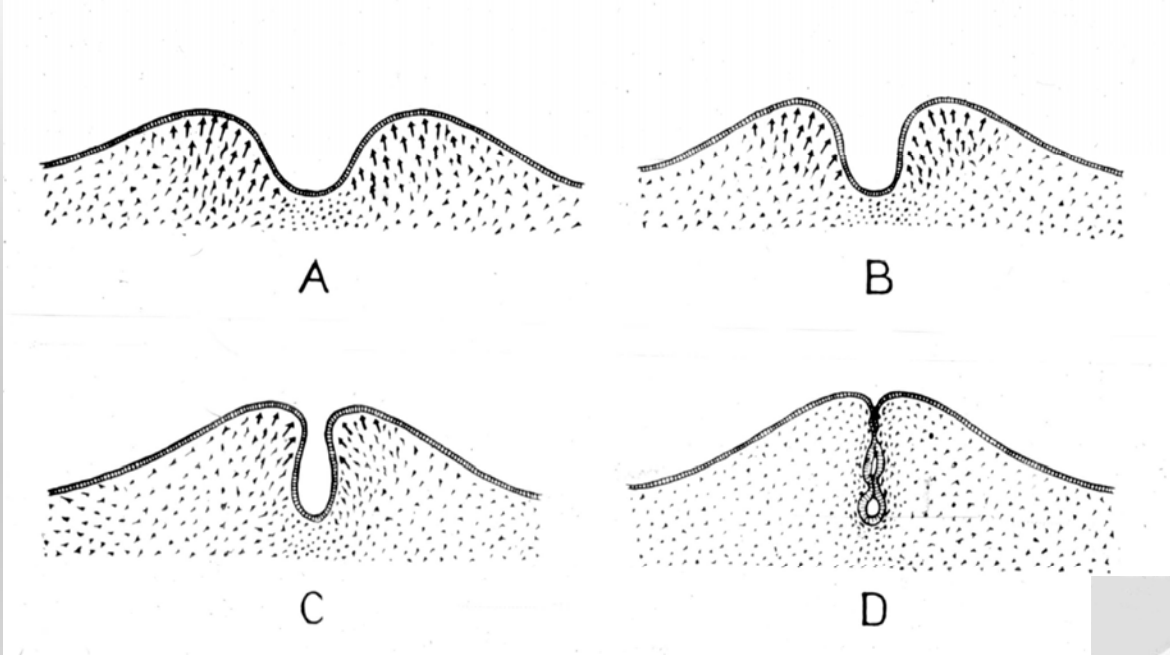
Merging

Differential mesenchymal proliferation. Elimination of groove.



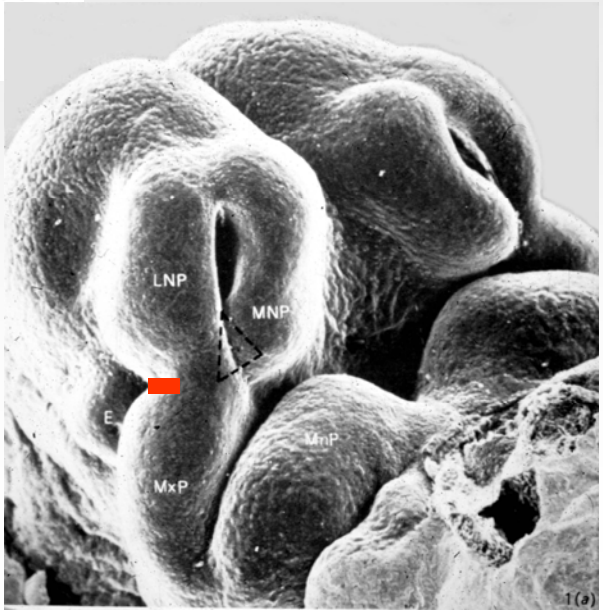
Ten Cate AR (1988)

Merging with epithelial inclusion



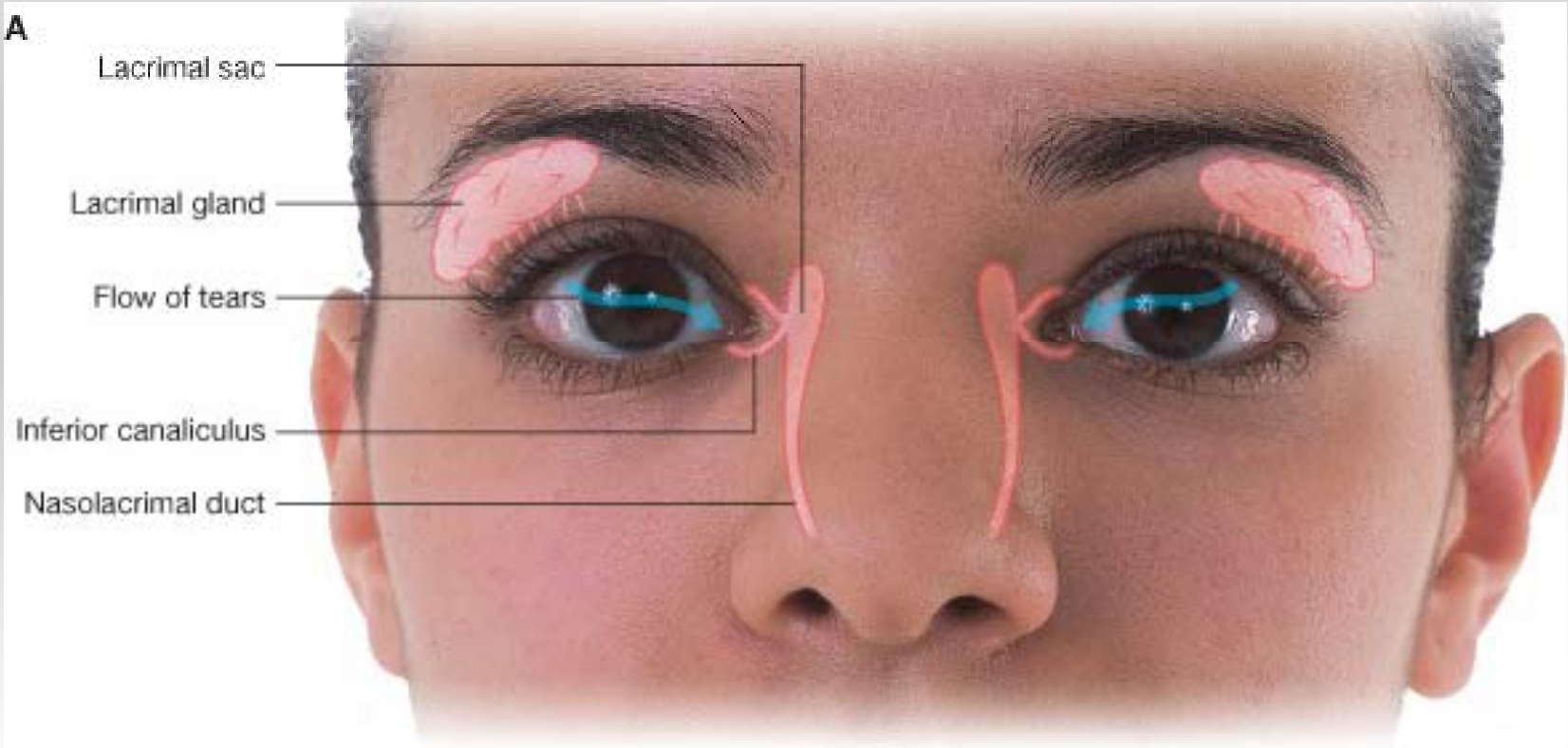
May result in facial cleft.

May be normal between LNP and maxillary process where enclosed epithelium gives rise to part of nasolacrimal duct epithelium.



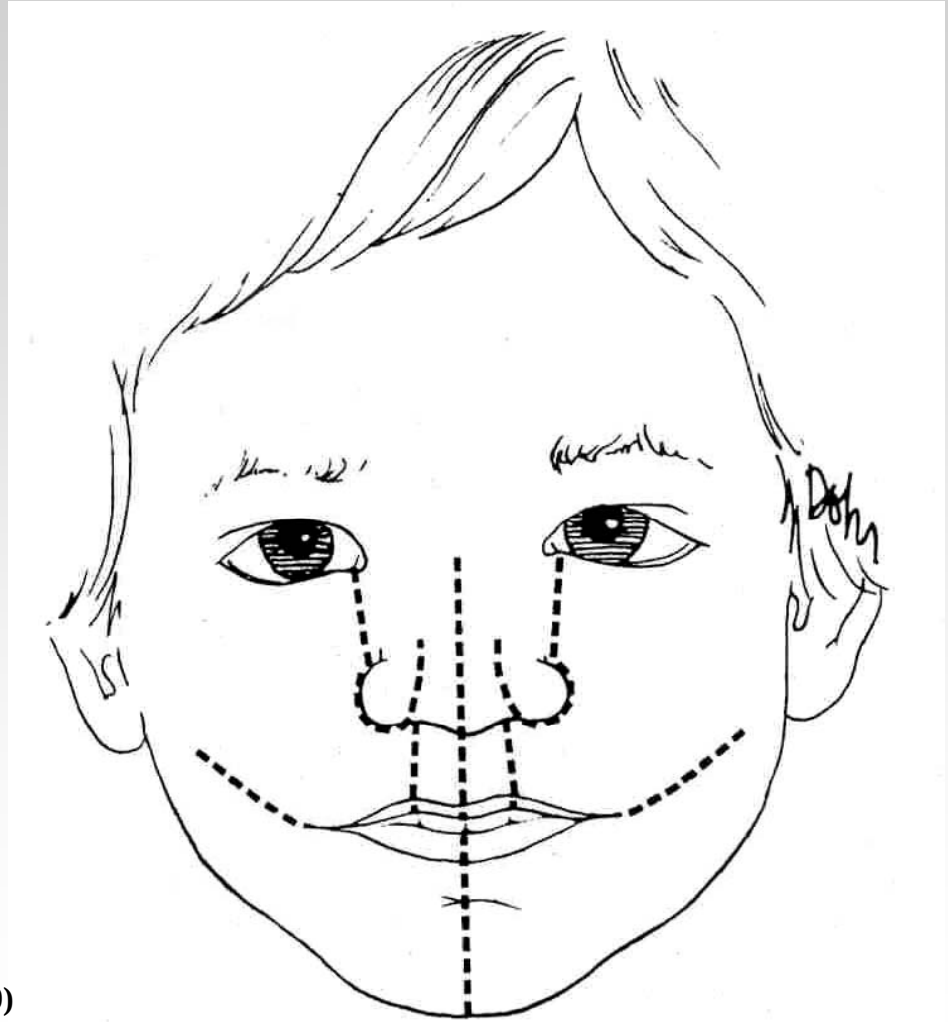
Millicovsky G, Johnston MC (1981)

Nasolacrimal duct between maxillary and lateral nasal processes



© Elsevier Ltd. Drake et al: Gray's Anatomy for Students www.studentconsult.com

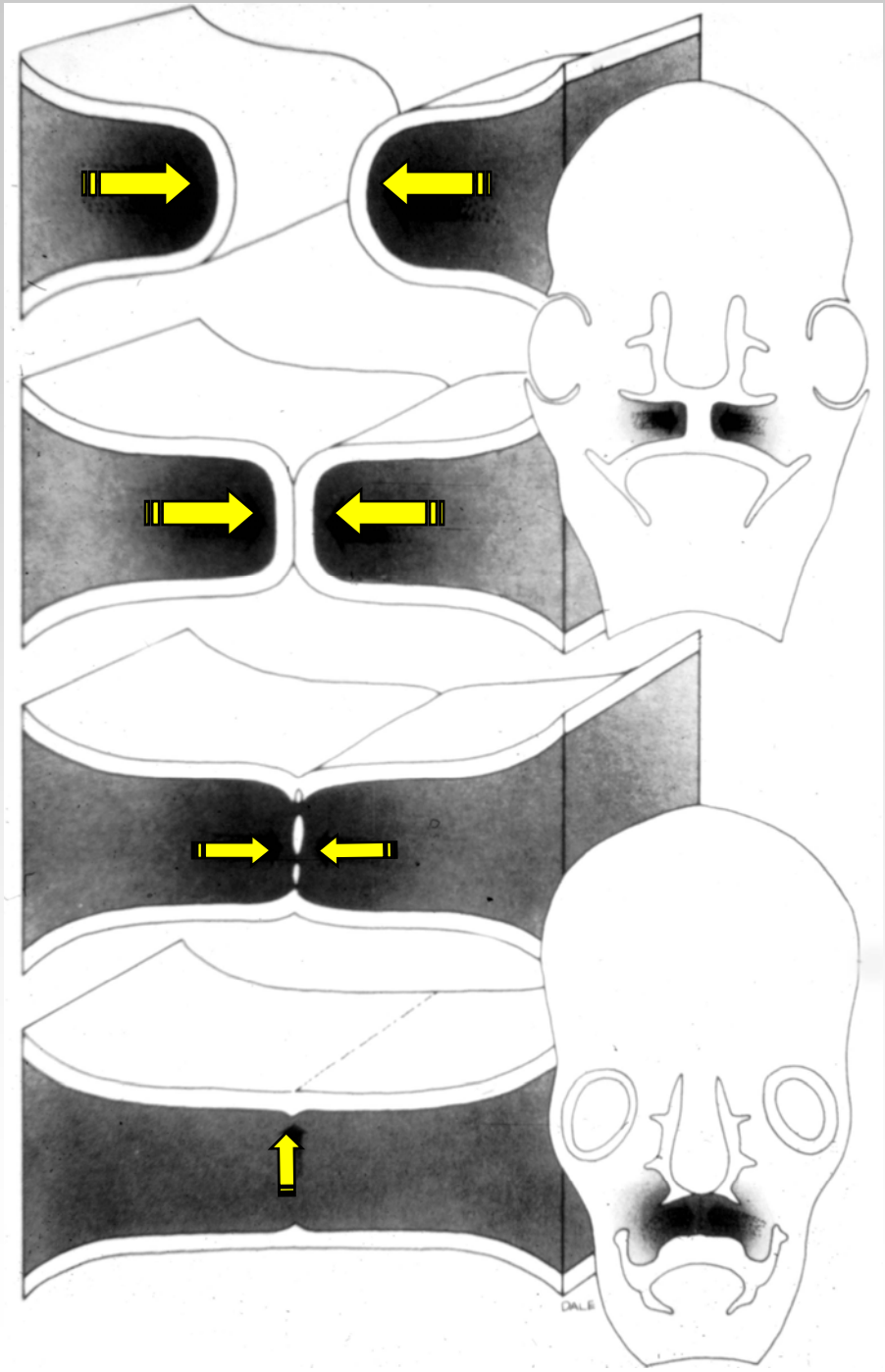
Sites of potential facial clefts



Moss-Salentijn L, Klyvert M (1990)

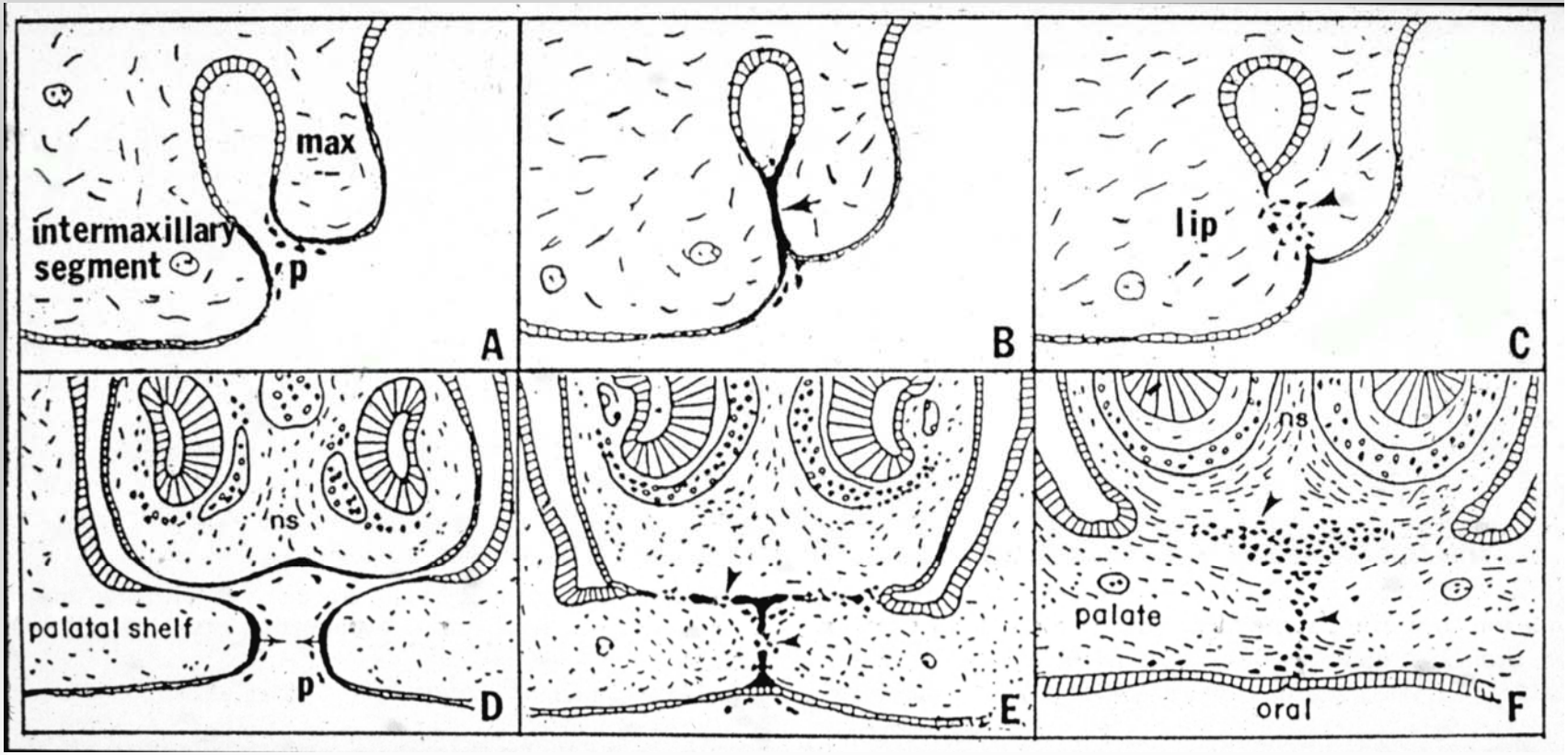
Fusion

Contact and fusion of epithelium-covered surfaces. Removal of epithelium



Ten Cate AR (1988)

Fusion in primary and secondary palate development

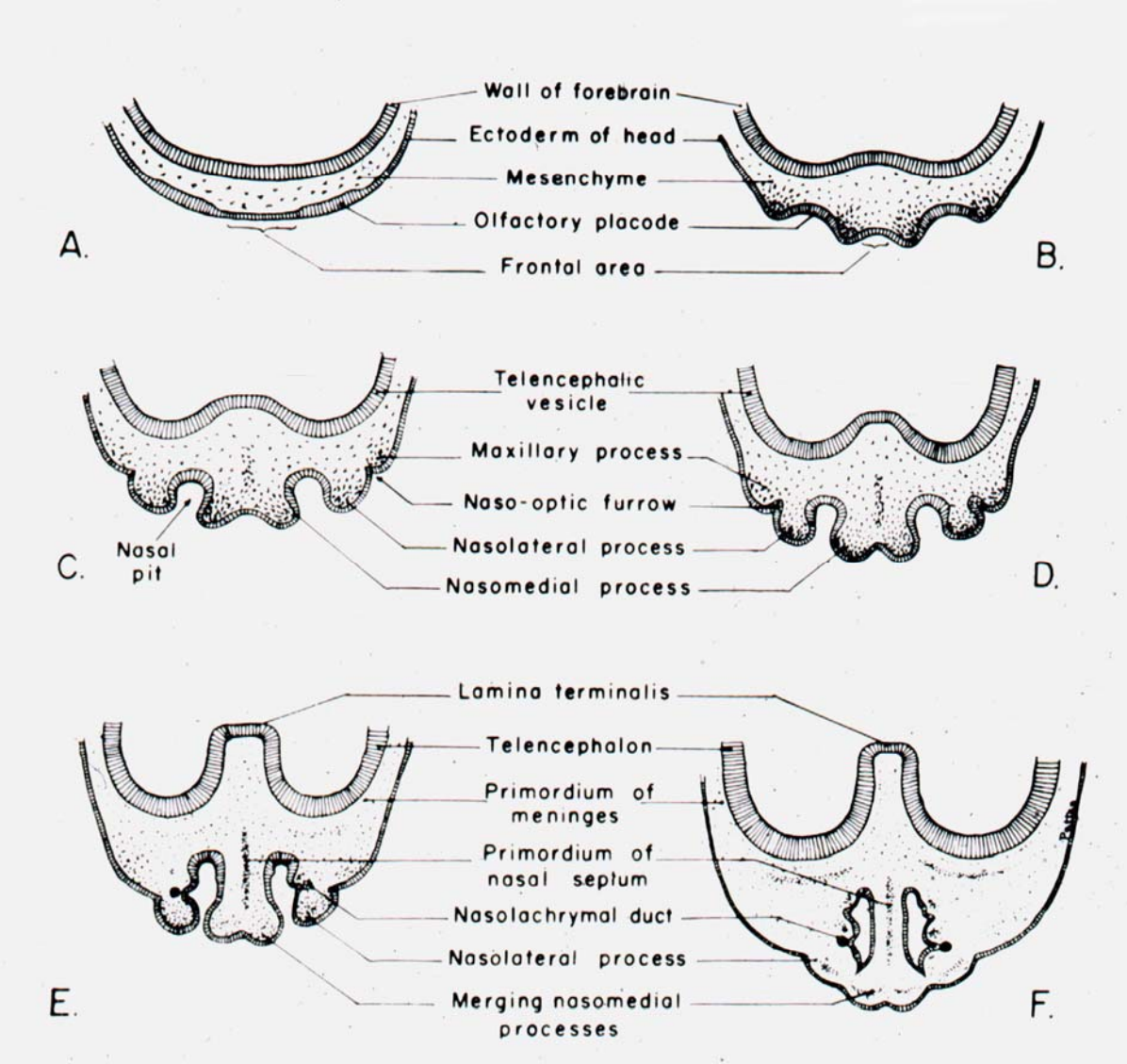


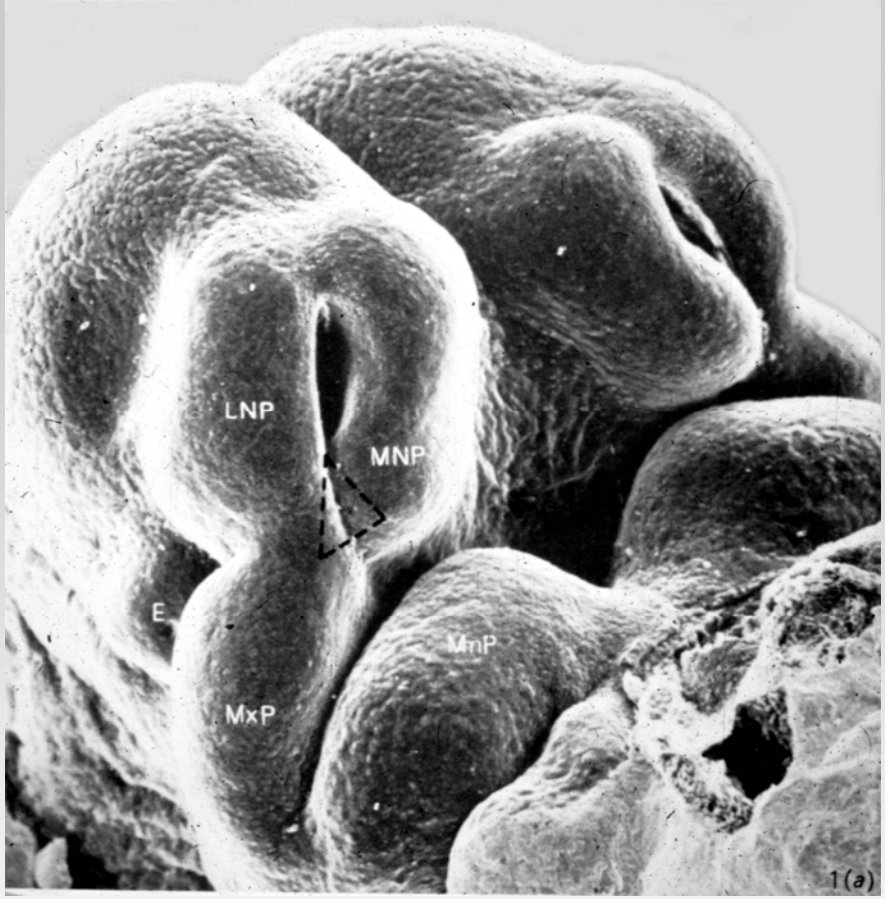
Sun D, Baur S, Hay ED (2000)

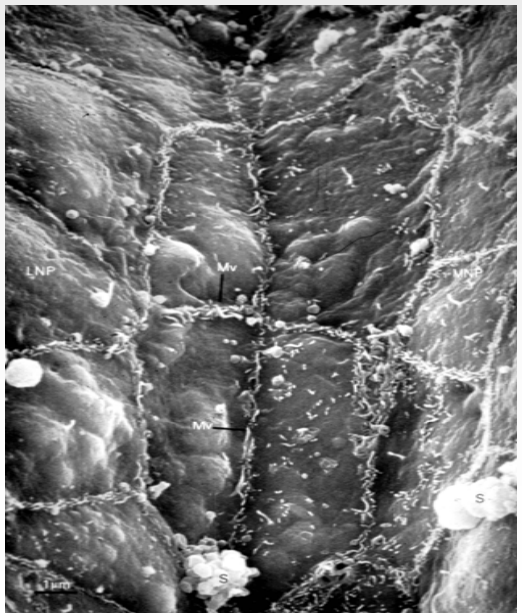
Fate of fused epithelium

- Non-proliferating epithelium in rapidly growing environment: passive stretch and incorporation in nearby surface epithelia
- Apoptosis and phagocytosis
- Epithelial-mesenchymal transformation

Development of nose

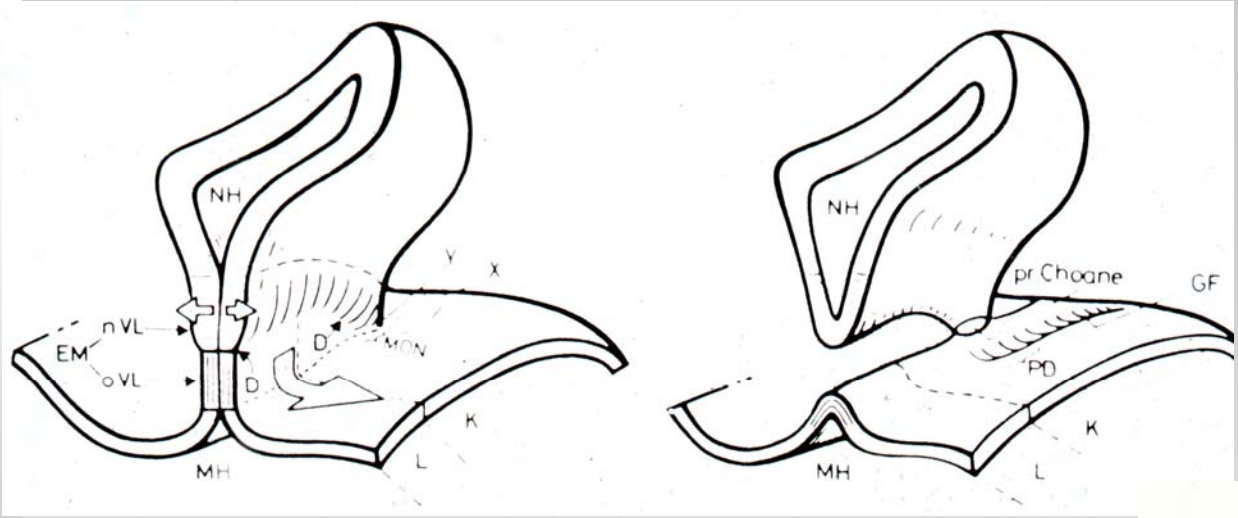






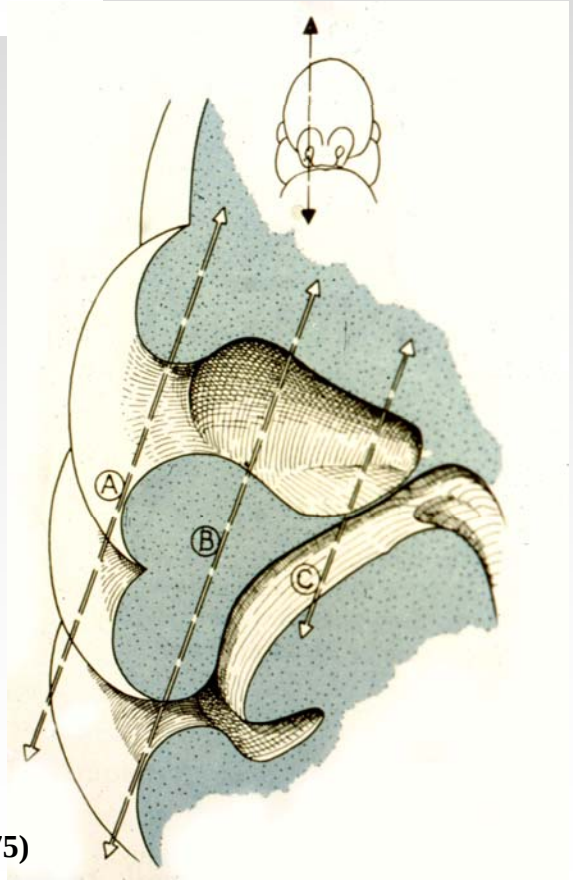
Initial fusion of medial and lateral nasal processes, and subsequently between medial nasal and maxillary processes.

Millicovsky G, Johnston MC (1981)

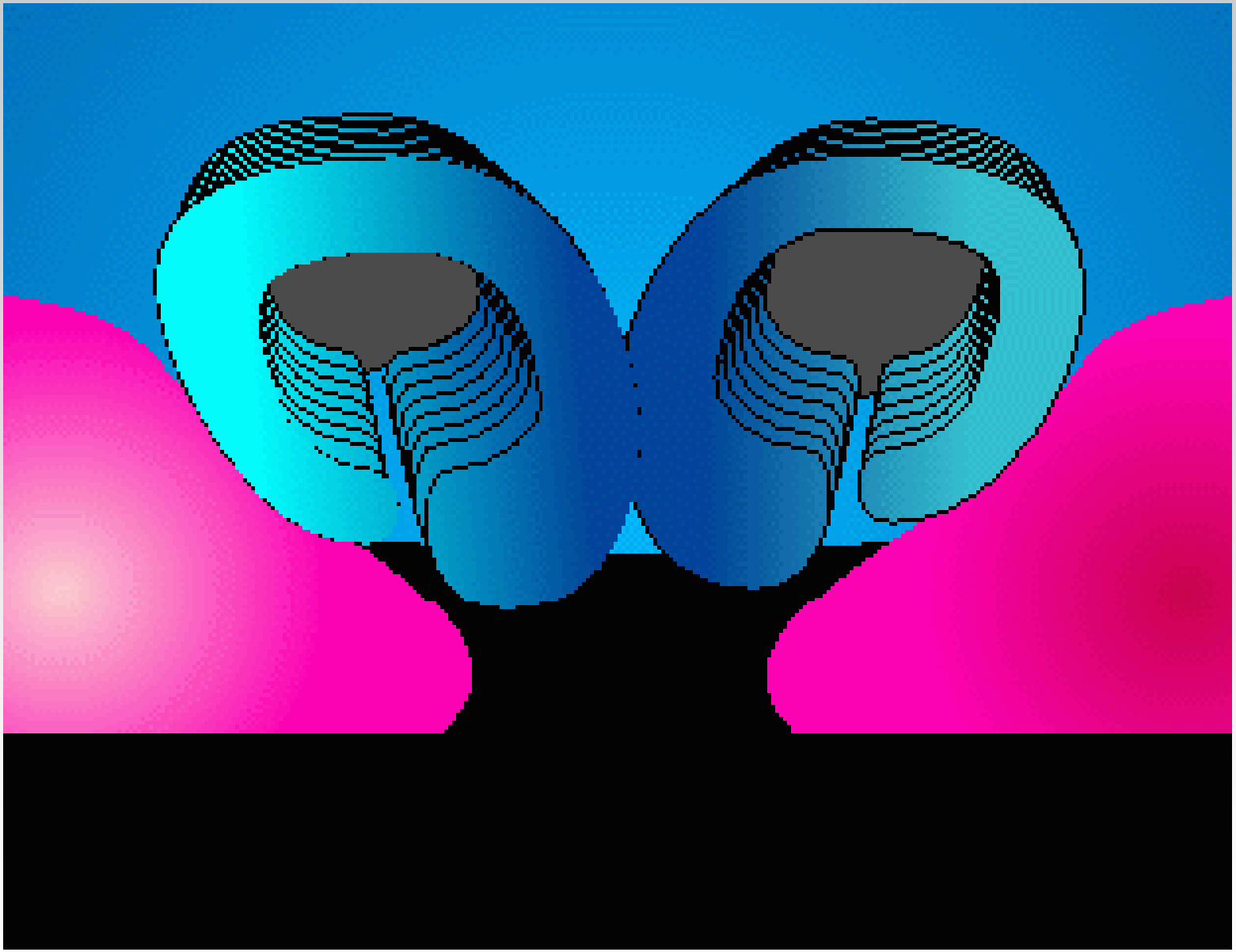


Otto H-D, Opitz Ch (1987)

All epithelium in fusion line is removed except oronasal membrane (ectoderm-ectoderm)

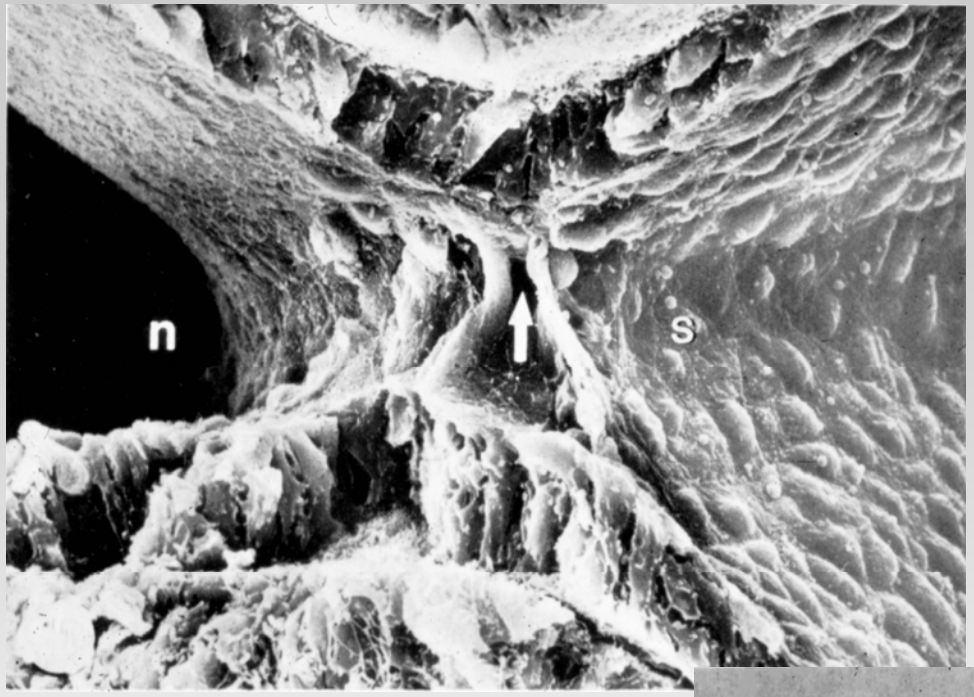


Tuchmann-Duplessis H, Haegel P (1975)

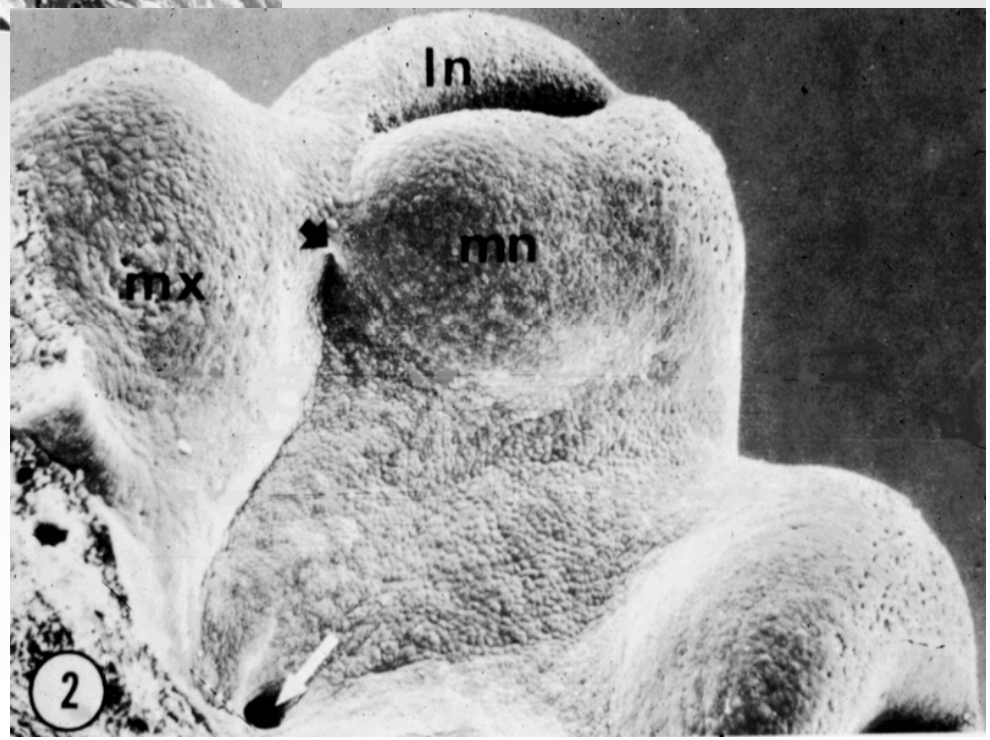


Watt, Marie A, and Sanders Colin, Univ Glasgow

Oronasal membrane

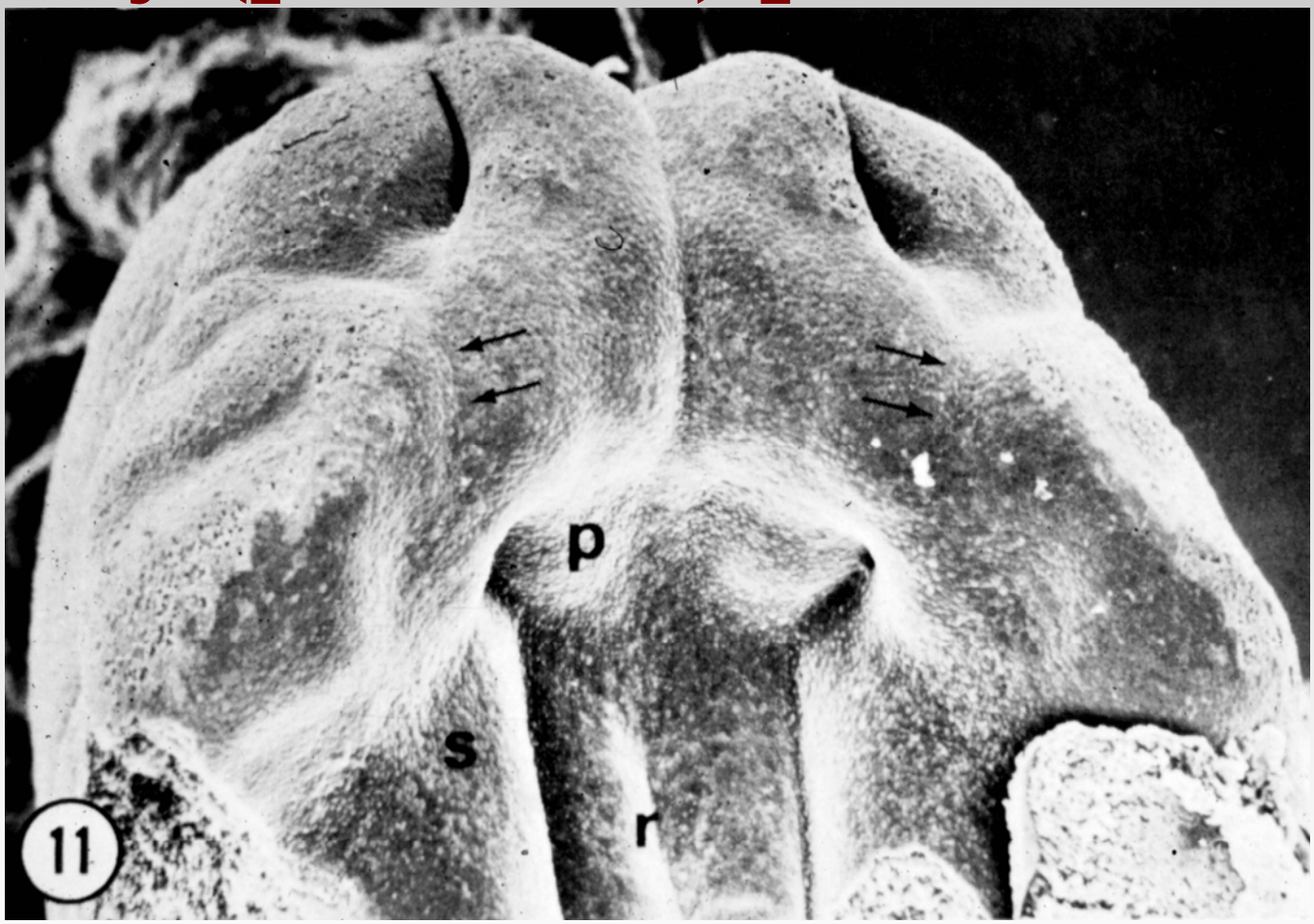


Breaks down at about 6 wks of development.



Tamarin A (1982)

Primary (primitive) palate

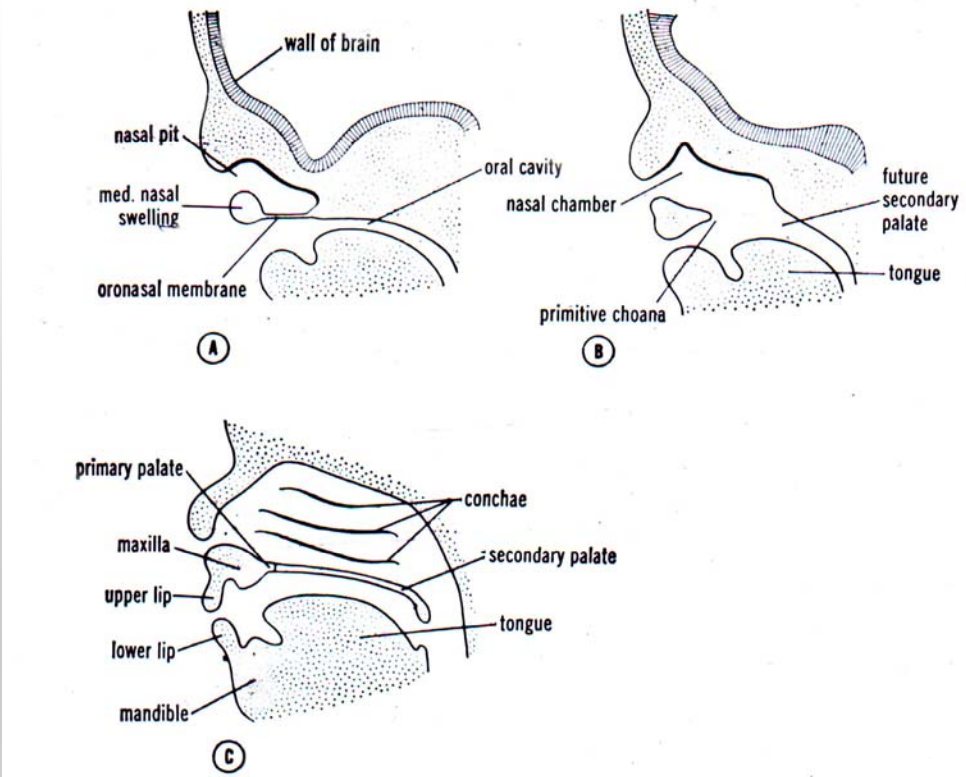


Tamarin A (1982)

Primary palate composed of: intermaxillary segment of merged MNP's and the rostral tips of the maxillary processes.

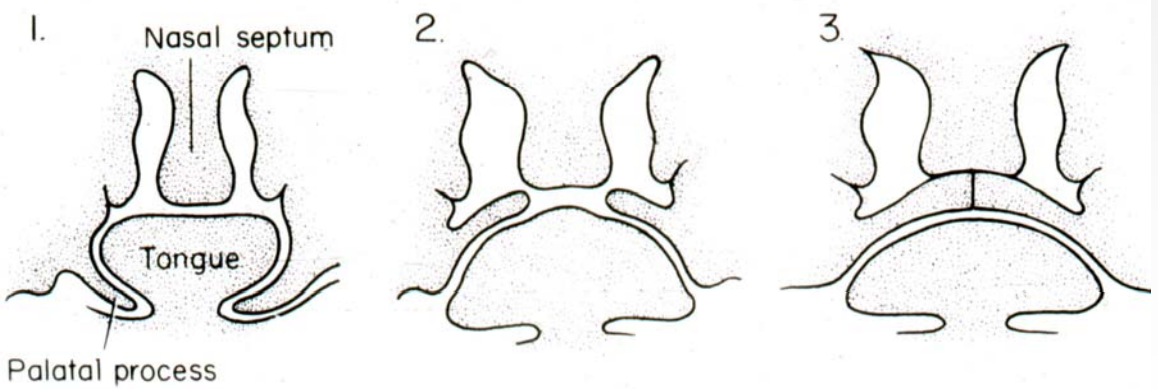
P: primary (primitive) choana permitting oro-nasal communication

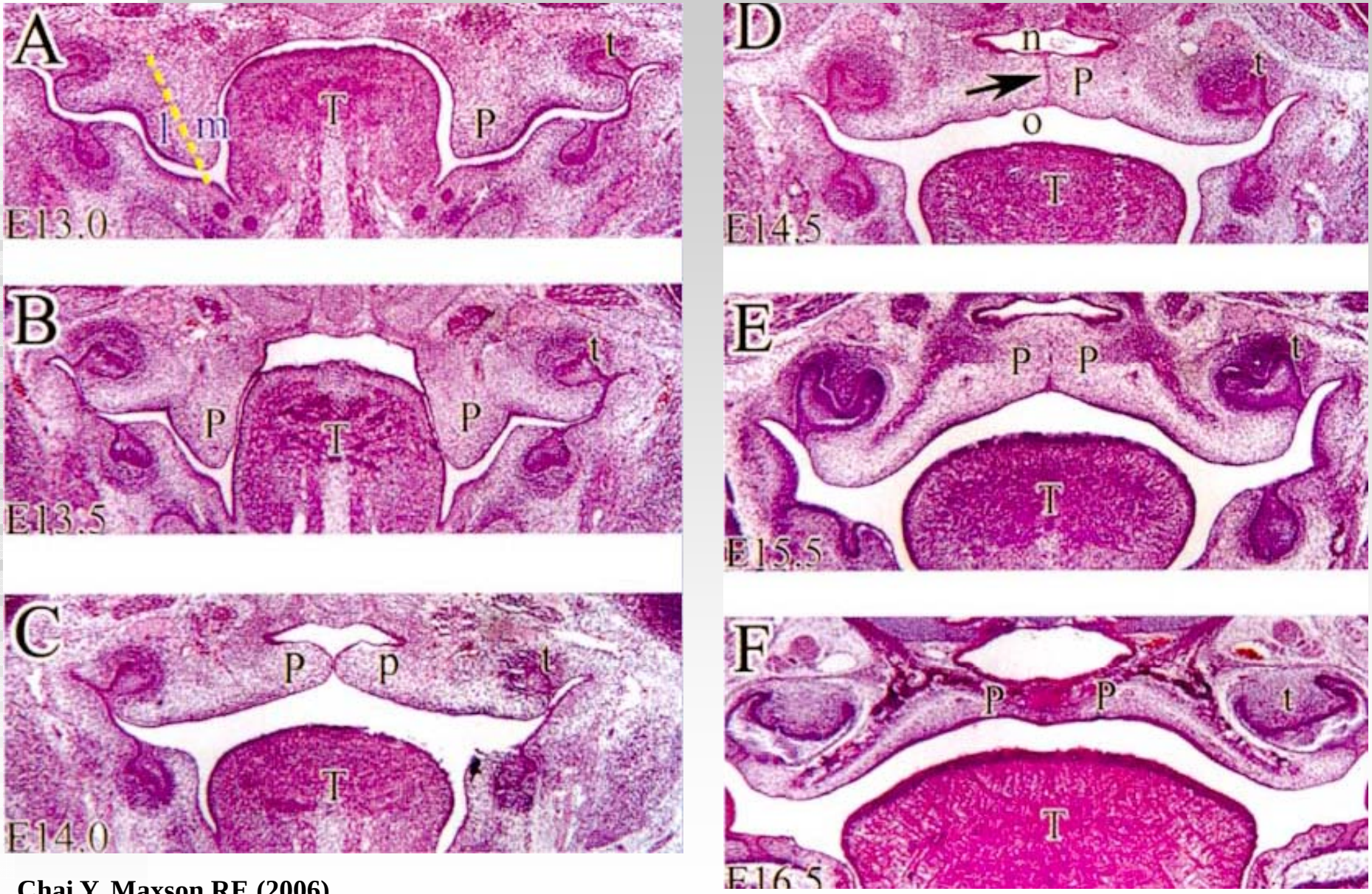
Development of primary and secondary palate



Langman J Medical Embryology

Secondary palate development



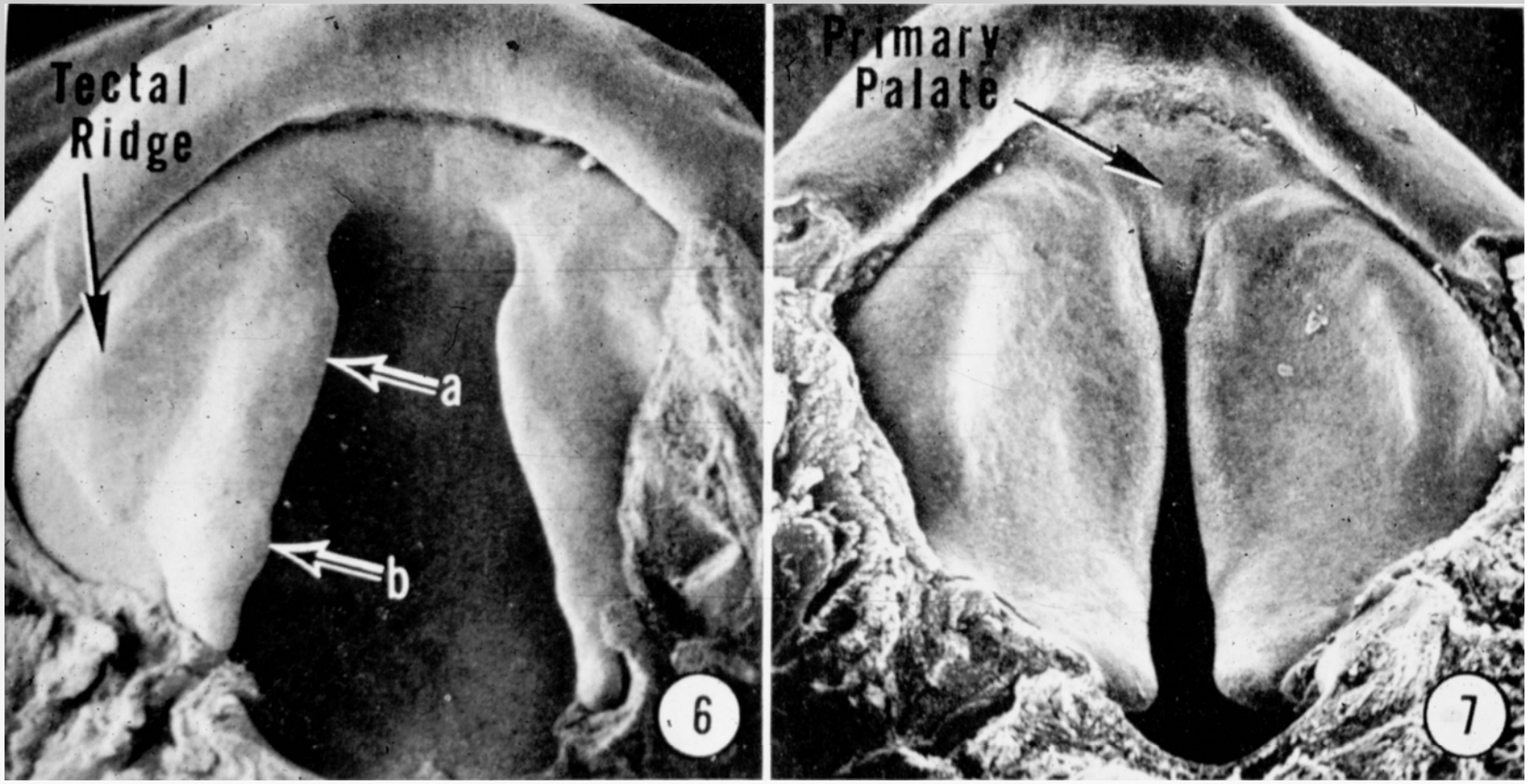


Chai Y, Maxson RE (2006)

Intrinsic factors in the successful development of the secondary palate: increase in size of palatal processes

- Mesenchymal cell proliferation – ceases hours before palatal processes become horizontal
- ECM production increasing volume of palatal processes
- Hydration of ECM – major increase in volume and turgor just prior to horizontalization

Secondary palate development



Waterman RE, Meller SM (1974)

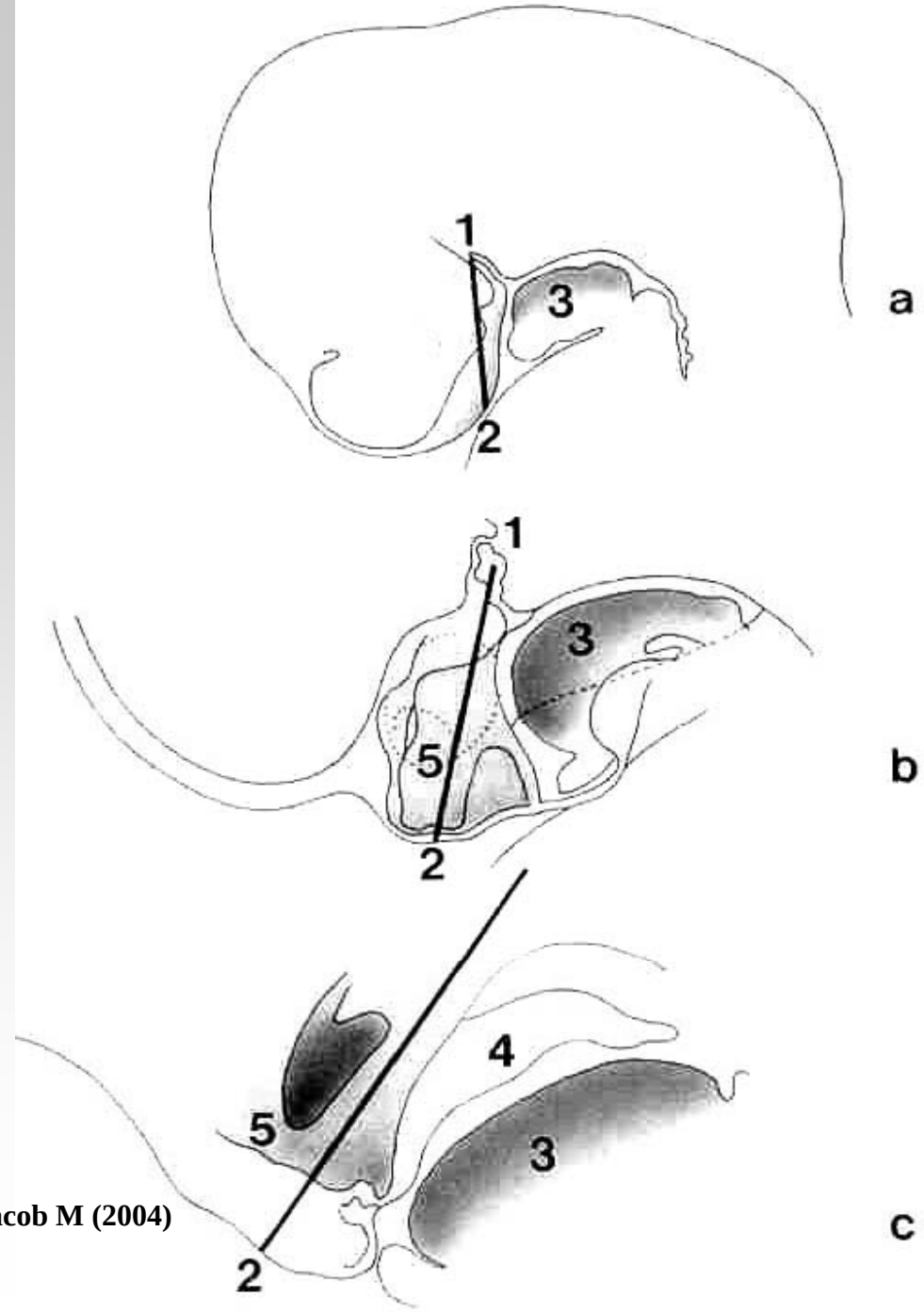
Palatal processes develop on the oral surfaces of the maxillary processes: initially vertically oriented, they assume horizontal orientation during eighth week of development.

Horizontalization of palatal processes

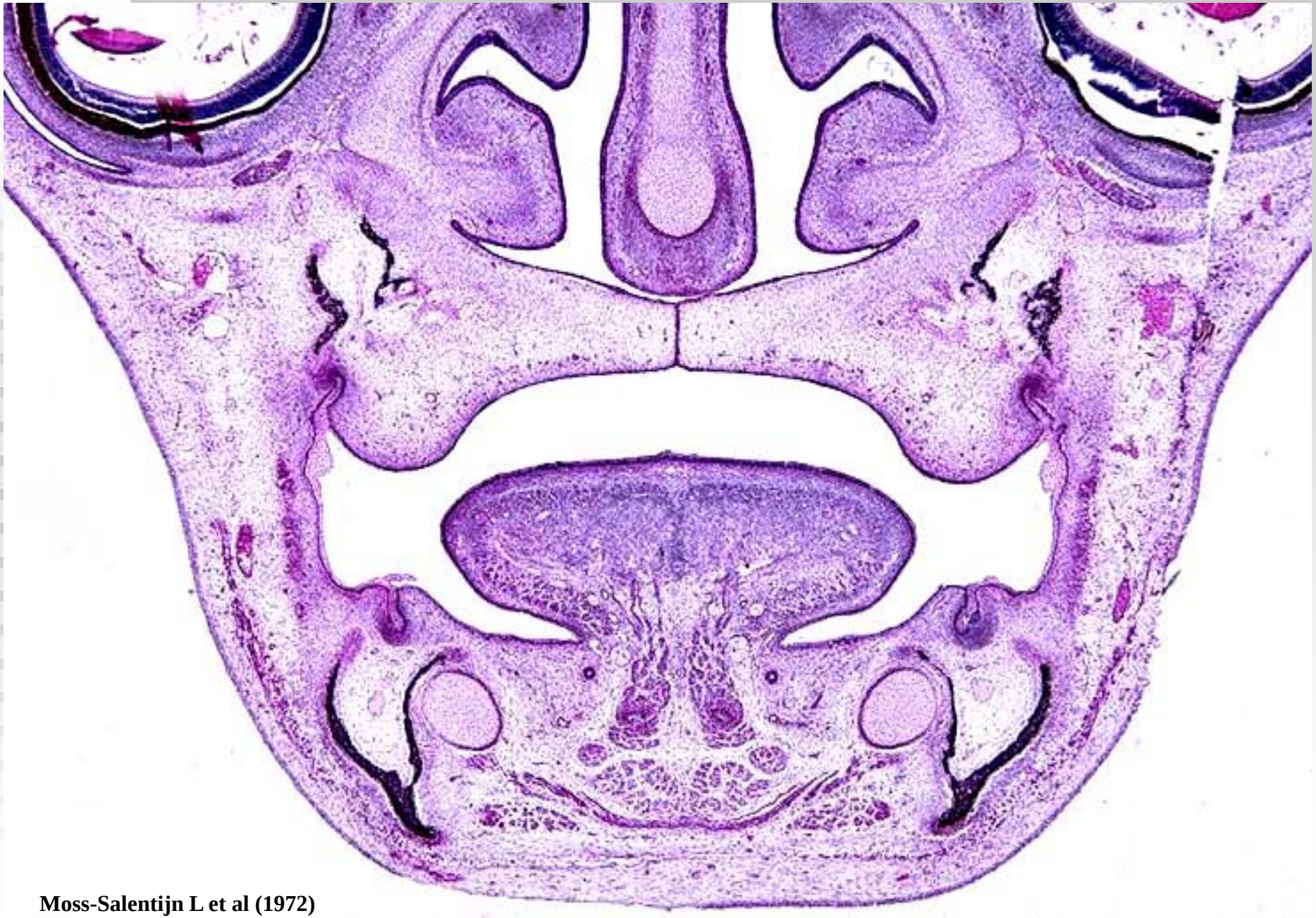
Watt, Marie A, and Sanders, Colin

Factors contributing to the horizontalization of the palatal processes

- Turgor in the palatal processes
- Movements of the tongue – primitive swallowing- allowing tongue to move out of the way
- Downward and forward growth of lower jaw complex – providing space for the secondary palate
- Straightening of the cranial base – providing mechanical conditions for horizontalization



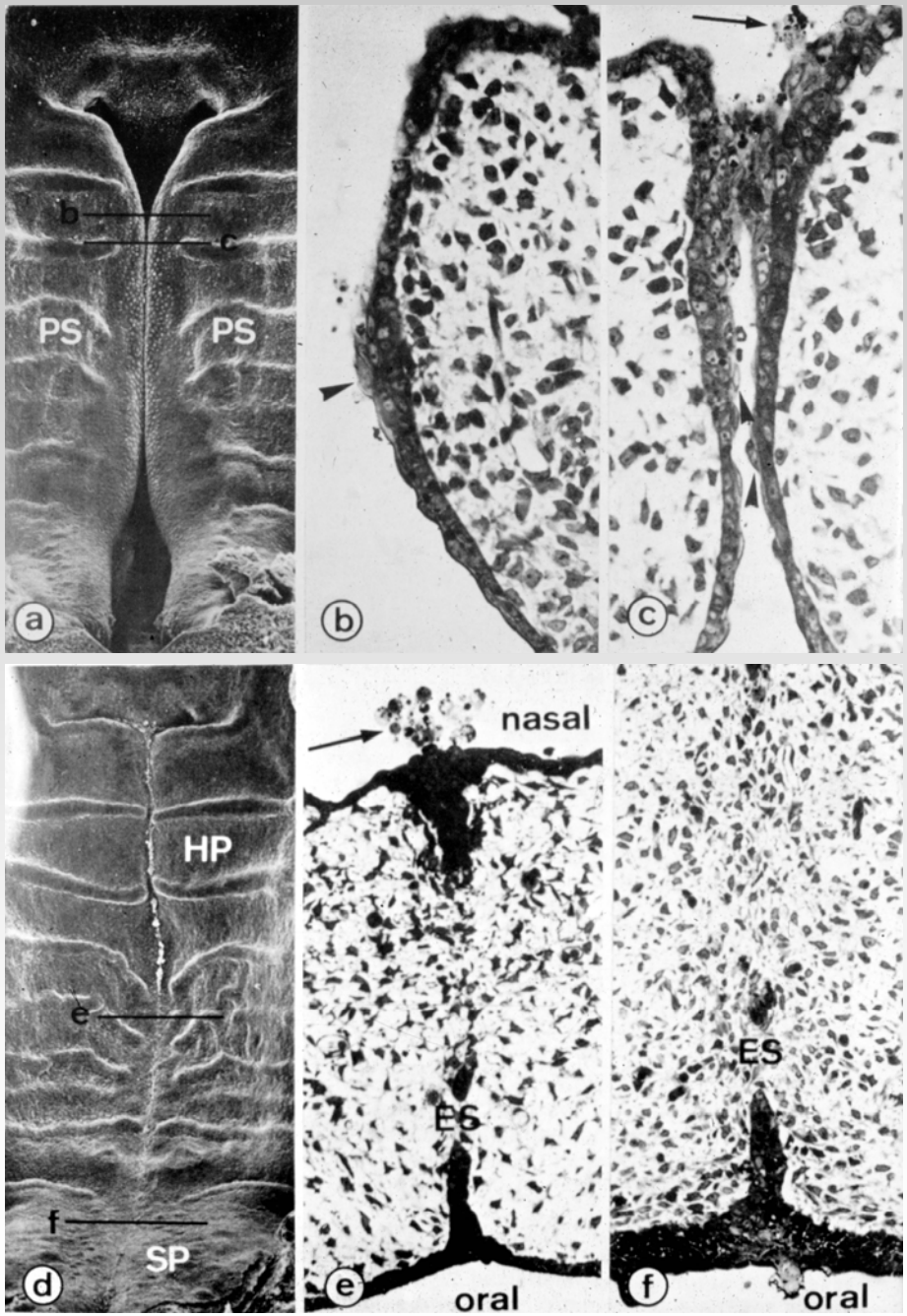
Barteczko K, Jacob M (2004)



Moss-Salentijn L et al (1972)

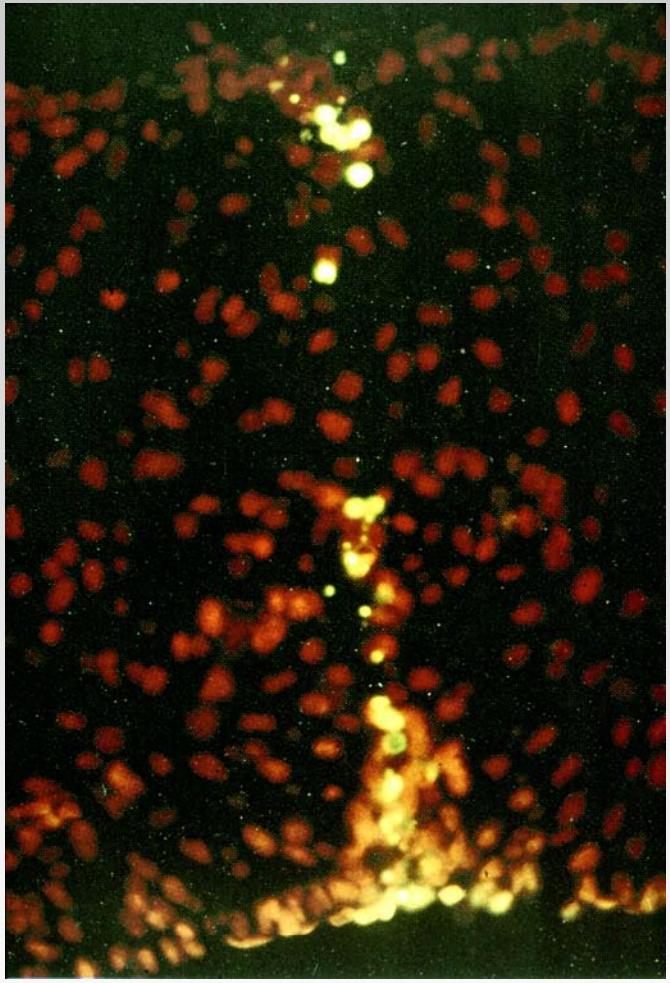
Factors contributing to the successful fusion of the secondary palate: the medial edge epithelium (MEE)

- Apoptosis of MEE surface cells immediately prior to fusion
- Development of temporary glycoprotein membrane coating, enabling adhesion between MEE cells of opposing palatal processes
- Successful removal of MEE from fusion line



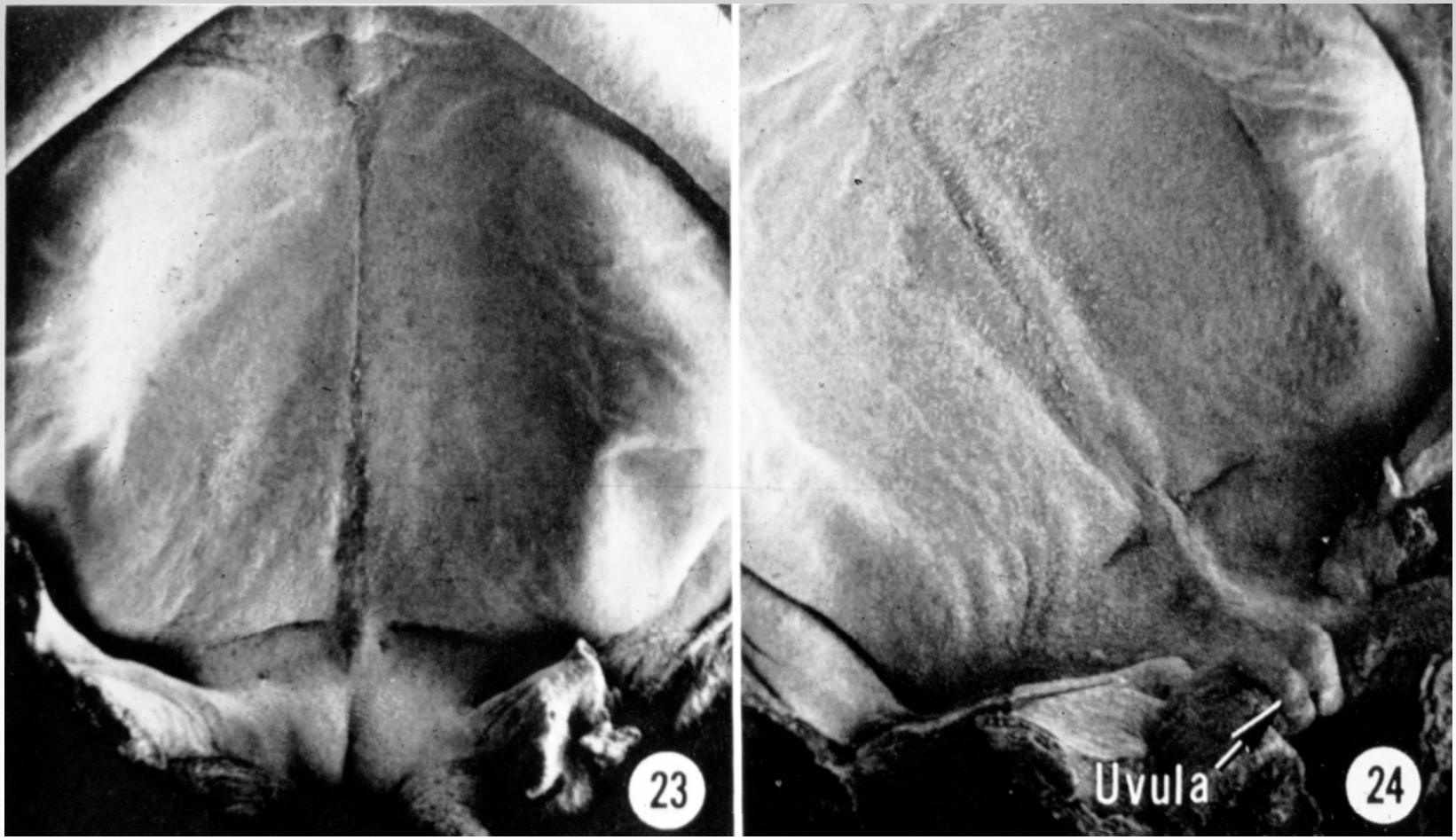
Schupbach PM, Schroeder HE (1983)

Mori C, et al. (1994)



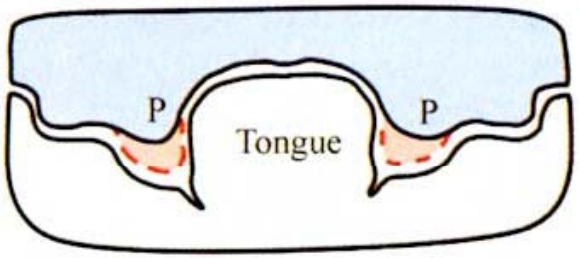
Fate of MEE cells: apoptosis (TUNEL reaction above) and phagocytosis

Completion of palate formation

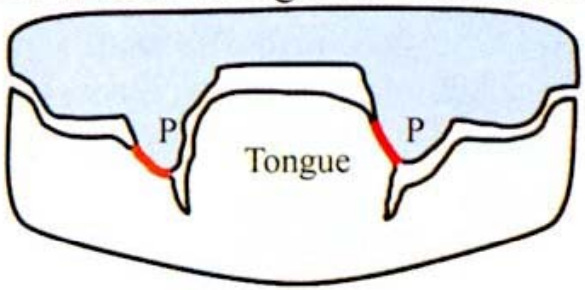


Waterman RE, Meller SM (1974)

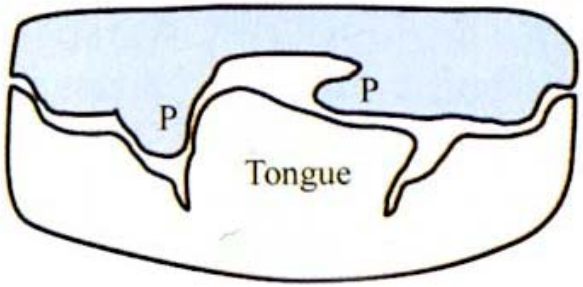
Failure of palatal shelf formation



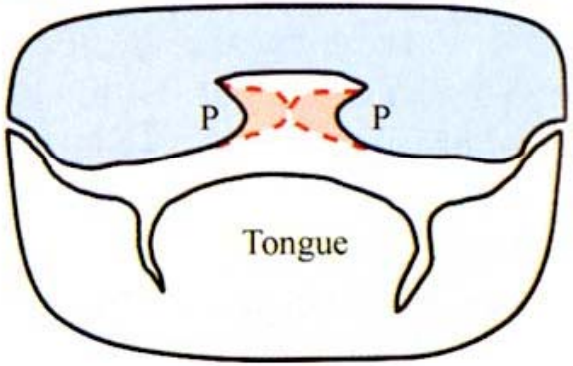
Fusion with the tongue or the mandible



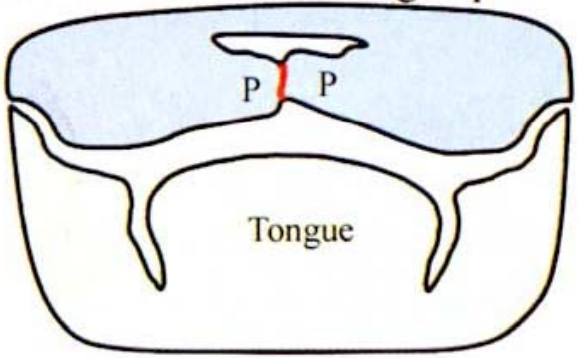
Failure of palatal shelf elevation



Failure of shelves to meet following elevation

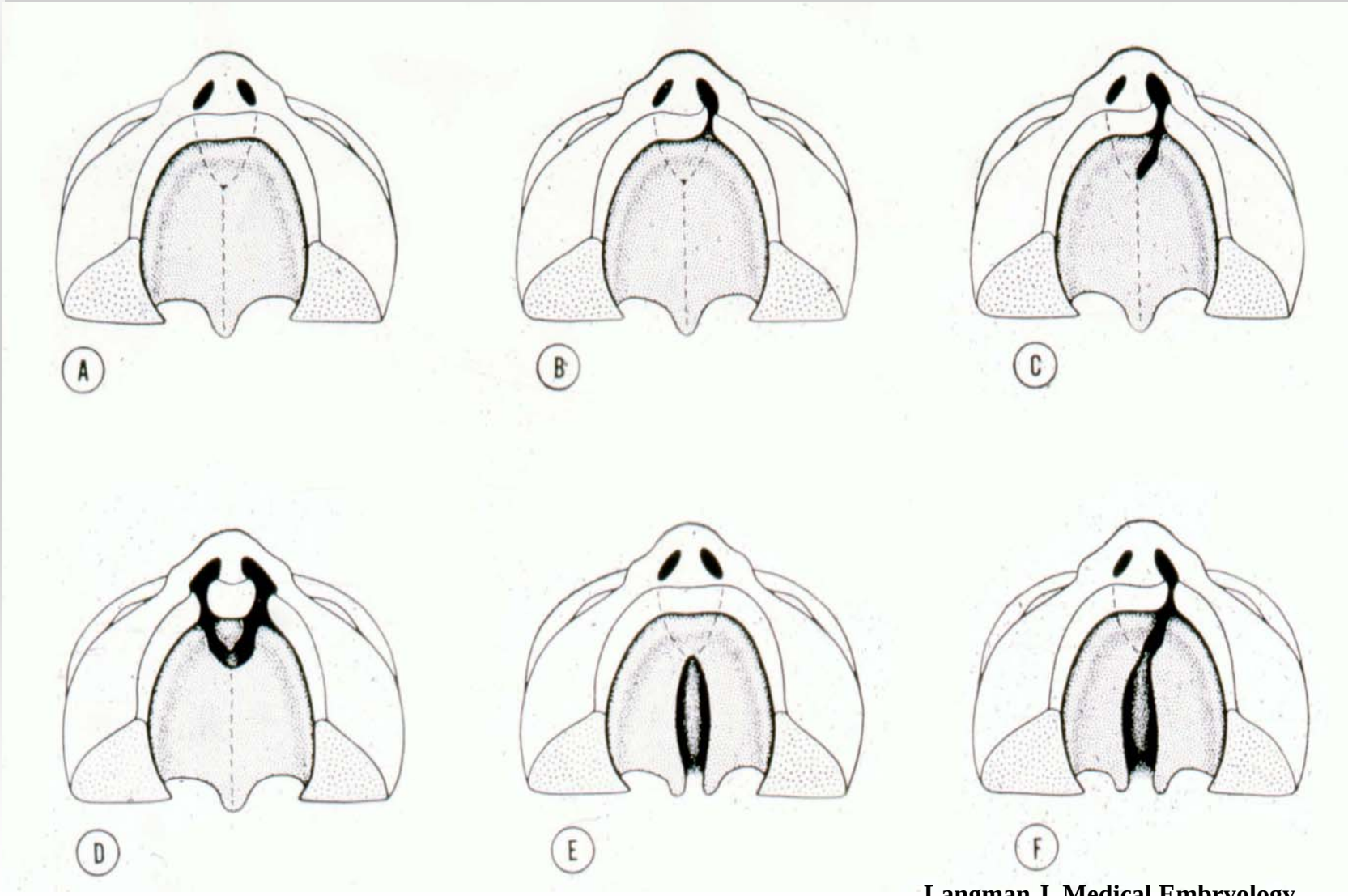


Persistence of medial edge epithelium



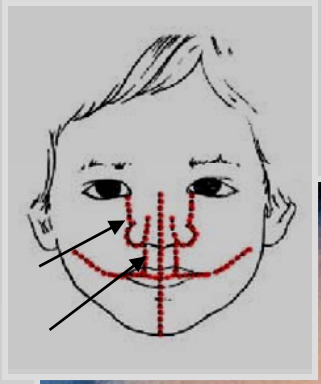
Chai Y, Maxson RE (2006)

Sites of potential palatal clefts



Langman J, Medical Embryology

Median Facial Cleft



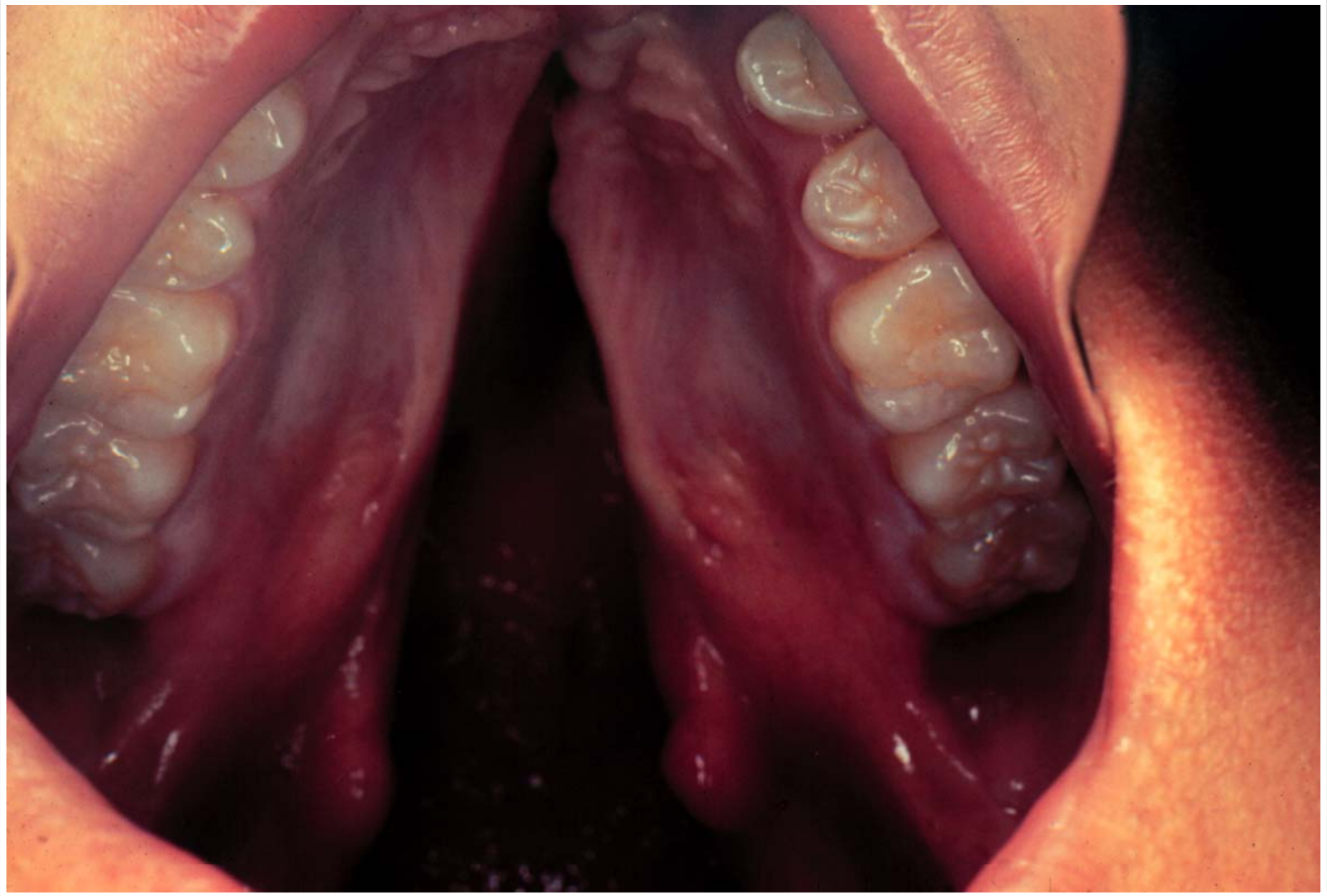
Oblique Facial Cleft and Cleft Lip

Cleft Lip

Unilateral (R) complete cleft lip and palate

Bilateral incomplete cleft lip

square.umin.ac.jp/~prstmc/ tmcprs/tmcjp.html



Complete Cleft Palate

= Cleft of hard palate + Cleft of soft palate + Cleft uvula

Submucous Cleft Palate and Bifid Uvula

Submucous cleft palate may be indicated by 1) bifid uvula, 2) partial separation of muscle with intact mucosa, 3) palpable notch at the posterior end of the palate. It can be confirmed by occlusal radiograph.

Source: Left: Dr. Sidney Horowitz; Right: http://author.emedicine.com/PED/topic2679.htm