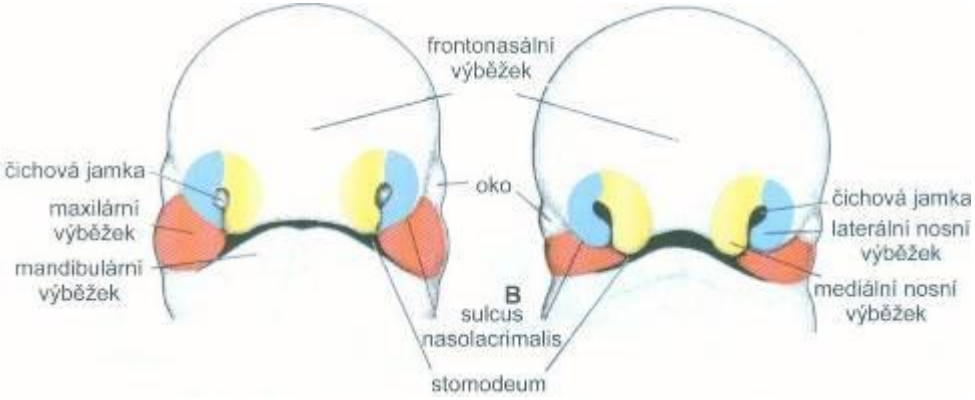
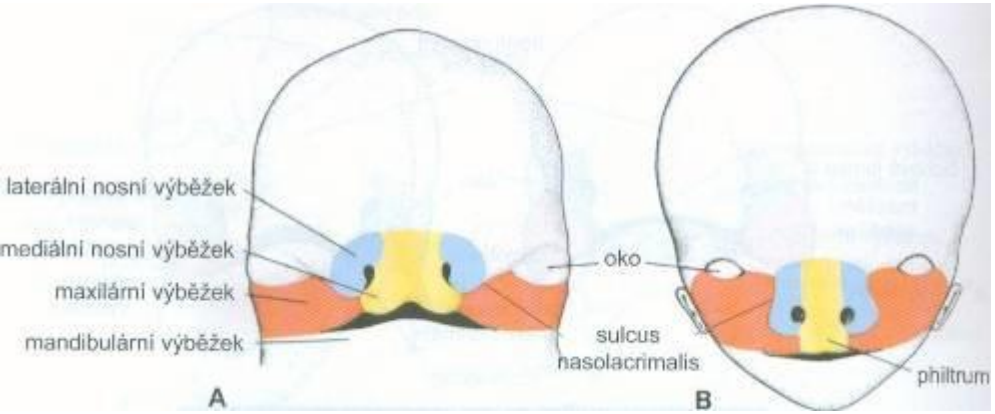
Development of face

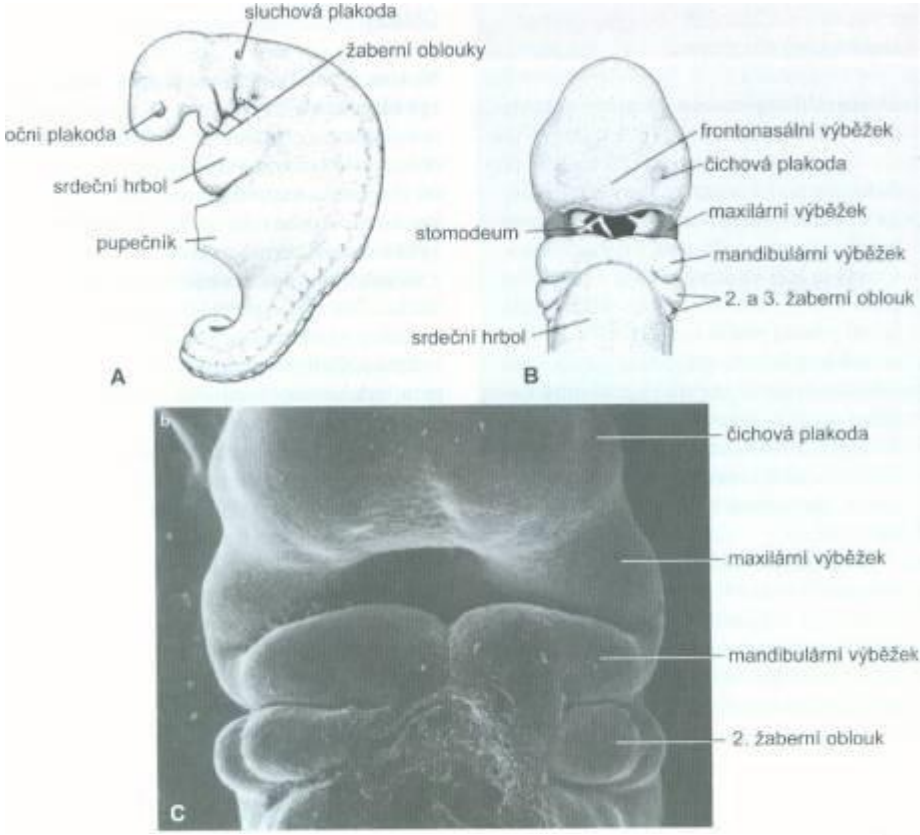
facial primordia appear at end of 4th week (neural crest ectomesenchyme of 1st pharyngeal arch) around stomodeum

- frontonasal prominence cranially
- maxillary prominences laterally
- mandibular prominences caudally
  - on each side develop bilateral oval thickenings of the surface ectoderm → **nasal placodes**
    - they depress within 5th week → **nasal pits**
    - pits are bordered by horseshoe-shaped elevations = **medial and lateral nasal prominences**

Development of face







Face development. A. Position of branchial arches in lateral view in 4th week. B. Front view of face foundation in the 5th week. Maxillary and mandibular extensions are well visible, olfactory placodes are formed in margins of frontonasal extension. C. SEM photo of the face of human embryo in 5th week of dev.

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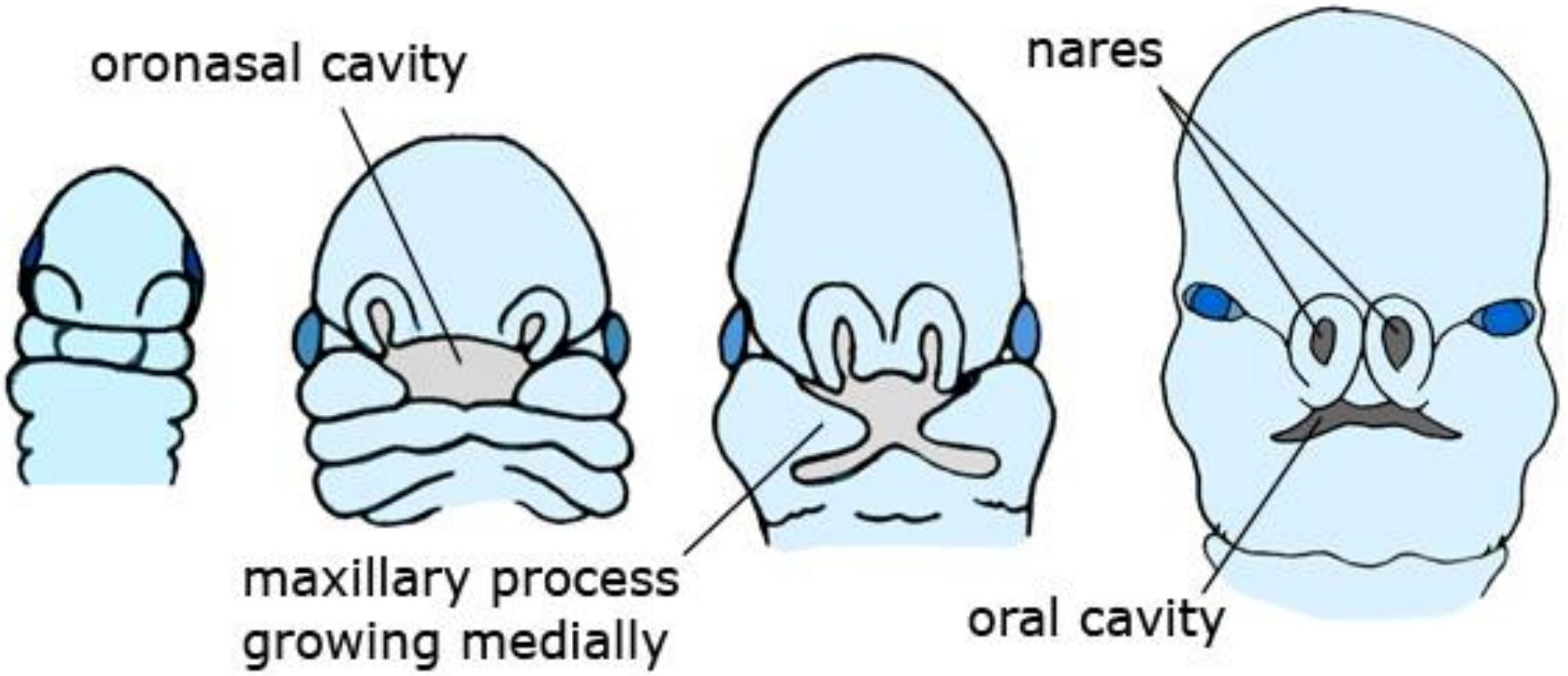
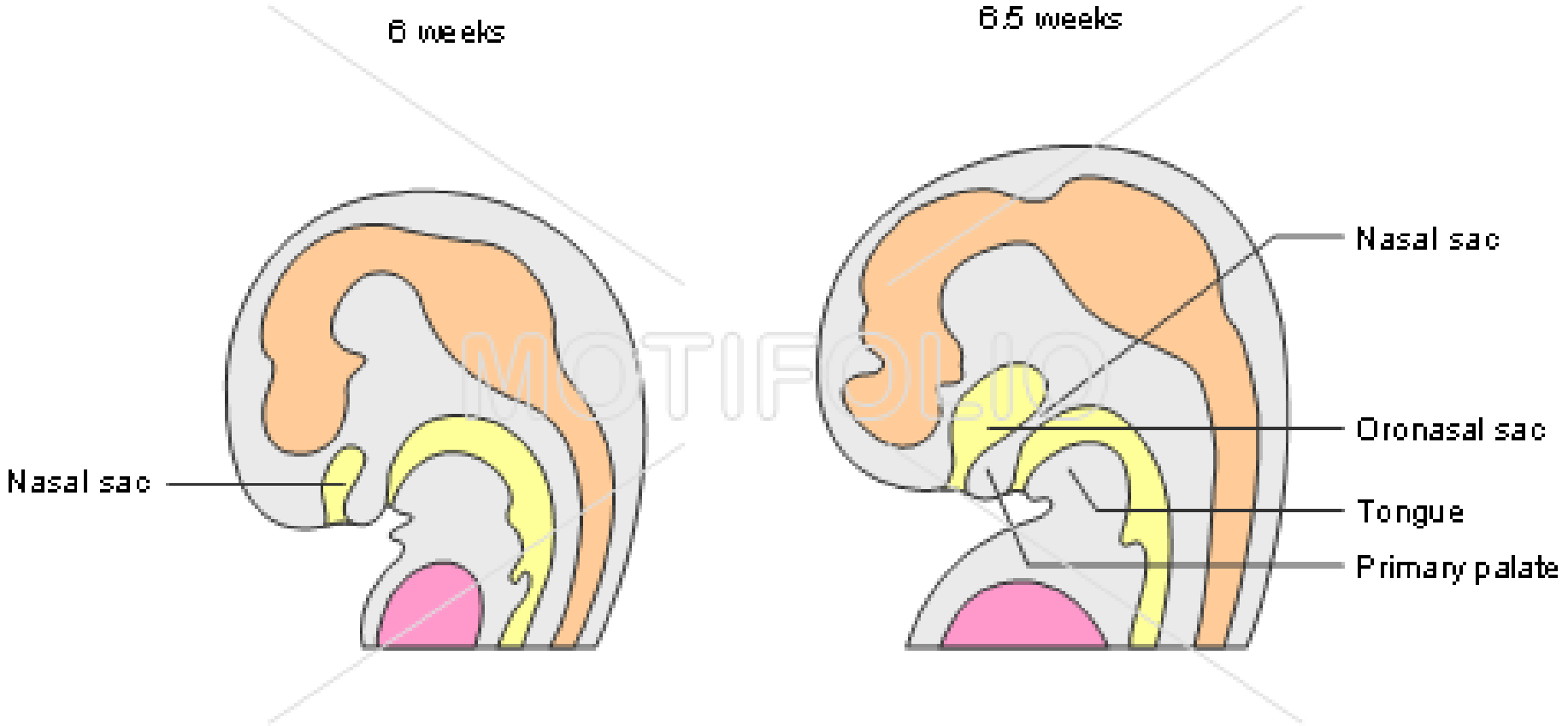


Development of the nasal cavities

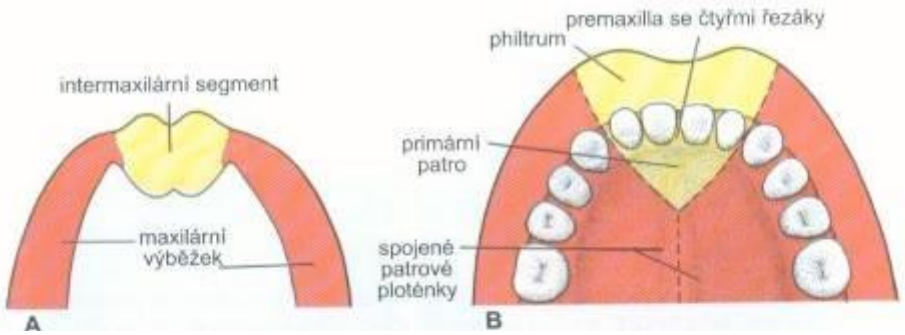


Development of palate

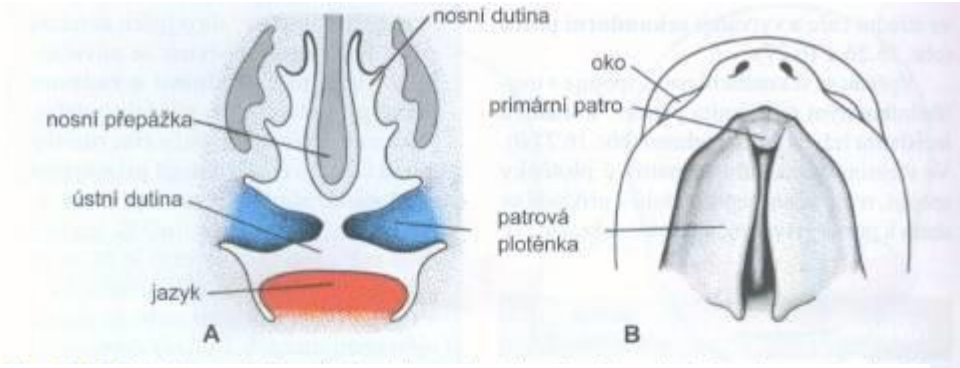
- primary palate
  - from *intermaxillary segment*
    - by merging of both medial nasal prominences
  - lip component → *philtrum*
  - component for the upper jaw (carries 4 incisors)
  - palatine component (forms the primary palate)
  - passes continuously into nasal septum (from frontonasal prominence)

- secondary palate
  - by merging of palatine processes of maxillary process (6th week)
  - ventrally fusion with primary palate (future *os incisivum*)

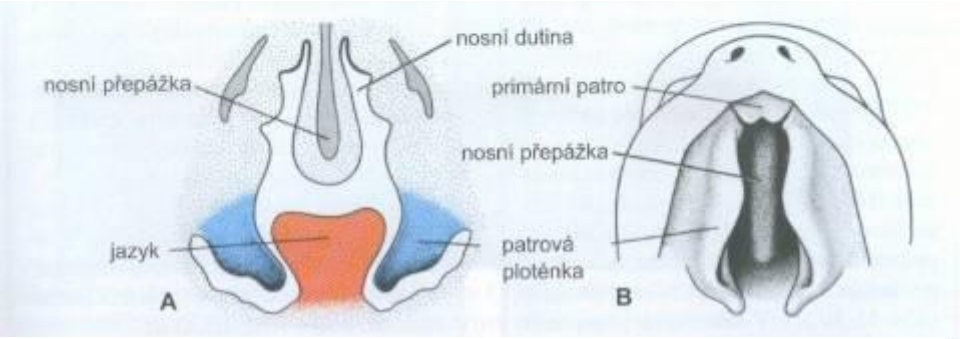
Development of palate



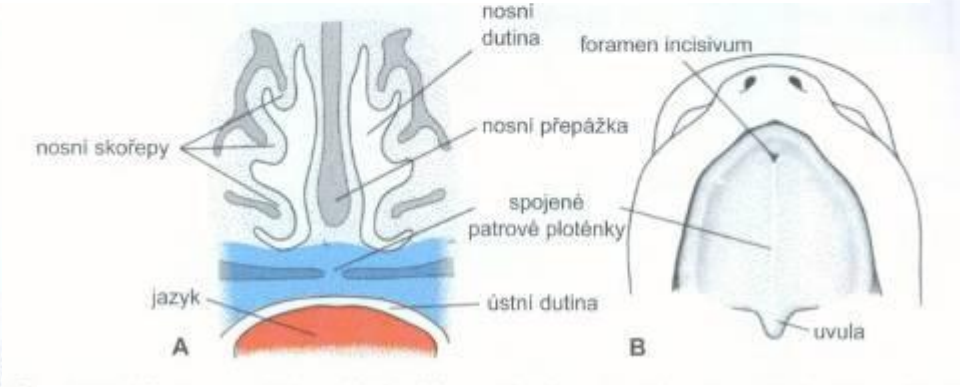
A. Intermaxillary segment and maxillary extensions. B. From intermaxillary segment originate part of middle sulcus of upper lip (philtrum), next ventral part of upper jaw (premaxilla) in the extent of four dentes incisivi and also primary palate having triangular shape.



Palate development. A. Frontal section of head in 8th week of development. Tongue moves caudally and palate plates moved into horizontal position. B. Frontal view of palate plates that are already in horizontal position but not fused yet so that nasal septum could be visible.



Palate development. A. Frontal section of head in 7th week of development. Palate plates are in vertical position on both sides of tongue foundation. B. View of palate plates before their horizontalization. Primary palate is not yet separated.



Palate development. A. Frontal section of the head in 10th week . Palate plates fuse and connect with nasal septum. B. Foramen incisivum is preserved in the place of fusion of primary and secondary palate.

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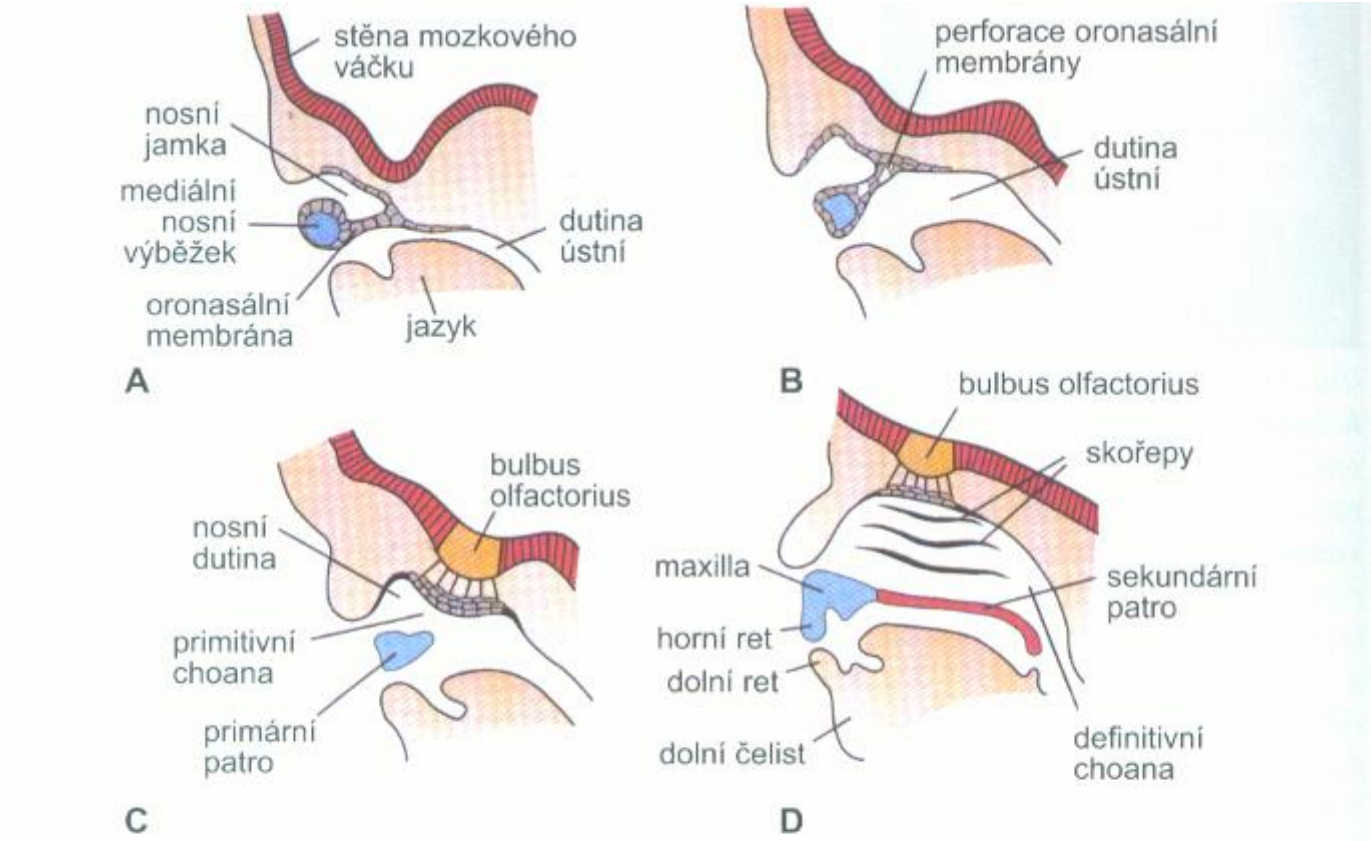
Separation of oral and nasal cavity



Stages of nasal and mouth cavity separation. A. Sagittal section via nasal pit and cadal margin of medial nasal extension in 6th week of development. Primitive nasal cavity is separated from mouth cavity by oronasal membrane. B. Similar section as in A in time when oronasal membrane ceases. C. Embryo in 7th week, primitive nasal cavity is connected with mouth cavity. D. Sagittal section of face in 9th week. Definitive nasal cavity is separated from mouth cavity by primary and secondary palate. Defininitive choane connect nasal cavity with pharynx.

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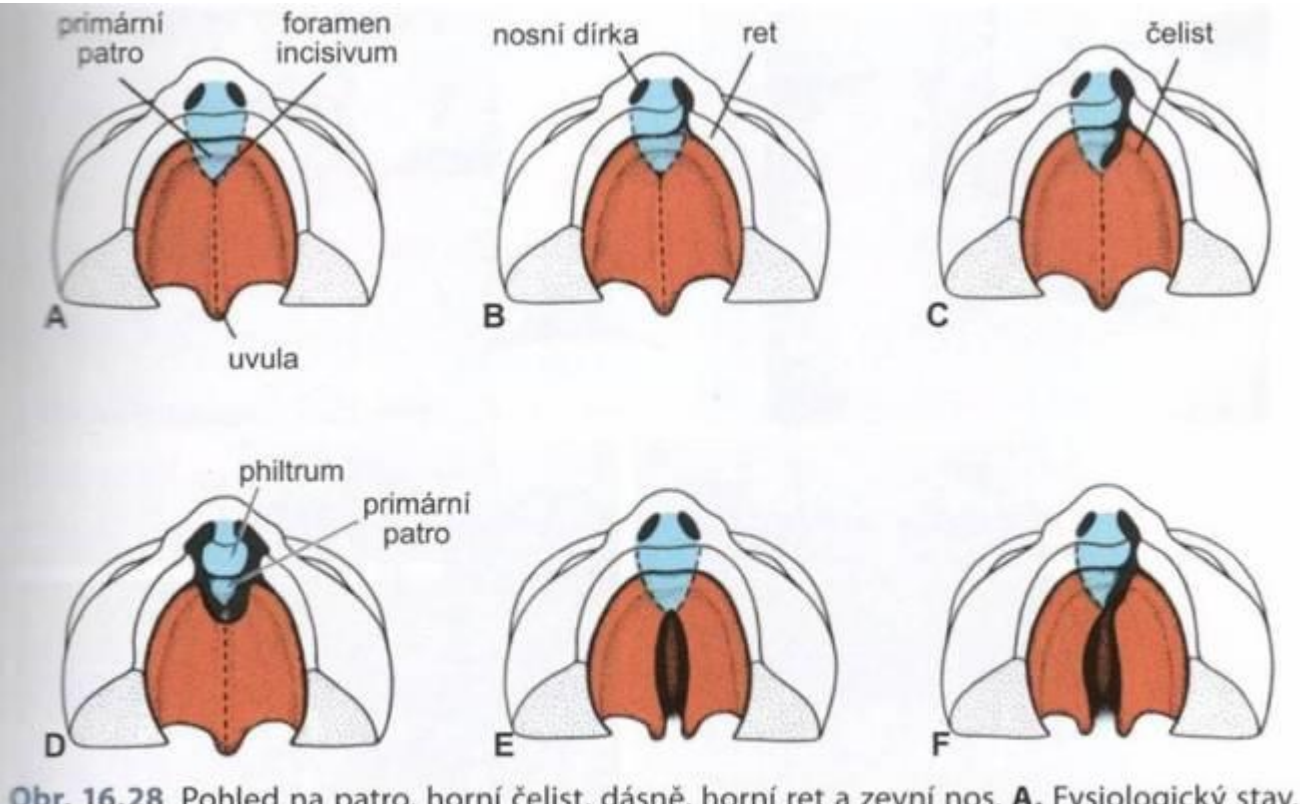
Cleft malformations of face and palate

- impaired fusion of structures (1:550)
- **anterior** palate clefts (*cheiloschisis*, *cheilognathoschisis*)
  - lateral lip, upper jaw cleft, cleft between the primary and secondary palates
  - partial or complete lack of fusion of maxillary prominence with medial nasal prominence on one or both sides
- **posterior** palate clefts (*palatoschisis*)
  - secondary palate cleft, uvula cleft (*staphyloschisis*)

Cleft malformations of face and palate

- **combination** of clefts lying anterior as well as posterior to incisive foramen (*cheilo-gnatho-palatoschisis*)
- **oblique** facial clefts
  - failure in merging of maxillary prominence with its corresponding lateral nasal prominence
- **median (midline)** lip cleft
  - rare abnormality
  - incomplete merging of two medial nasal prominences in the midline

Cleft malformations of face and palate



Obr. 16.28 Pohled na patro, horní čelist, dásně, horní ret a zevní nos. **A**. Fysiologický stav

View of palate, upper jaw, gingiva, upper lip and external nose. A. Physiological situation. B. One sided cleft of lip continuing into nostril. C. One sided cleft of lip and jaw continuing into foramen incisivum. D. Both sided cleft of lip and upper jaw. E. Isolated cleft of palate. F. Palate cleft with one sided cleft of jaw and lip.

http://blog.johnrchildress.com/2011/06/07/real-leadership-and-hope/

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http://www.craniofacial.net/cleft-lip-cleft-palate-only

Cleft malformations of face and palate

Before operation

Before operation

After operation

After operation

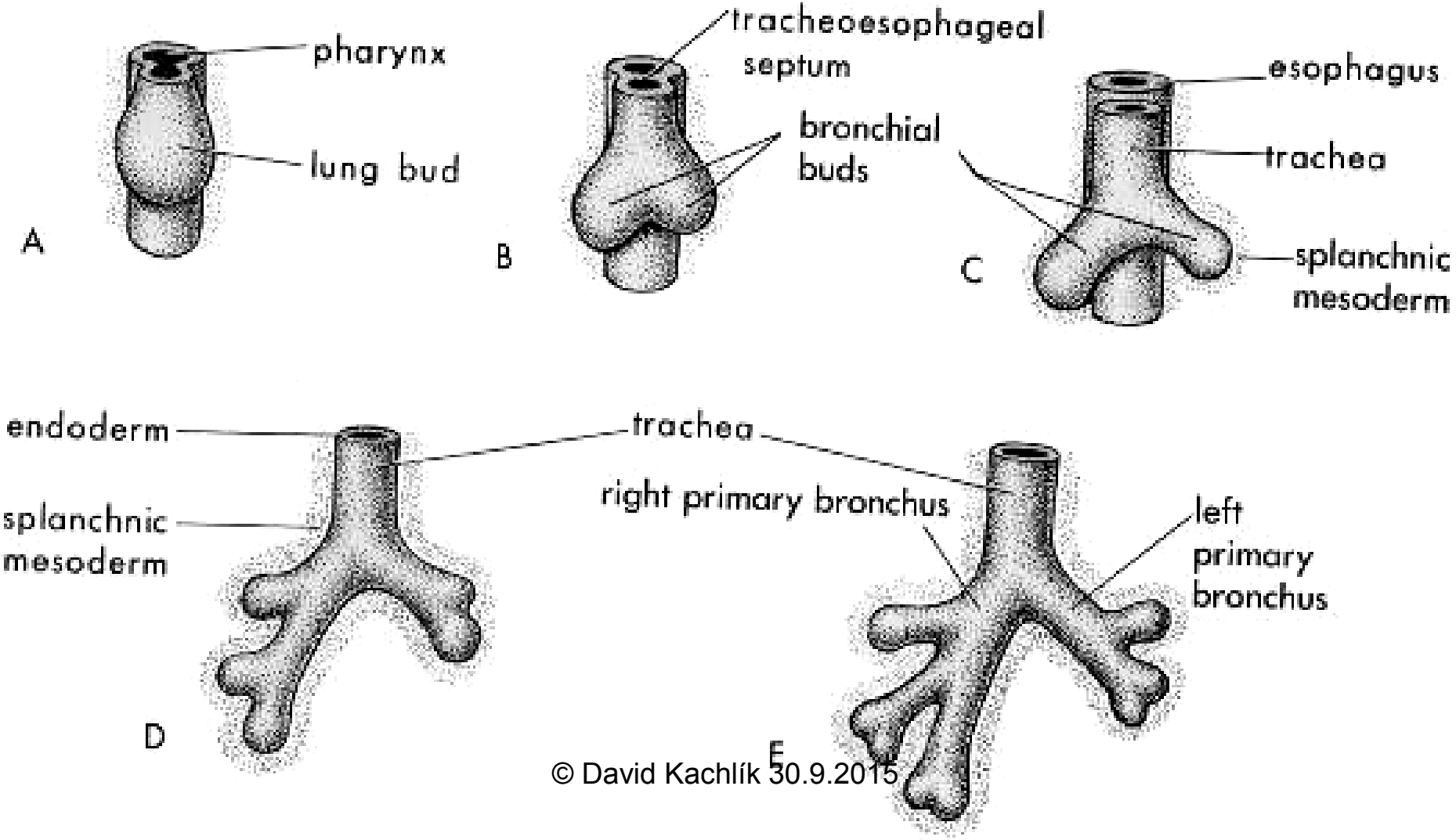
http://www.rodina.cz/clanek3188.htm

Paranasal sinuses

- sinus maxillares
  - small (4 mm)in the time of delivery
- cellulae ethmoidales

- the rest postnatally
- from the invaginations of the wall of nasal cavity – pneumatized spaces in bones
  - only sinus sphenoidalis directly from nasal mucosa

Development of respiratory system



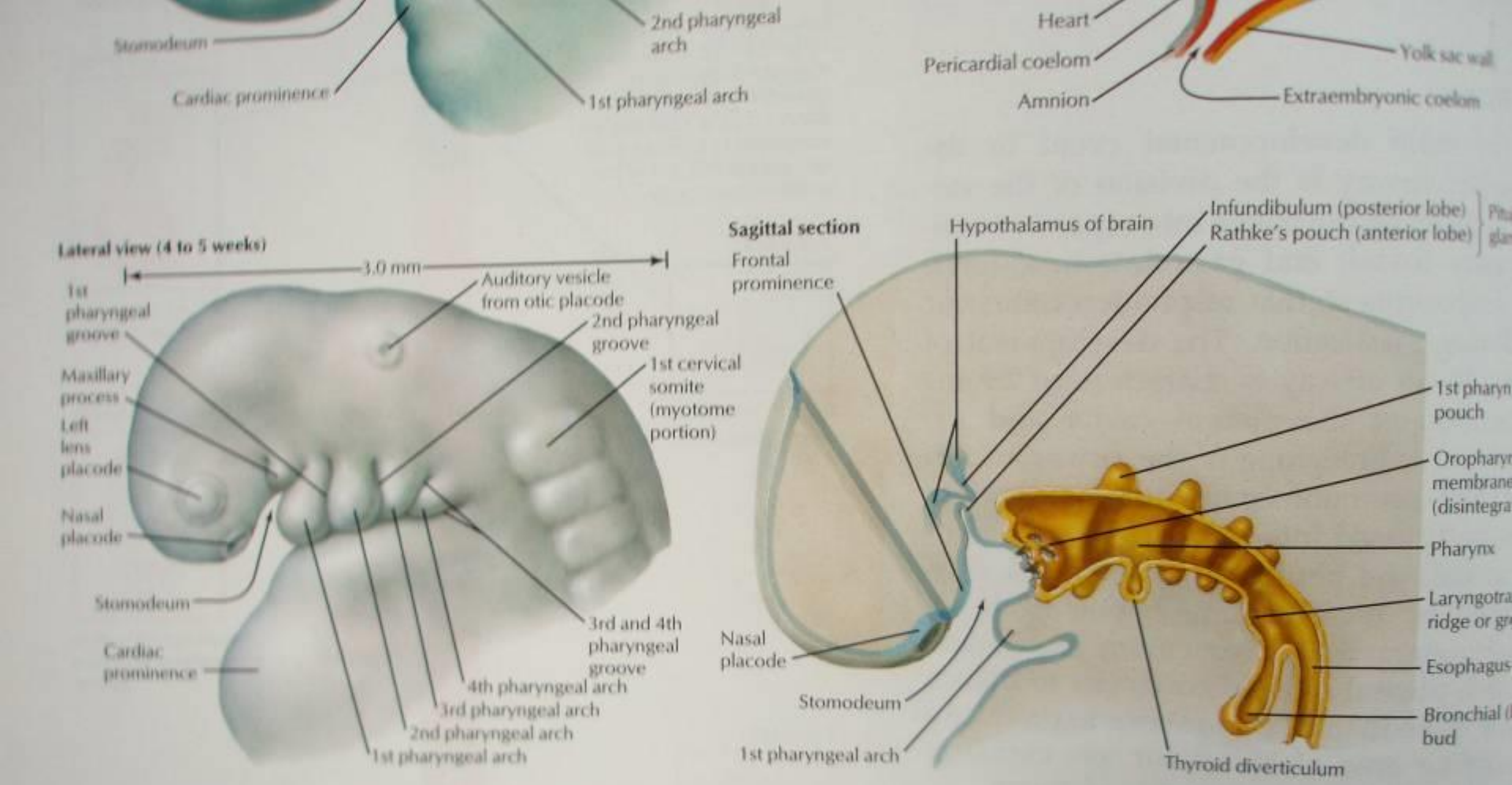
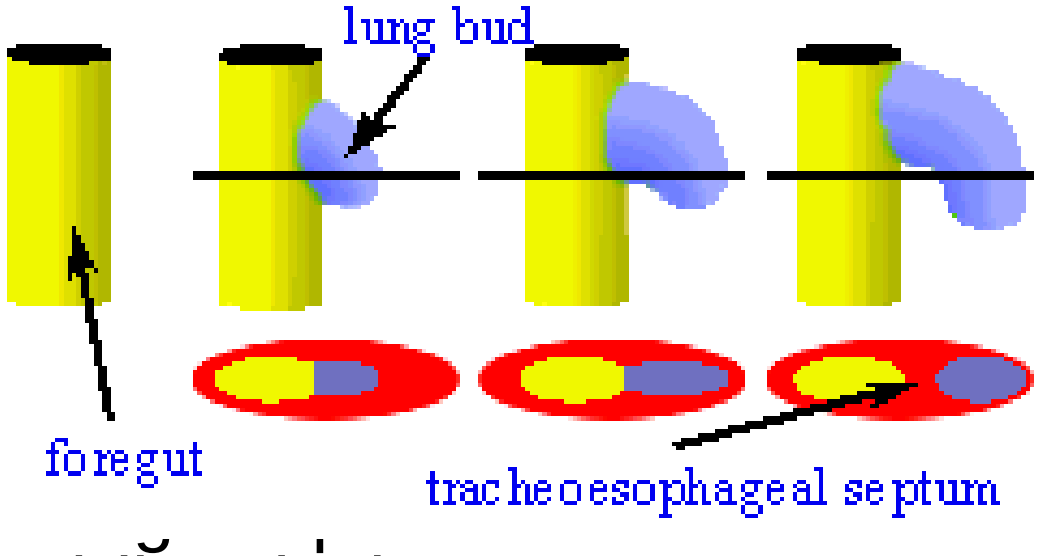


FIGURE 5.1 EARLY PRIMORDIA

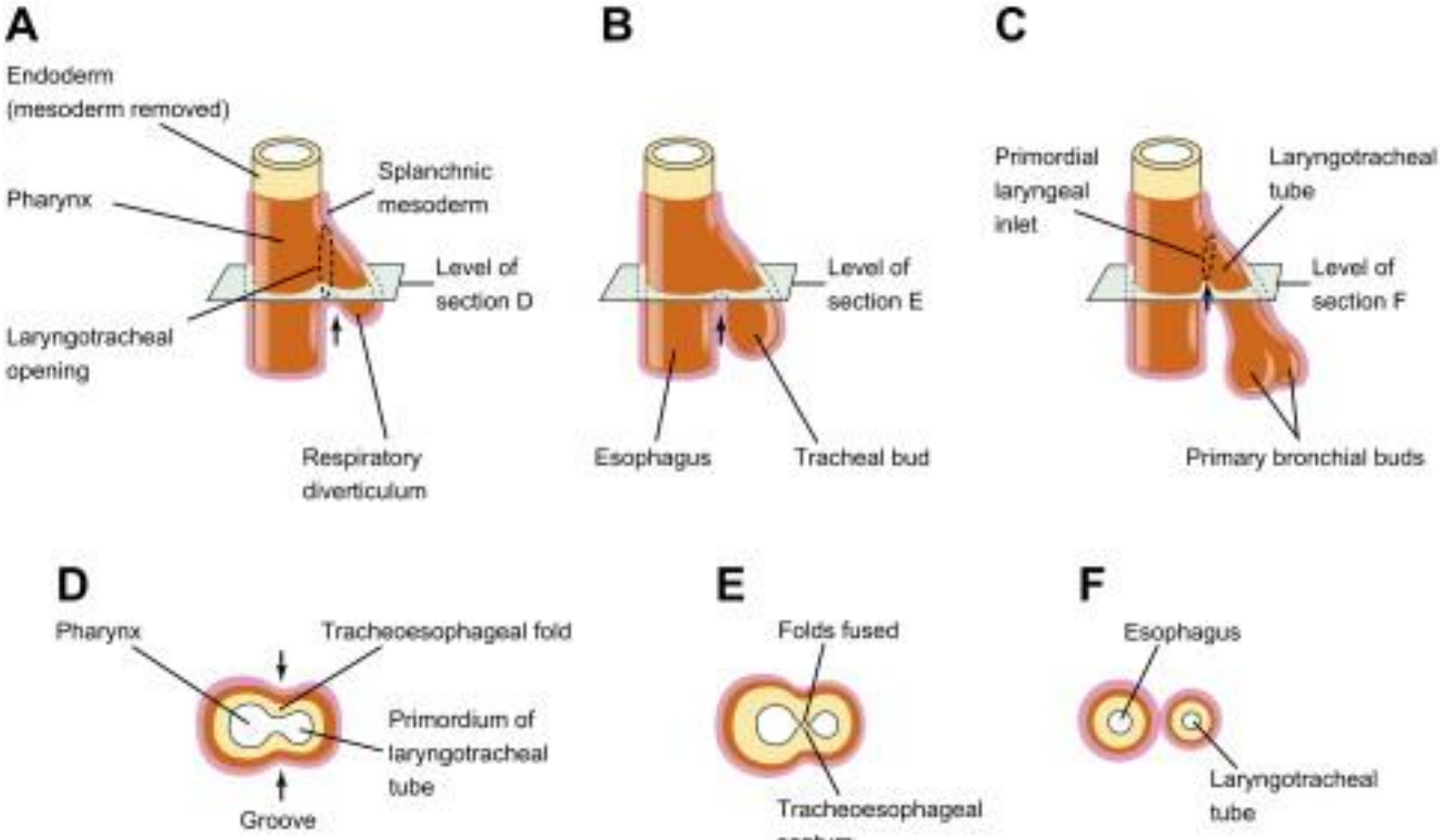
The early primordia of the upper and lower airways:

Development of



- **endoderm** of ventral → respiratory bud (*g*
- unpaired **sulcus lary**
- foregut elongates in t larygotracheal diverticle (*diverticulum laryngotracheale*)
- caudal end of diverticle is enlarged into the paired buds of lungs
- diverticle gets separated from oesophagus by growth of lateral edges on the sides, pushing the wall inside in the shape of longitudinal crests (*cristae tracheooesophageae*)
- medial margins of crests fuse and forms the **septum tracheooesophageum**

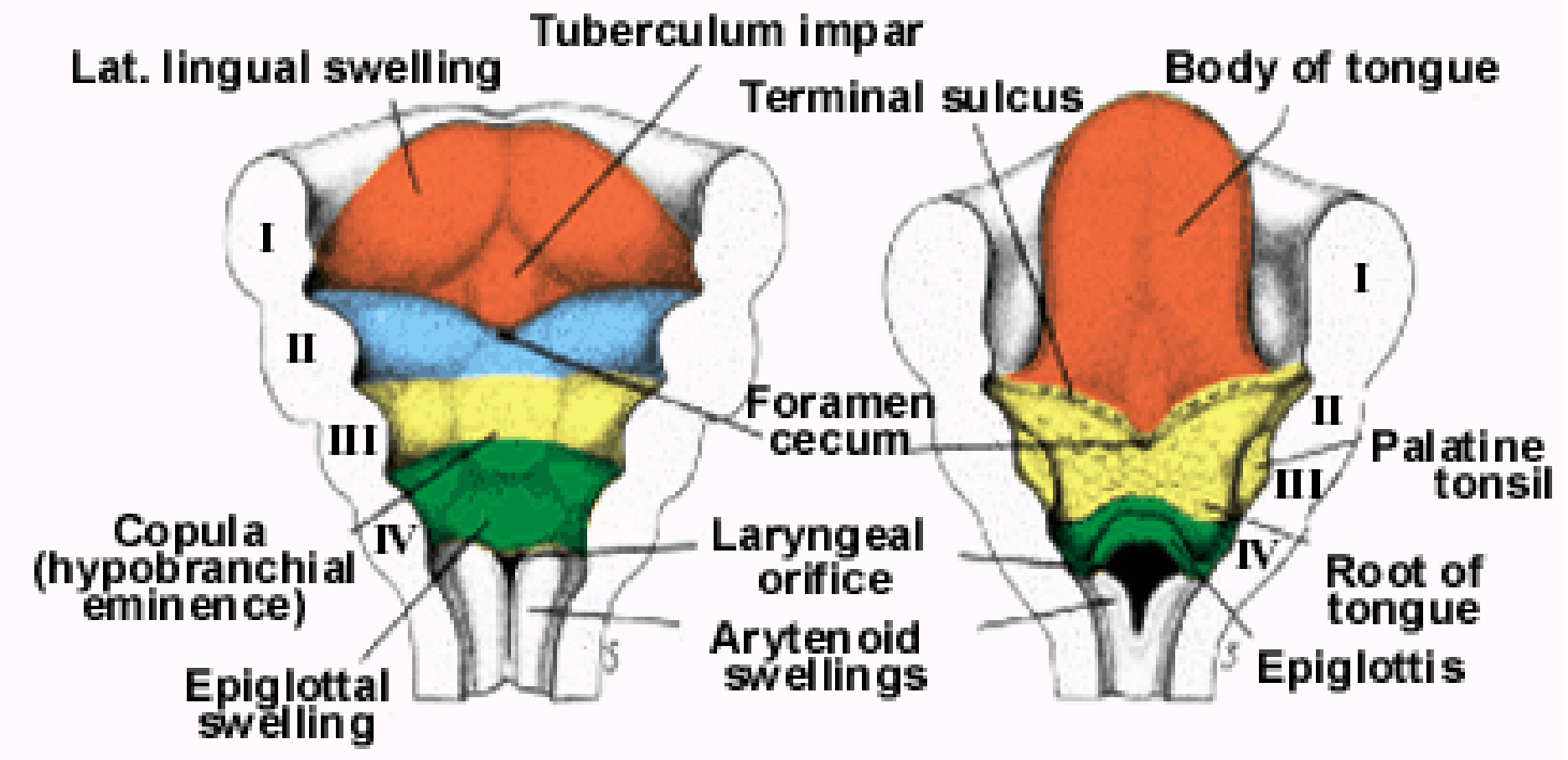
Development of lower respiratory tract



Development of lower respiratory tract

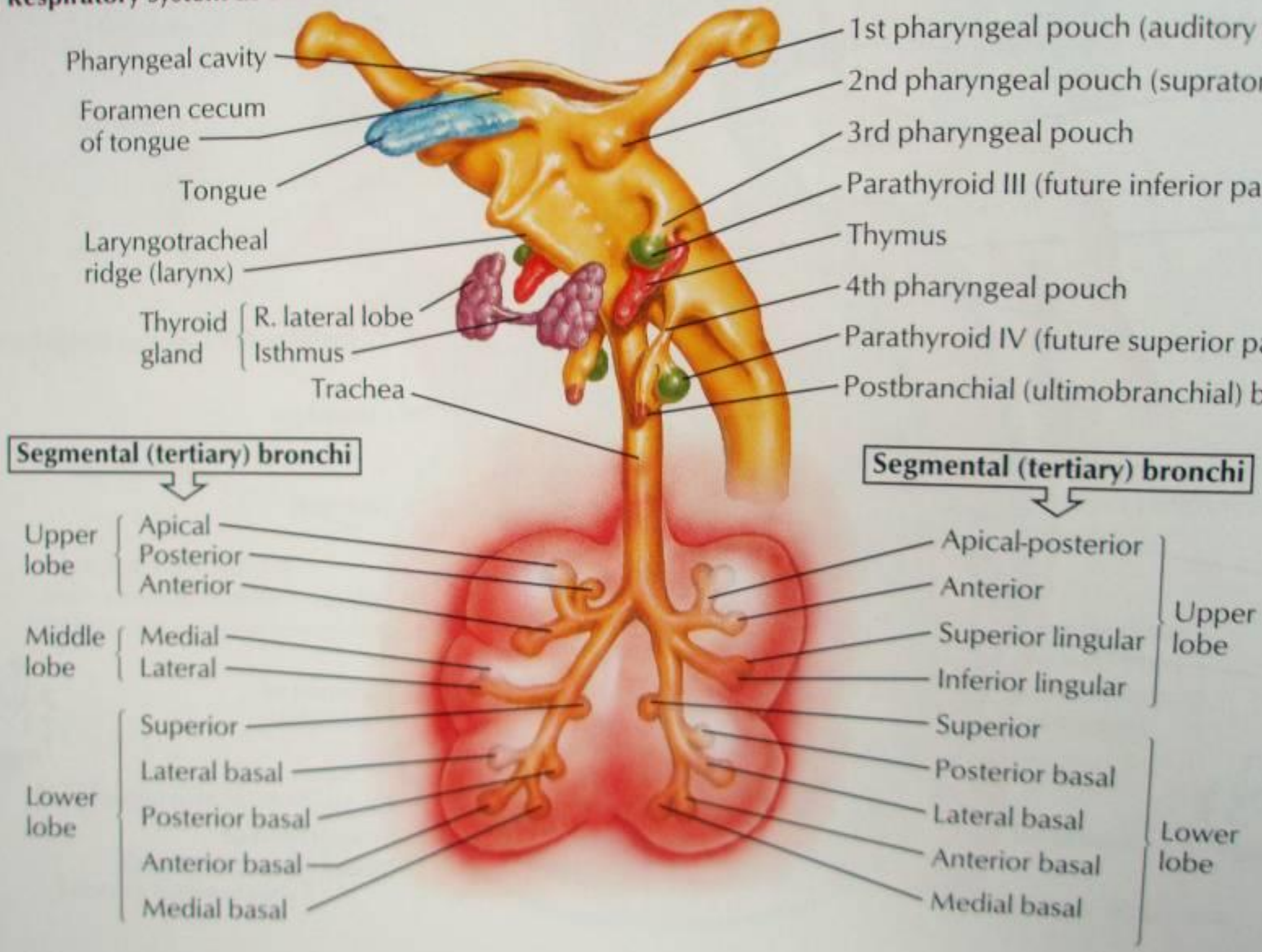
- septum separates the originally one tube into the ventral tube → **future larynx and trachea –** and the dorsal tube → **future oesophageus**
- at the cranial end both tubes communicate with the pharyngeal cavity
- arytenoid tubercles (*tubera arytenoidea*)
- epiglottis originates from lower part of eminetia hypopharyngea
- tubus laryngotrachealis → at the end of 1st month thie internal surfaces of larynx **fuse** by proliferation of endoderm
- later on larynx **recanalizes** by apoptosis of cells in the central part of tube on both ends (10th week)
- cartilages and muscles from 4th and 6th arch (n. X)
- descensus laryngis
  - nn the 5th month: is epiglottis located at the level of nasopharynx
  - In the newborn: is epiglottis located at the level C2-C3
  - In adult: is epiglottis located at the level C5

Development of larynx

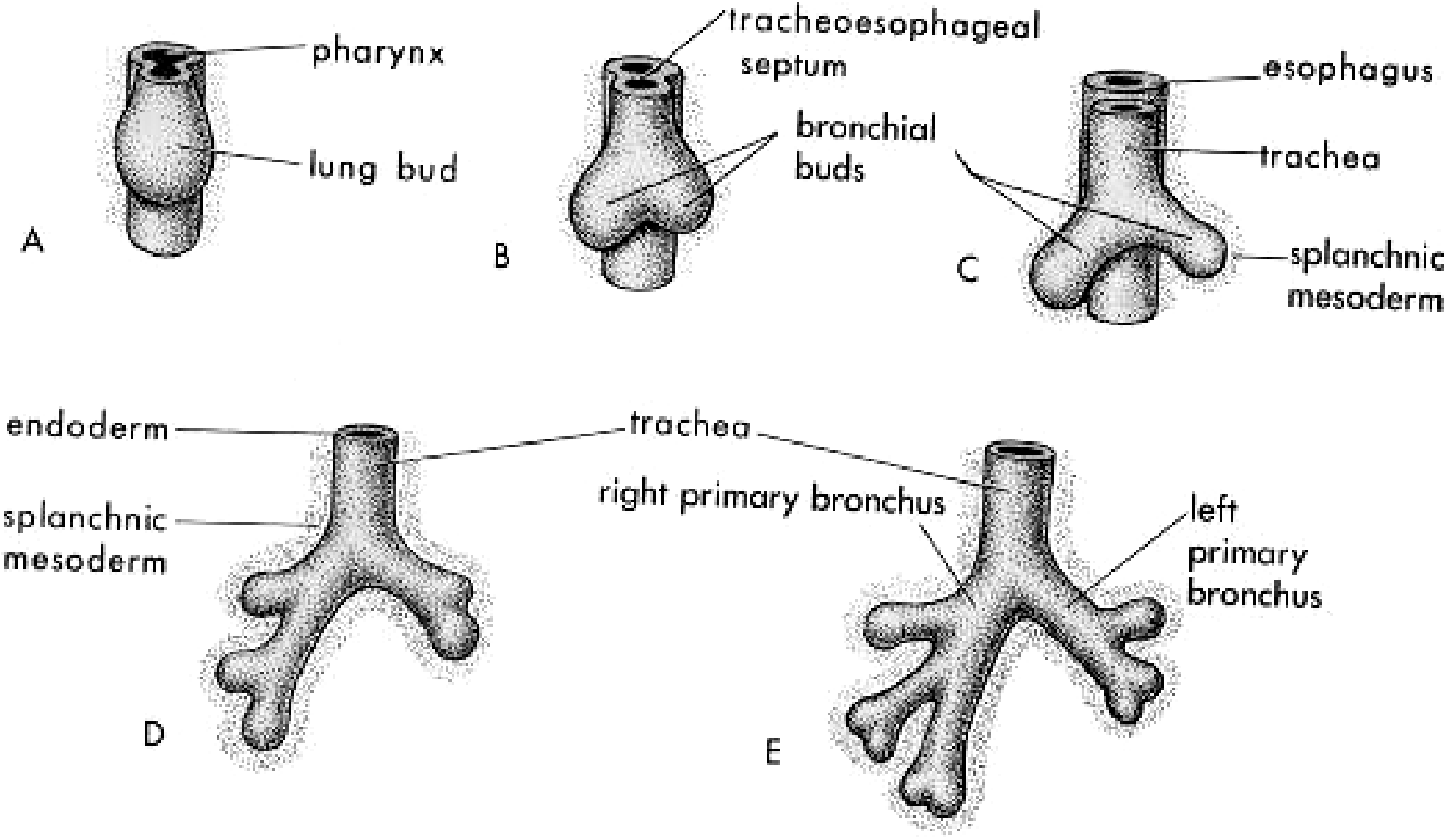


The airway is lined by epithelium
derived from endoderm of the f

Respiratory system at 6 to 7 weeks



GURE 5.7 THE AIRWAY AT 4 TO 7 WEEKS



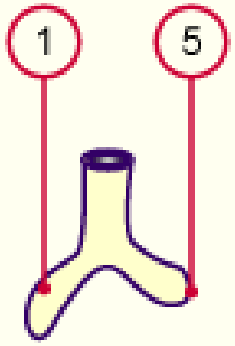
Development of bronchi

- laryngotracheal tube terminates caudally by blind evangination of endoderm = **bronchopulmonal bud** (*gemma bronchialis primaria*) → future bronchi and lungs
- at first buds are oriented transversally and ingrowth into mesenchyme of ventral mesenterium
- later on they push the visceral mesoderm into the **pleuroperitoneal canals**, that at first communicate with the peritoneal and pericardial cavity
- after closure of this communication, canals become paired base for the **pleural cavity**
- by budding **secondary evanginations (*gemmae bronchiales secundariae*)** are founded → on the right side two (terminate with three blind sacs) and on the left one (terminate with two blind sacs)

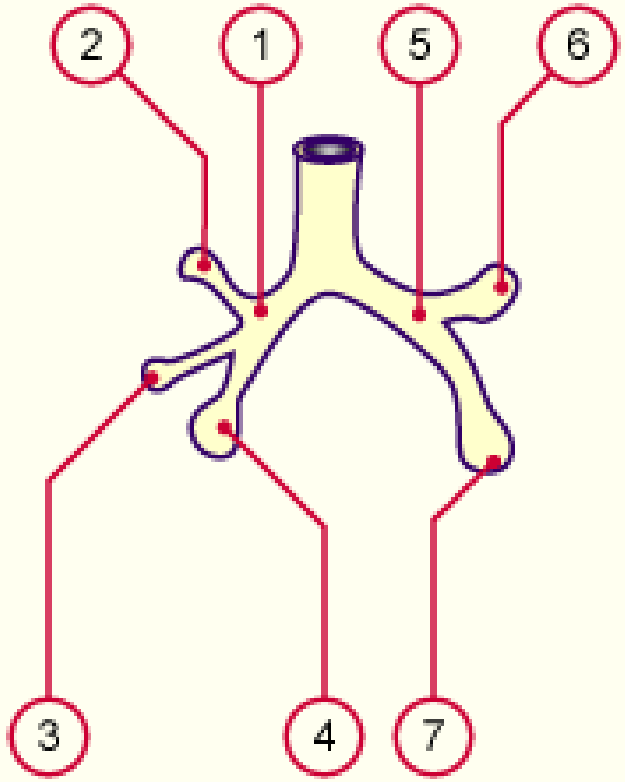
Development of tracheobronchial tree

- primary (principal) bronchi
  - 5th week, right bigger then left one
- secondary (lobar) bronchi
- tertiary (segmental) bronchi
- respiratory bronchioli (17th order)
  - developed at the end of 24th week
- next 7 orders after birth

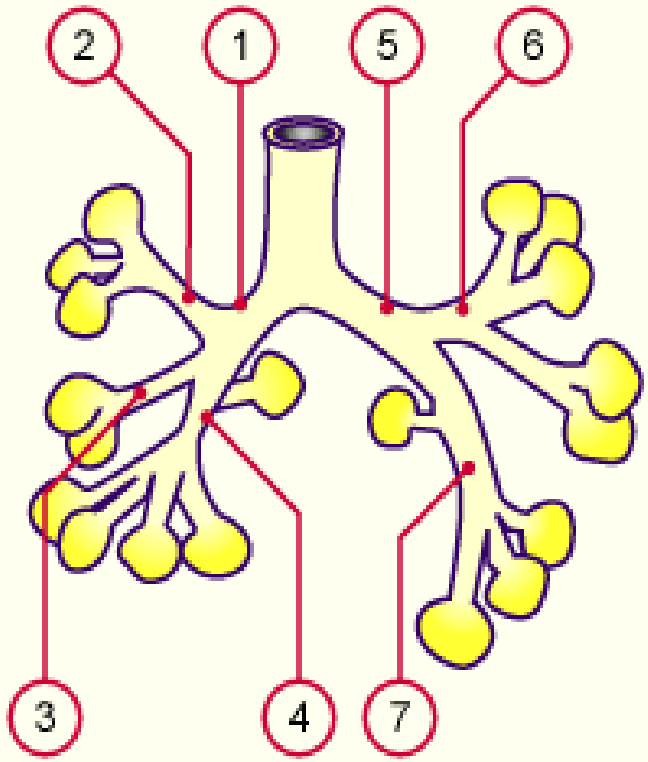
14 - 33



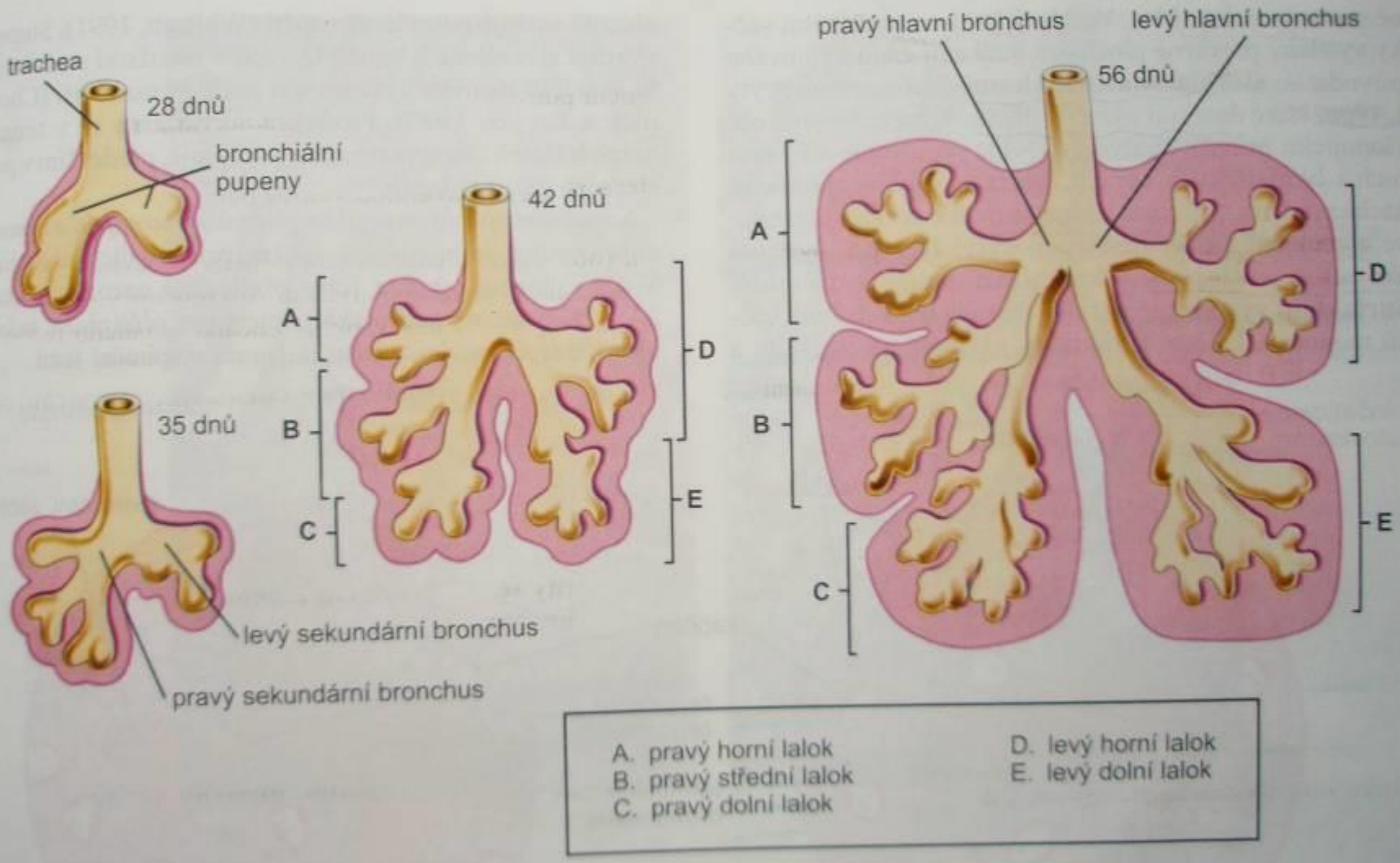
16 - 39



23 - 56



1 Right principal bronchus
2 Upper right pulmonary lobe
3 Middle right pulmonary lobe
4 Lower right pulmonary lobe
5 Left principal bronchus
6 Left upper pulmonary lobe
7 Lower left pulmonary lobe



Obr. 11-7. Postupná stadia vývoje bronchů a plic.

vnitřním povrchu pohrudničních dutin se vytvoří *parietální pleura*, jako derivát somatického mezodermu (obr.

KANALIKULÁRNÍ FÁZE

Lungs development

4 stages:

- pseudoglandular – 5th→17th week
- canalicular – 16th→25th week
- terminal pouches – 24th week→birth
- alveolar – late embryonic period →age of 8 years

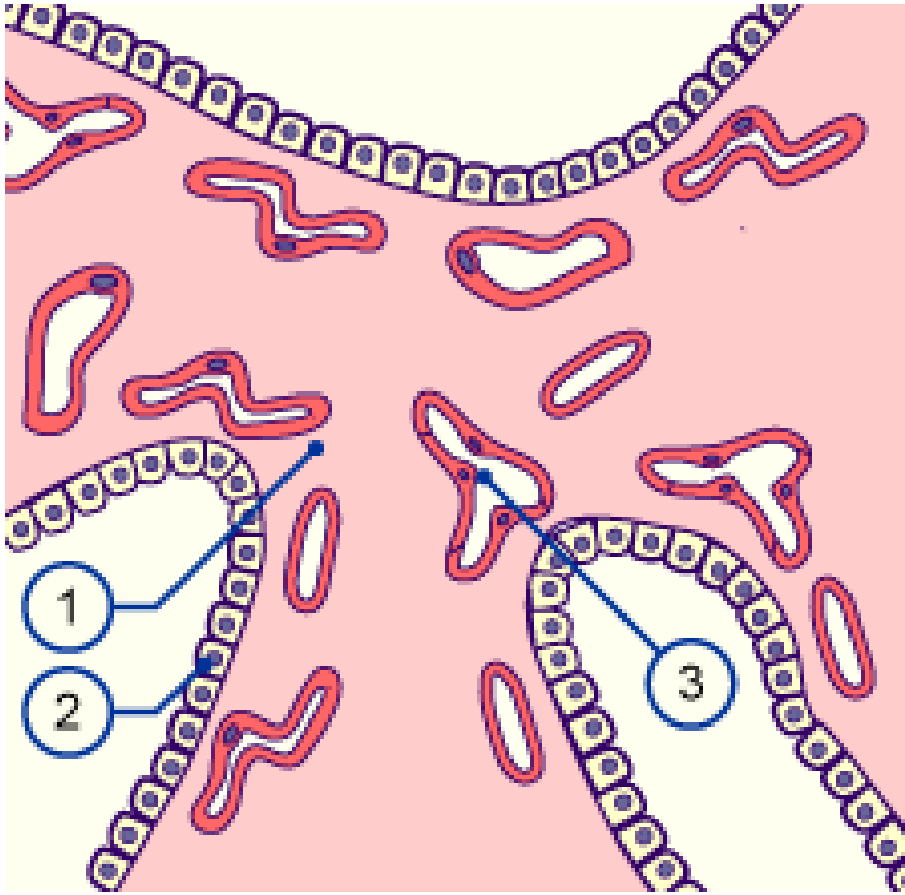
Lung development I.

- ingrowth into the splanchnic mesoderm and protrusion into the pleuroperitoneal canal

Pseudoglandular stage

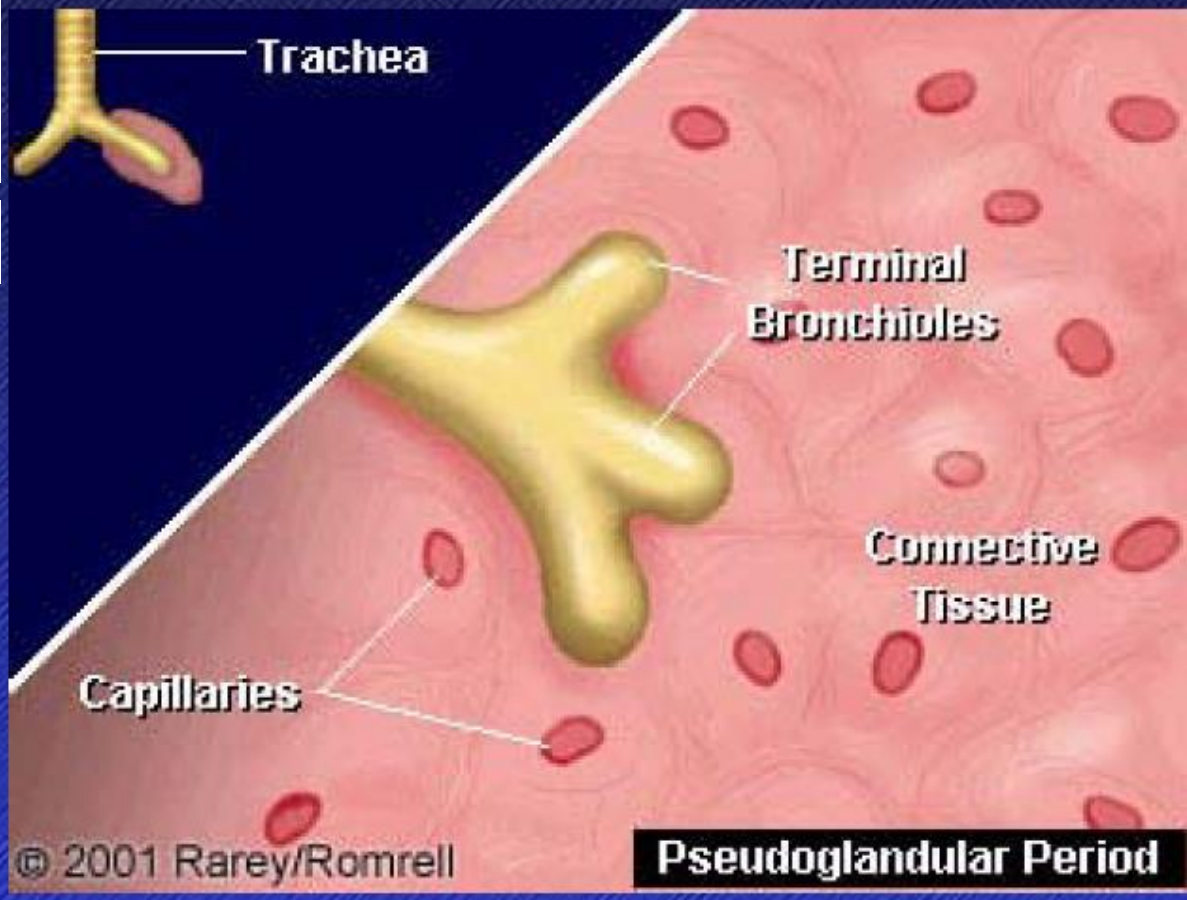
- 5th-17th week
- blindly ending epithelial tubules
- resembles exocrine gland
- all main parts present (bronchi and bronchioli)

- **respiration is not possible**



Lungs development

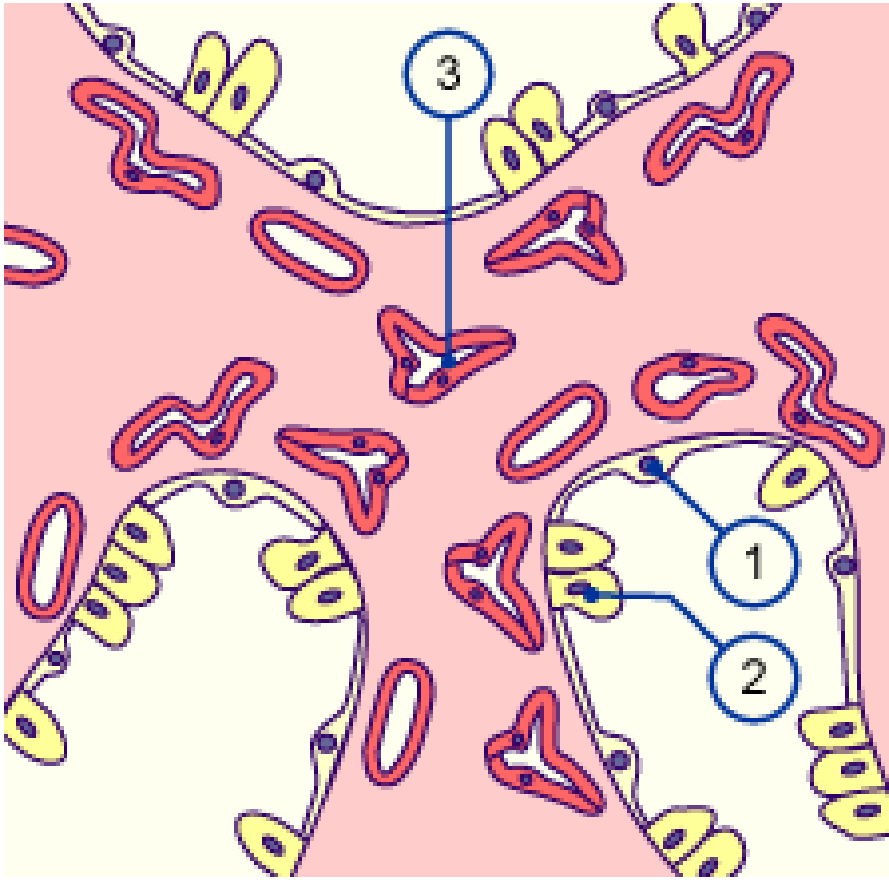
- Pseudoglandular stage
- **5th – 17th week**
- blindly ending epithelial cells



Lungs development II.

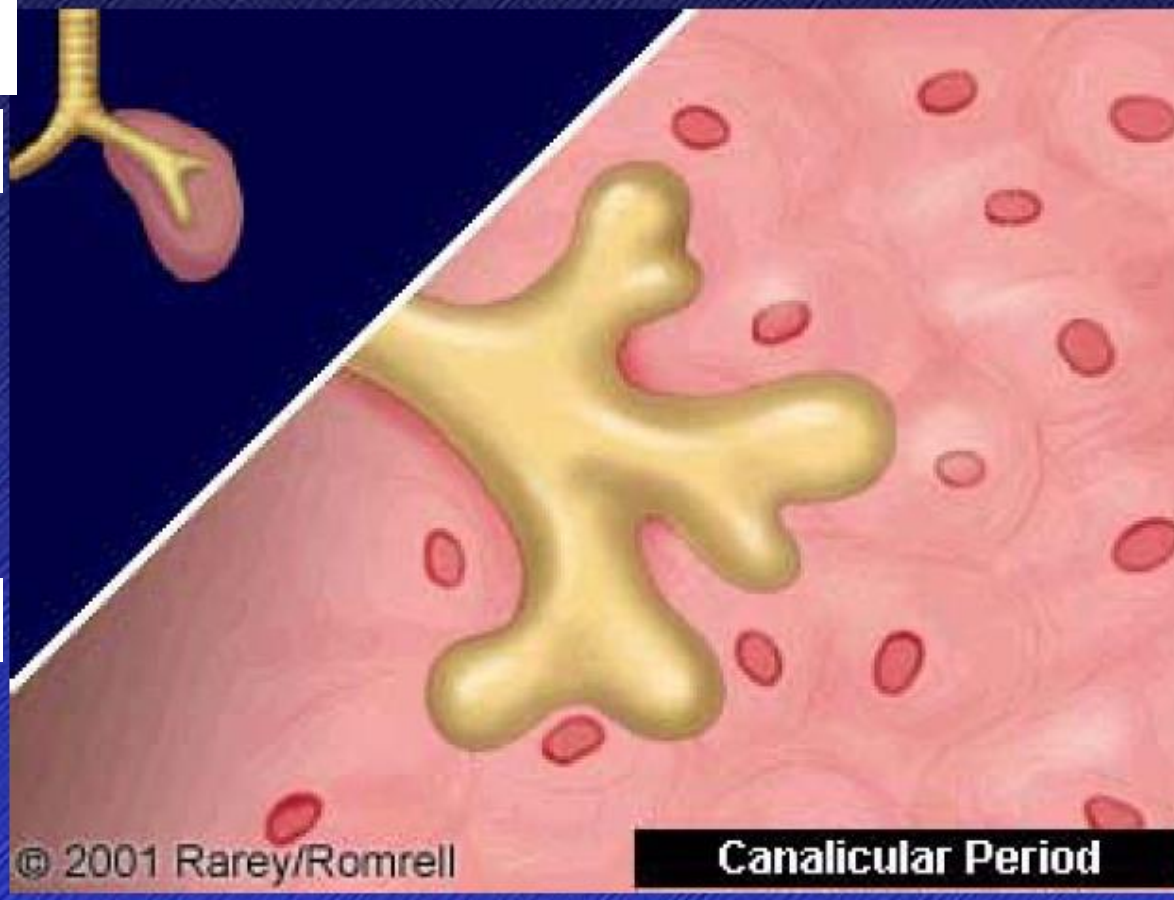
Canalicular stage

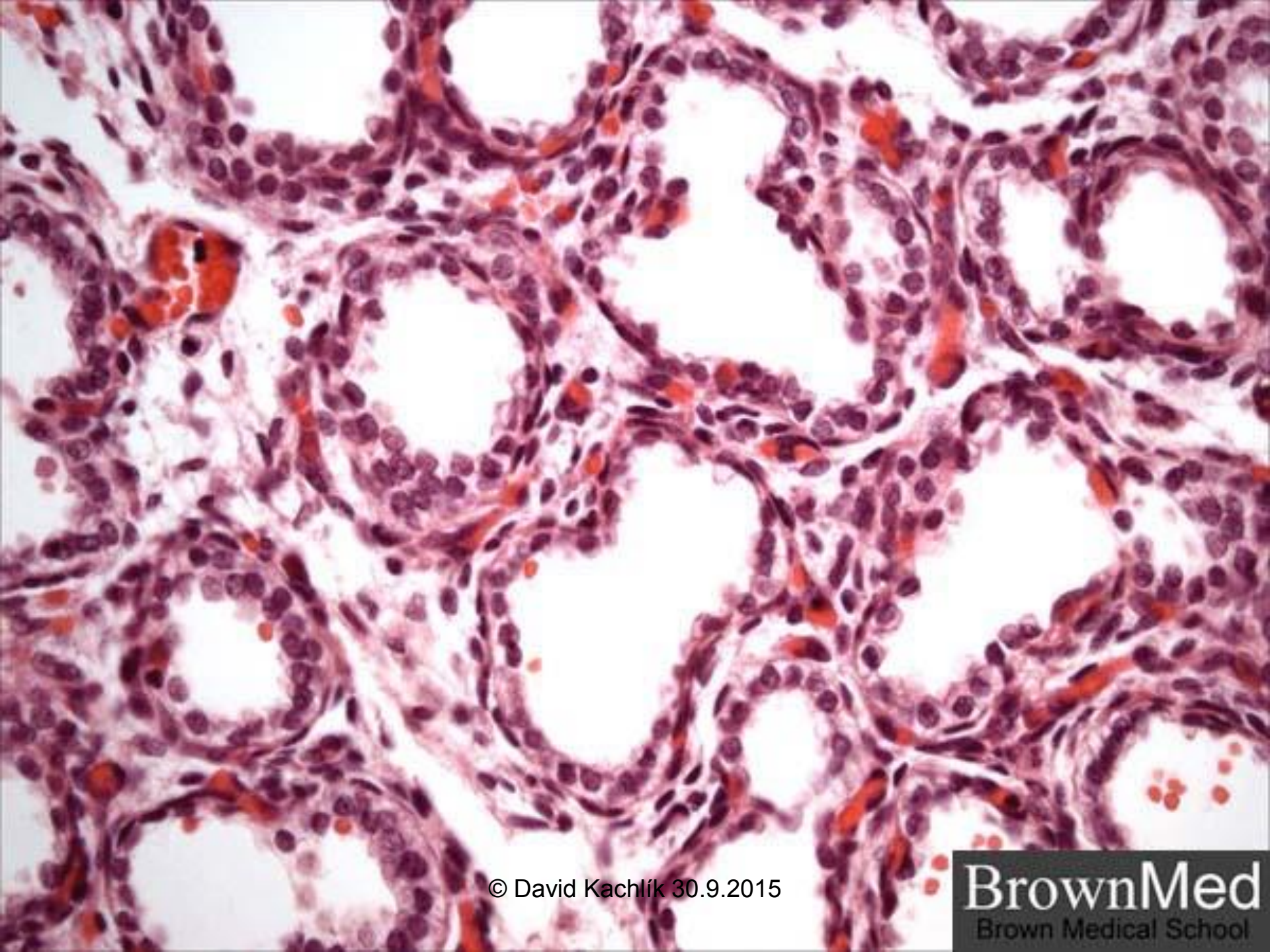
- 16th-25th week
- bronchi dilation, wall differentiation
- terminate with **respiratory bronchioli** having first thin walled pouches = **primitive alveoli**
- lungs are vascularized
- cranial segments maturate earlier
- survival only with apparatus (artificial ventilation, AU)
- usually death (up to 17th week no survival)
- **respiratory distress syndrome (RDS)**



Lungs development

- Canalicular stage
- **16th – 25th week**
- Bronchi dilation, wall differentiation
- terminates with respiratory bronchioli having primitive alveoli
- **surfactant production**

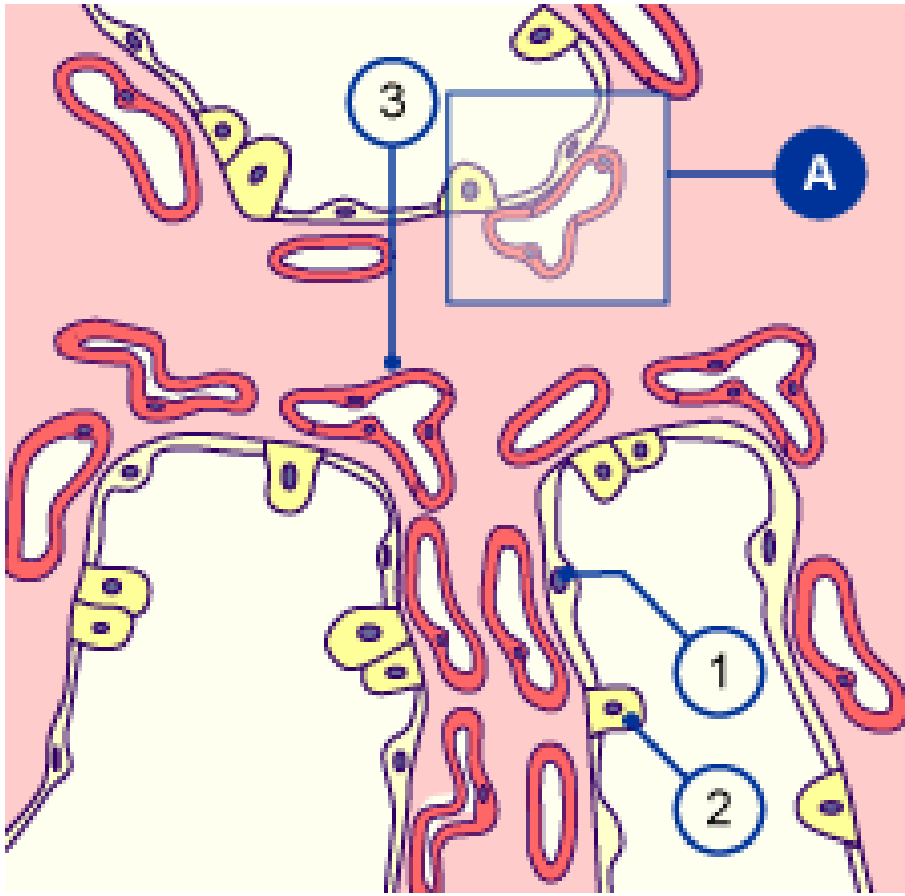


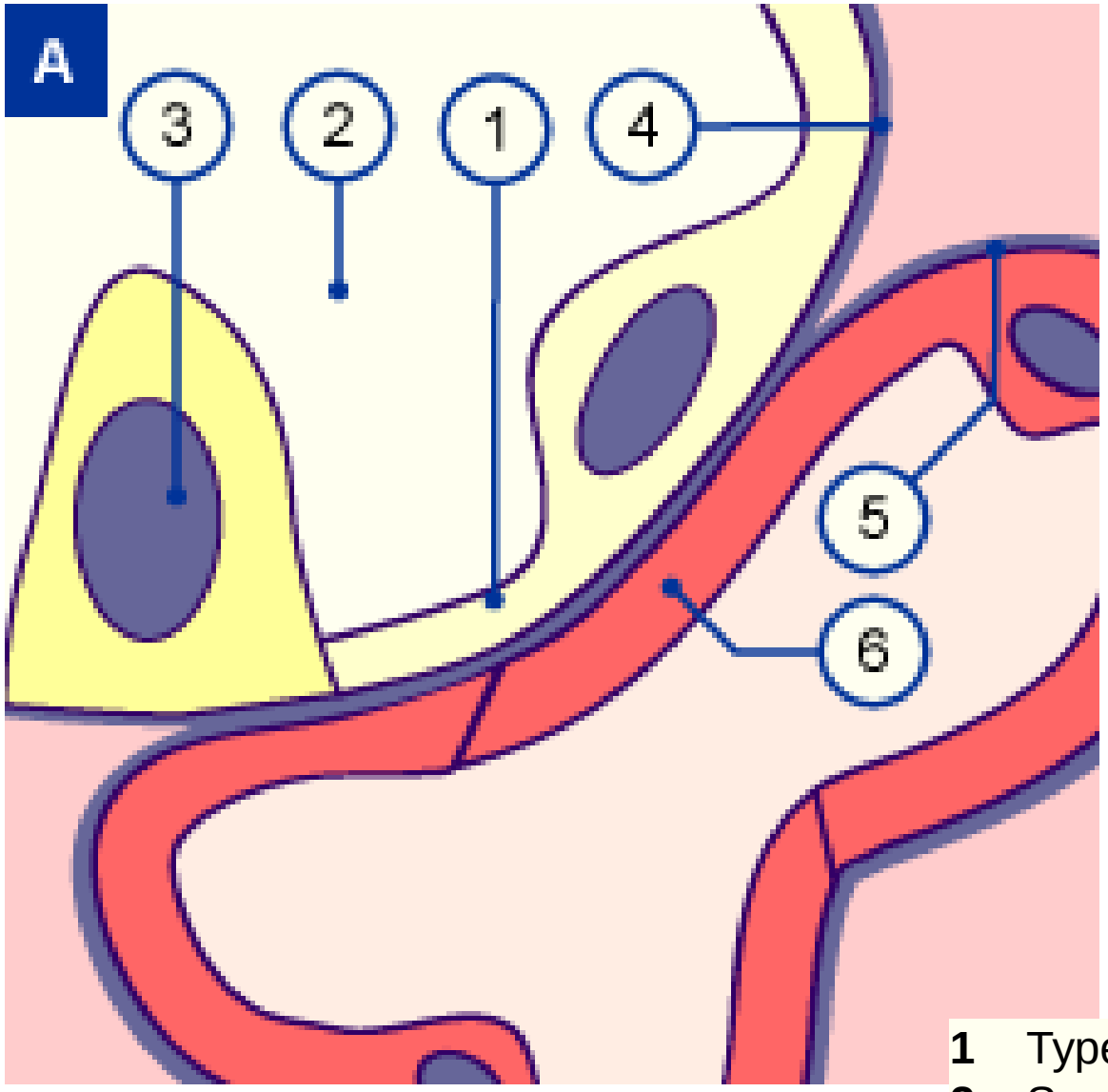


Lung development III.

Saccular stage (Terminal sacs stage)

- 24th week till birth
- growth of primitive alveoli
- cuboidal → flat epithelium
- cells differentiation (*pneumocyti typus I et II)*
- since **28th week** possibility of spontaneous **survival due to surfactant production**
- (sometimes 24th-26th – in *Japan*)
- fetus 1000 g, thin walled sacs (or alveoli) + surfactant (since 20th week) + density of capillary bed enabling survival without intervention





1 Type I pneumocyte
2 Saccular space
3 Type II pneumocyte
4 Basal membrane of the air passage
5 Basal membrane of the capillaries
6 Endothelium of the capillaries

Lungs development

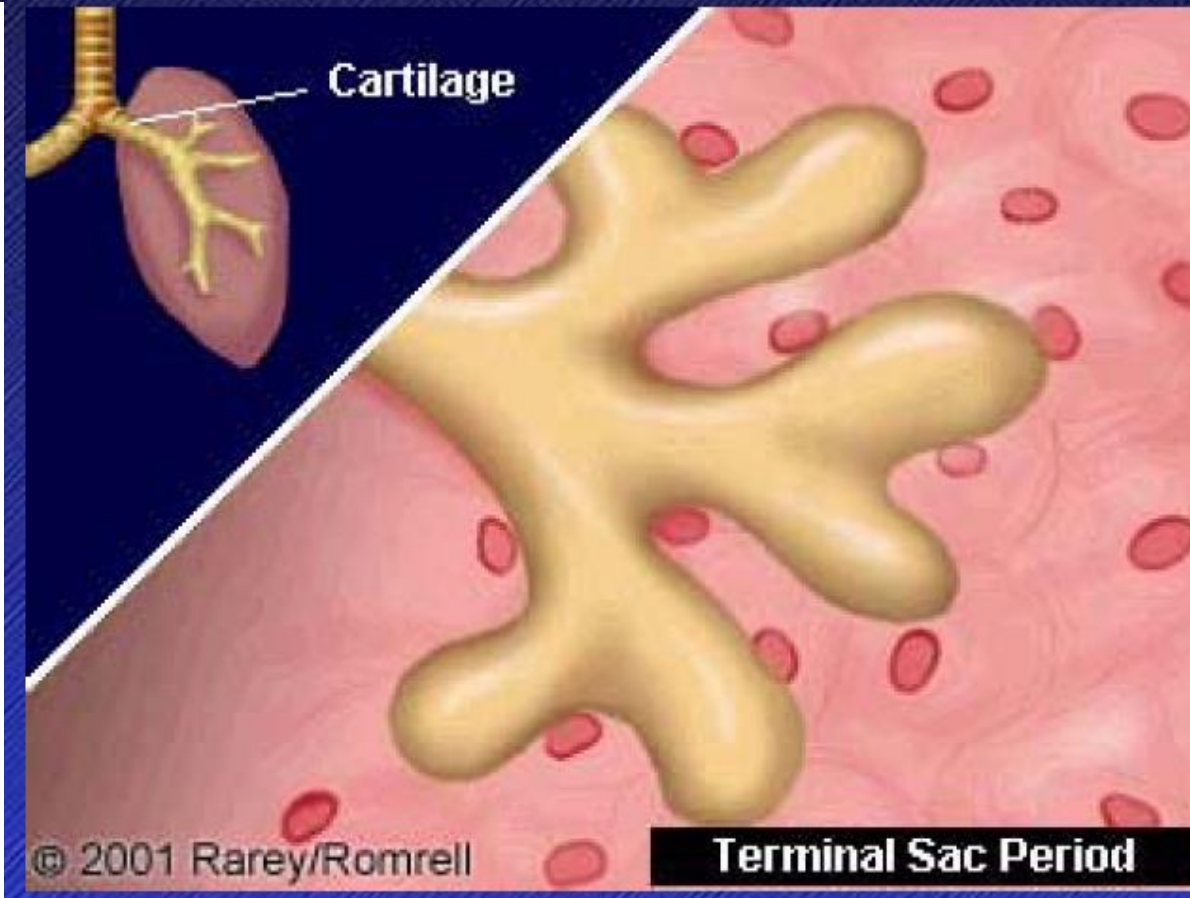
Saccular stage (Terminta sacs stage)

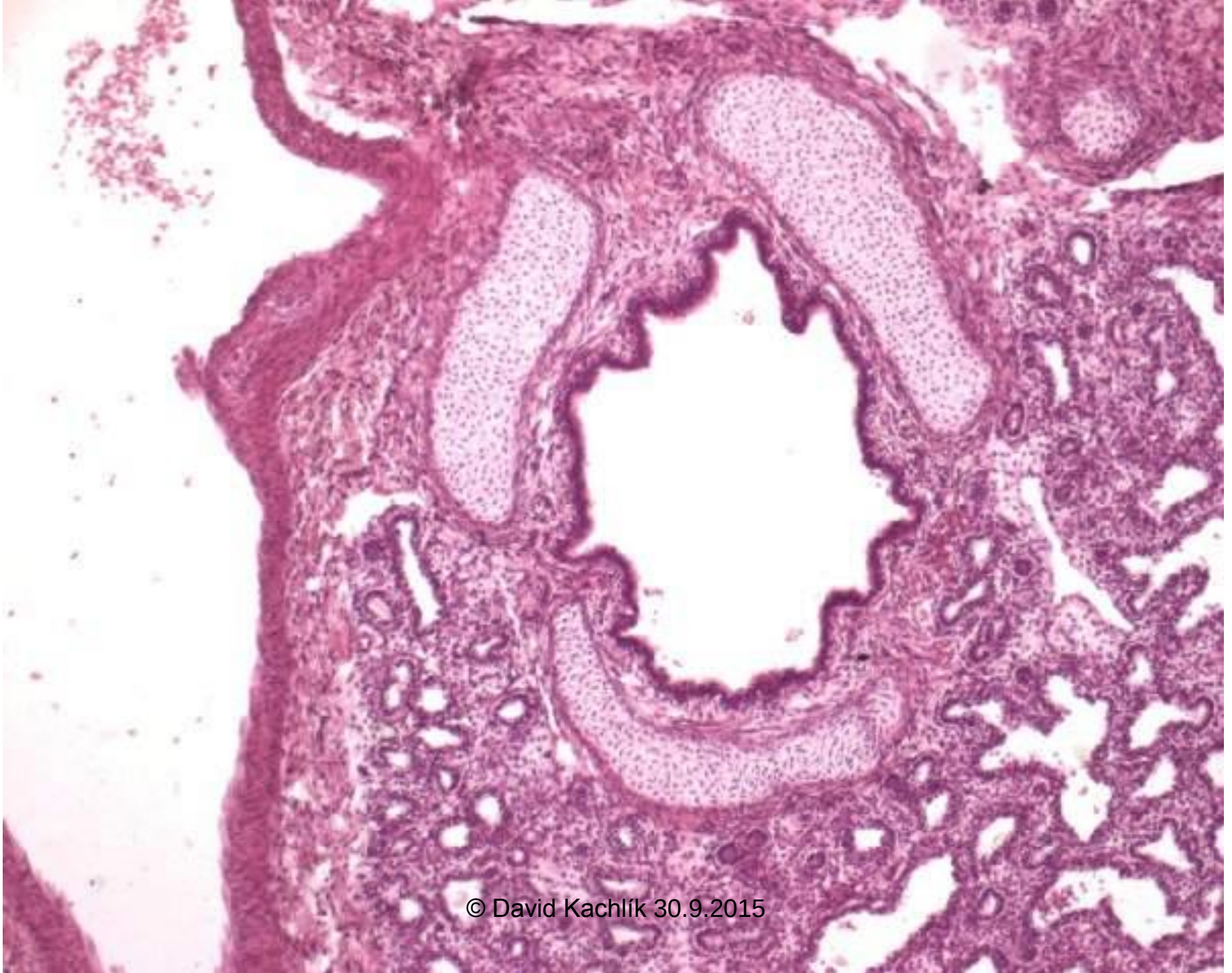
24th week till birth

growth of primitive alveoli

Covered by cuboidal (→flat) epithelium)

- since **28th week** possibility of spontaneous **survival due to surfactant production**





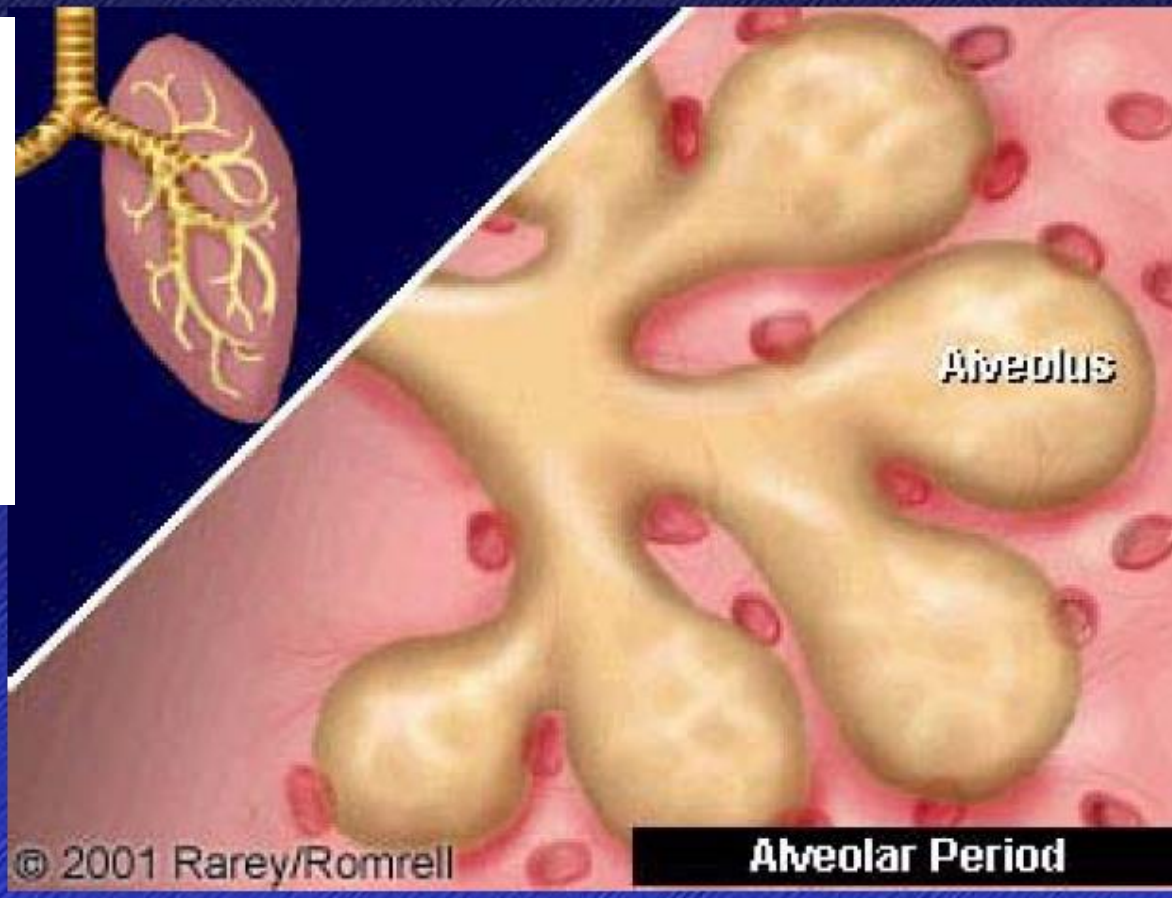
Lungs development IV.

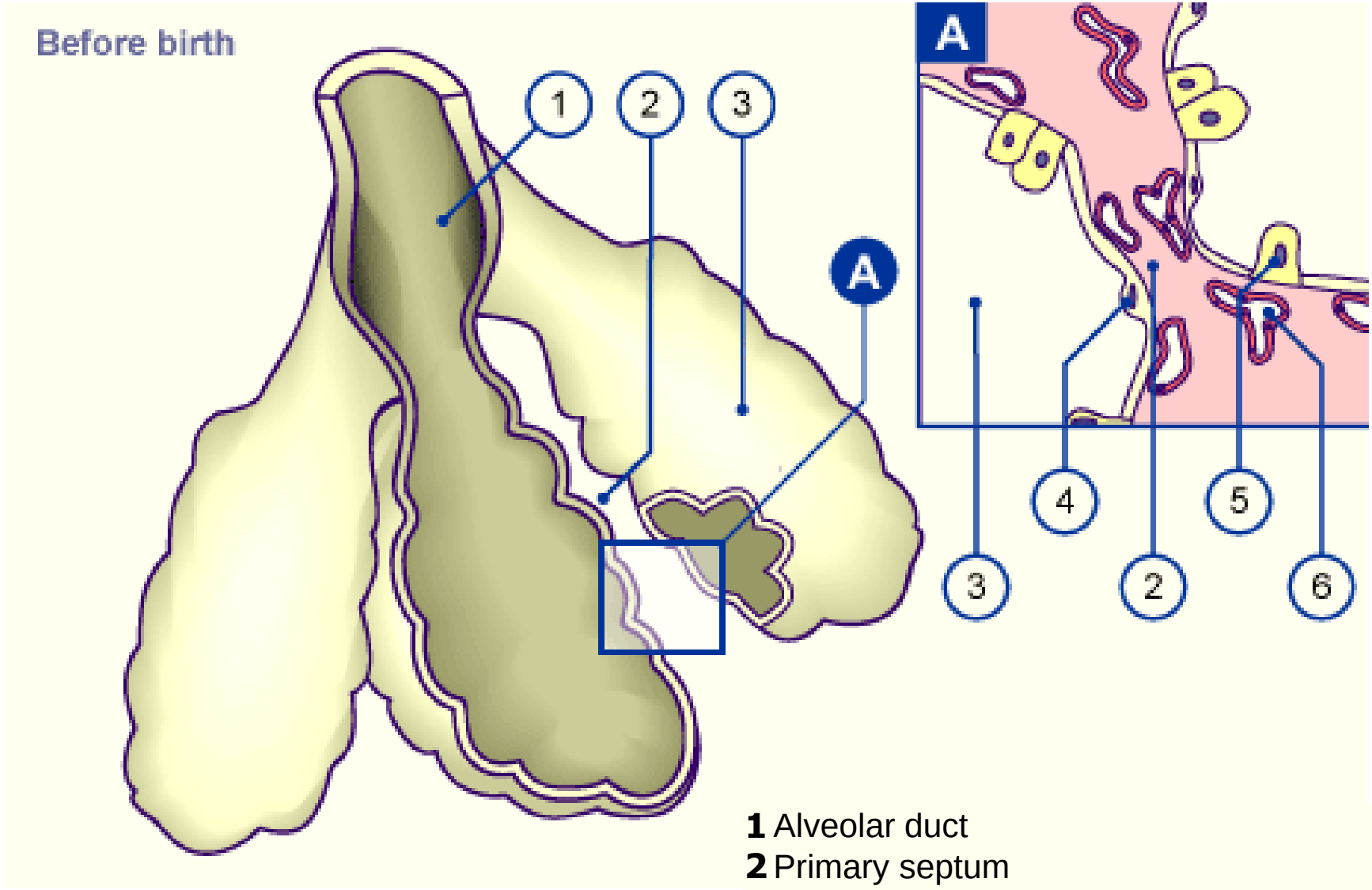
Alveolar stage

- since late fetal period till childhood (until **8th year**)
- massive flattening of epithelium
- formation of alveolocapillary membrane
- production of surfactant
- 95% of alveoli formed after birth
- transformation of lungs into true respiratory system
- changes in blood circulation (replacement of smooth muscle cells by elastic fibers, pressure decrease)

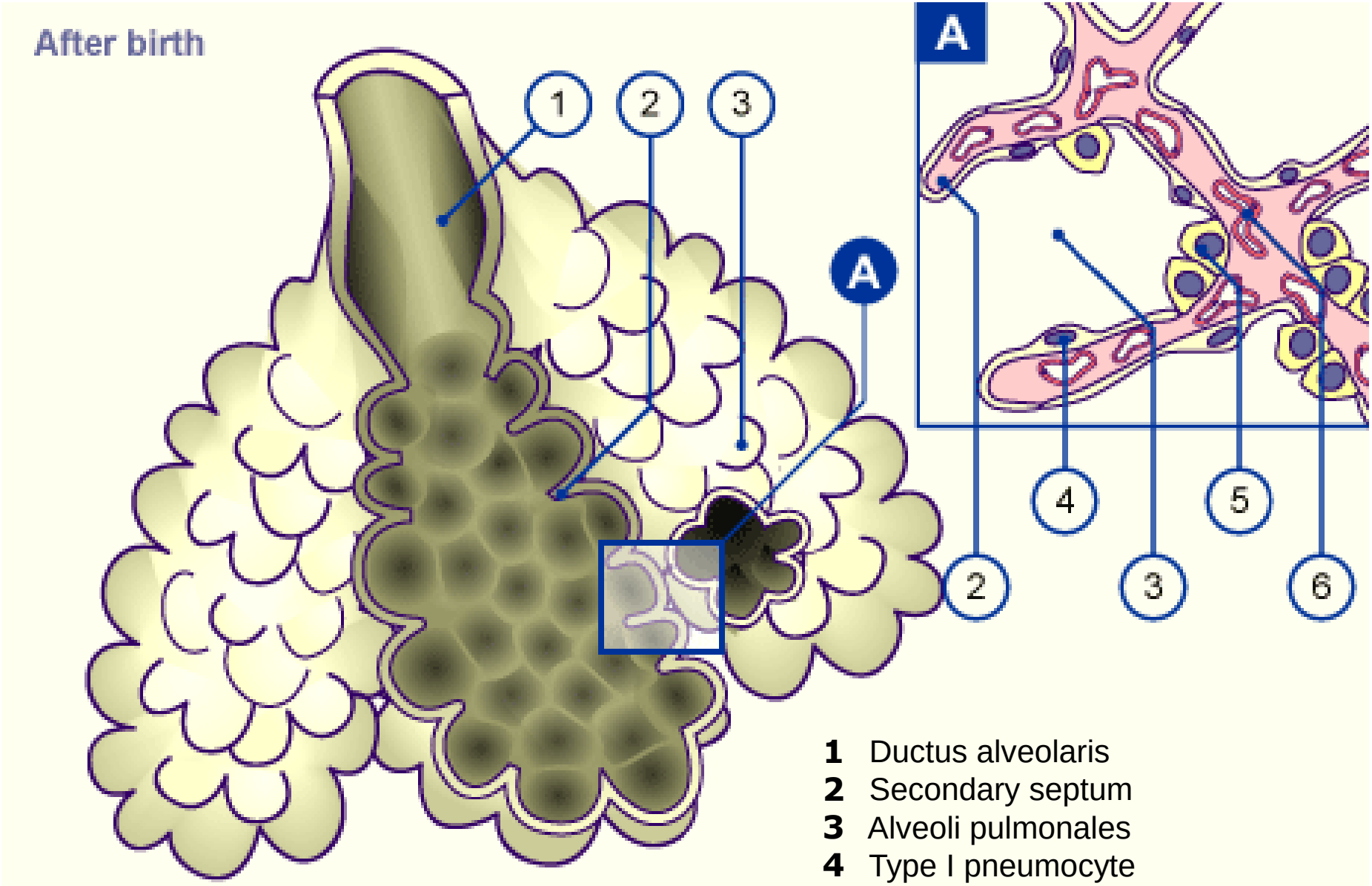
Lungs development

- Alveolar stage
- Since birth till childhood
- Massive flattening of epithelium

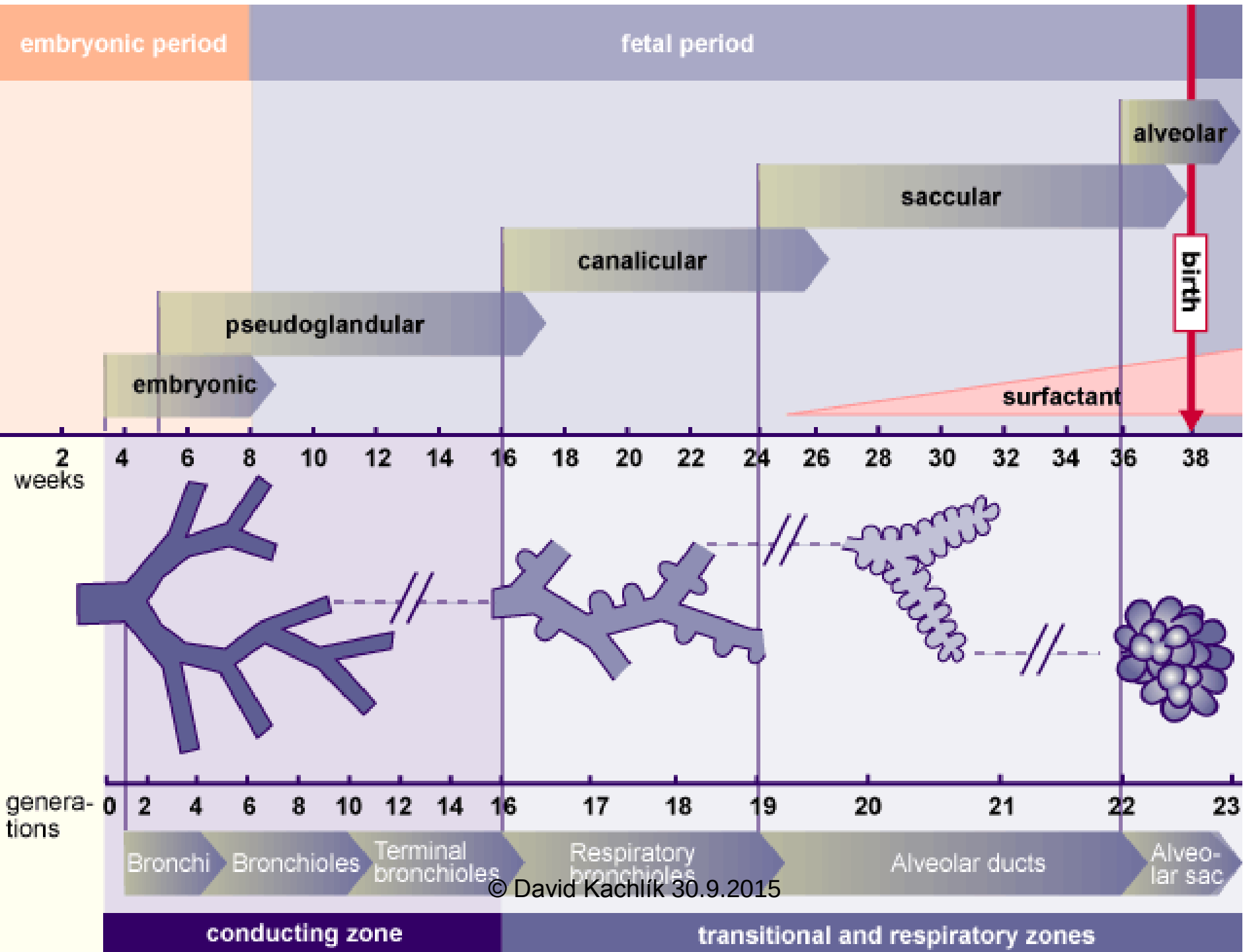




1 Alveolar duct
2 Primary septum
3 Alveolar sac
4 Type I pneumocyte
5 Type II pneumocyte
6 Capillary



1 Ductus alveolaris
2 Secondary septum
3 Alveoli pulmonales
4 Type I pneumocyte
5 Type II pneumocyte
6 Capillary



Lungs around delivery

- filled with amniotic fluid
  - growth factors
  - pressure gradient
- respiration movements present already prenatally (fetal respiratory movements)
  - vital for lungs development
  - vital for strengthening of respiratory muscles

Lungs immediately after delivery

- with first inspirations ventral lung segments open initially, then cranial and on the 3rd day also caudal segments open
- lung epithelium flattens and changes into the respiratory epithelium
- filled with fluid
- fluid fast removed after first inspirations
  - via mouth and nose
  - by resorption into blood capillaries
  - by resorption into lung lymph capillaries

Developmental defects

incidence – not much frequent

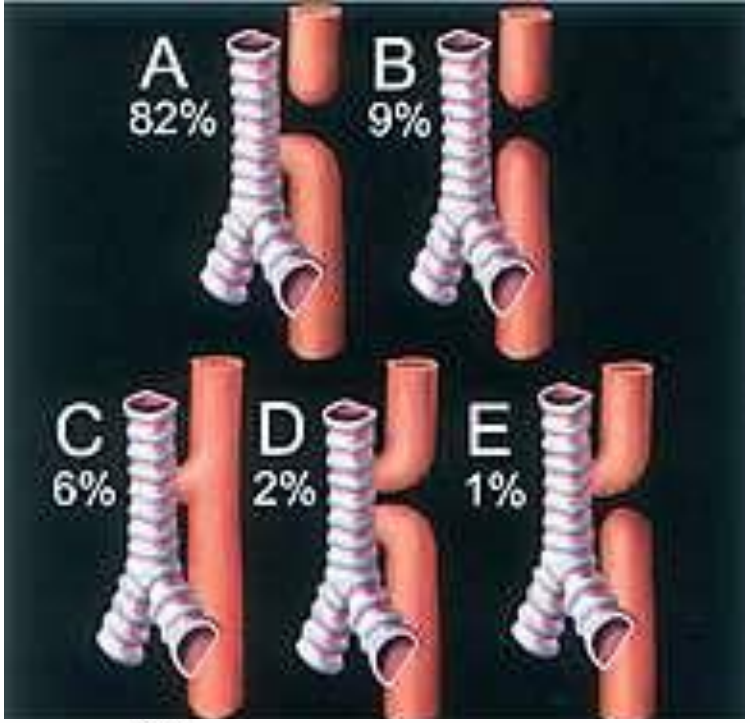
they have importance for differential diagnostic of more common illnesses (pneumothorax, bronchopneumonia, diaphragmatic hernia)

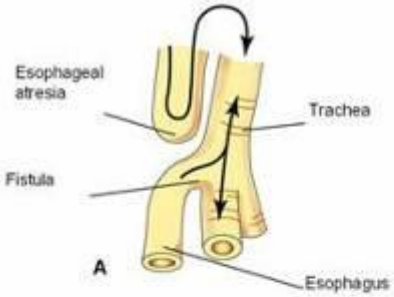
- **fistula tracheooesophagealis**

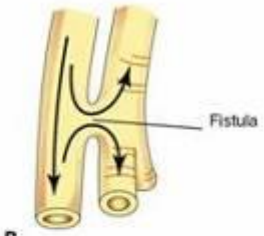
= inborn communication between trachea and oesophagus

  - most common developmental defect of respiratory tract (75%)
  - with oesophageal atresia (upper part blindly ending and caudal opens into trachea)
  - without oesophageal atresia – content gets into lungs
  - frequency 1:2500

- **defects of bronchi**
  - atresia
  - stenoses
  - bronchiectasia
  - bronchial cysts







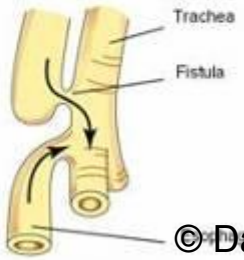
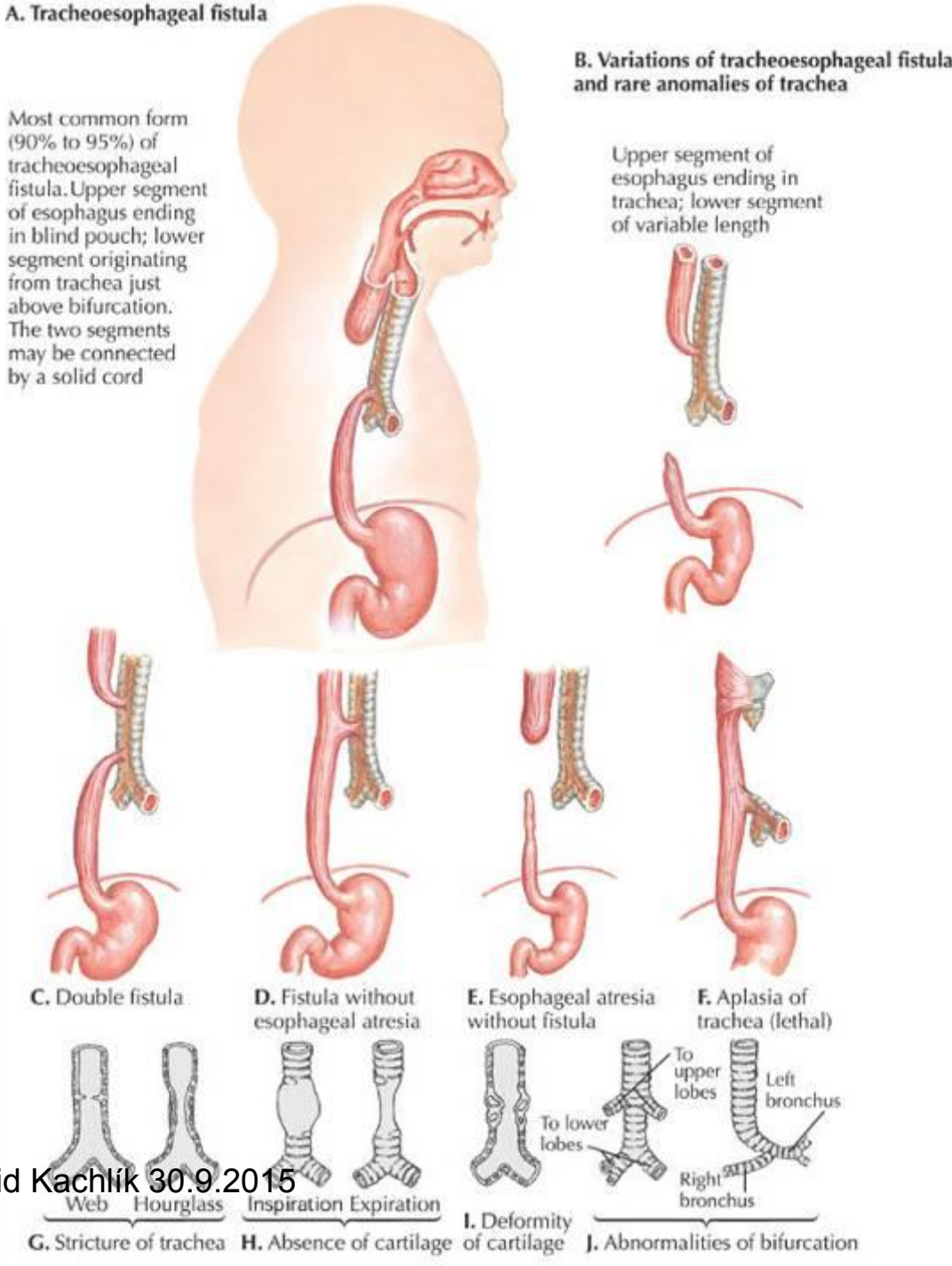


Fig. 11-5



Developmental defects

- **agenesis of lungs**
  - nor lung parenchyme, bronchi nor lung vessels
  - one sided agenesis is compatible with life
- **aplasia of lungs**
  - short bronchial branching without lung parenchyme and vessels
- **hypoplasia of lungs**
  - rudimentary bronchi, lung parenchyme and vessels
  - common in inborn diaphragmatic hernia
  - in case of one lung injury this lung inclines to infections
- **lung sequestration**
  - part of lung tissue not connected to tracheobronchial tree
  - arteries branch from thoracic aorta

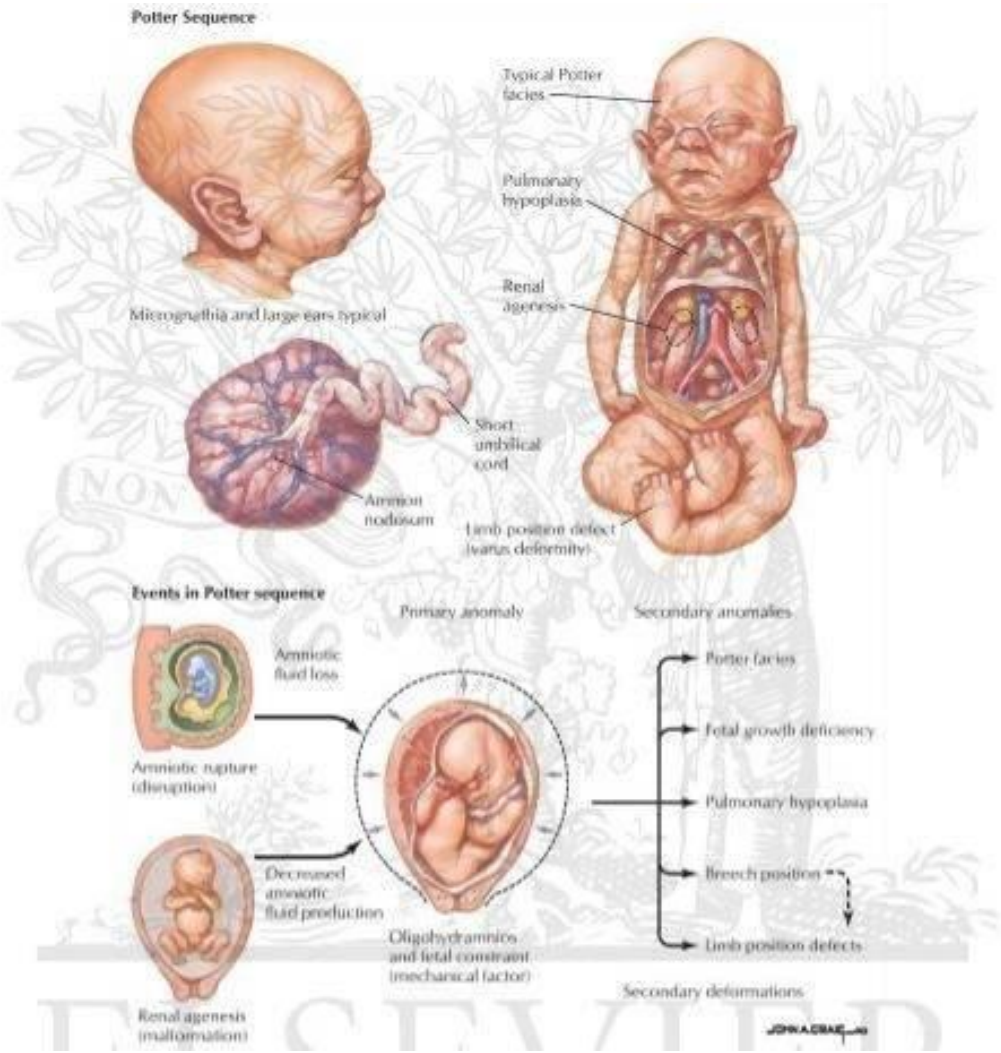
Oligohydramnion

- not enough amniotic fluid

→ hypoplasia of lungs

- causes: agenesis of kidneys, chronic leakage
- Potter‘s syndrome

- flat face, wide nose
- lateralized canthi
- skin fold on inferior palpebra
- malformed auricles
- renal agnesis
- oligohydramnion
- hypoplasia of lungs



Respiration distress syndrome (RDS)

- not enough surfactant
- lungs are not completely spread, pulmonary alveoli contain fluid with high amount of proteins (resemble hyaline membrane)
- intrauterine lack of oxygen (intrauterine asphyxia) → lesion of pneumocyte II. type

- treatment – glucocorticoids

Parietal pleura development

from intra-embryonal lateral mesoderm

- from mesenchyme of **somatopleura → parietal pleura**
- from mesenchyme of **splanchnopleura → visceral pleura**

- open pleuroperitoneal canal → **congenital posterolateral diaphragmatic hernia (of Bochdalek)**
  - more often on the left side, since left canal closes later on

Bochdalek hernia