
هو الأول والآخر والظاهر والباطن
وهو بكل شيء عليم

- دکتر فرزاد اعلا

Development of the
Respiratory
System and Body Cavities

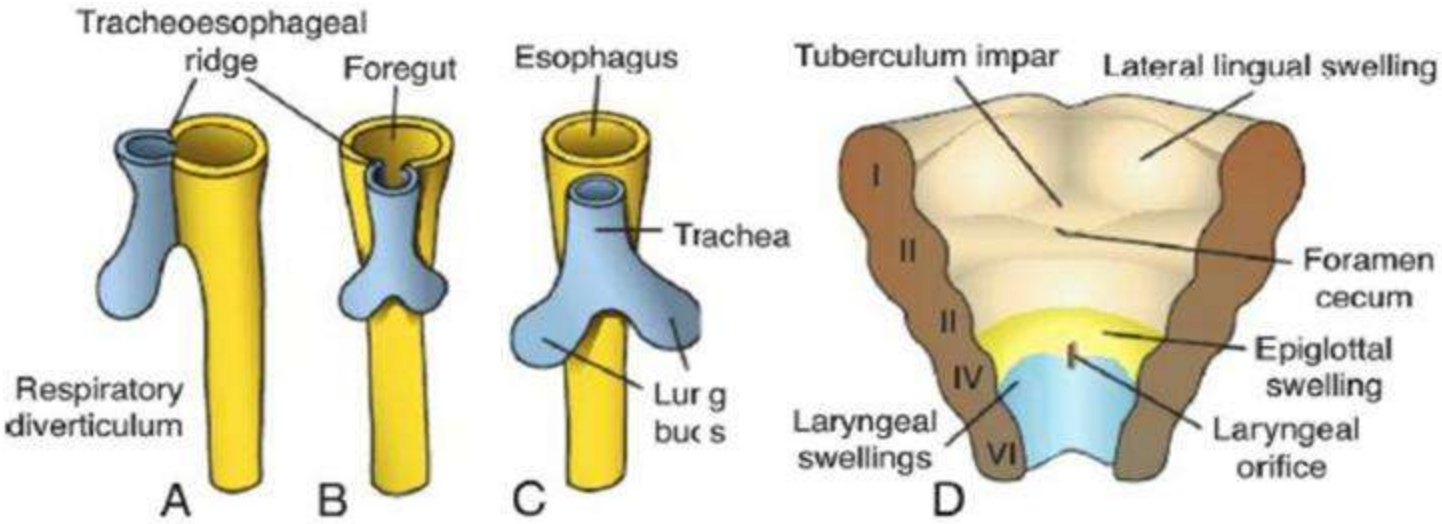
DEVELOPMENT OF LUNGS AND RESPIRATORY TREE

- When the embryo is approximately ***4 weeks old***, the respiratory diverticulum (lung bud) appears as an outgrowth from the ventral wall of the foregut

- Epithelium of the internal lining of the larynx, trachea, and bronchi, as well as that of the lungs, is entirely of ***endodermal origin***.

- The cartilaginous, muscular, and connectlve tissue components of the trachea and lungs are derived from ***splanchnlc mesoderm*** surrounding the foregut.

The proximal end (stem) of the diverticulum forms the **trachea and larynx**.



- The stem of the diverticulum begins to separate from the overlying portion of the pharynx, which becomes the esophagus.
- The pattern of branching of the lung endoderm is regulated by the surrounding mesenchyme, which invests the buds from the time that they first form

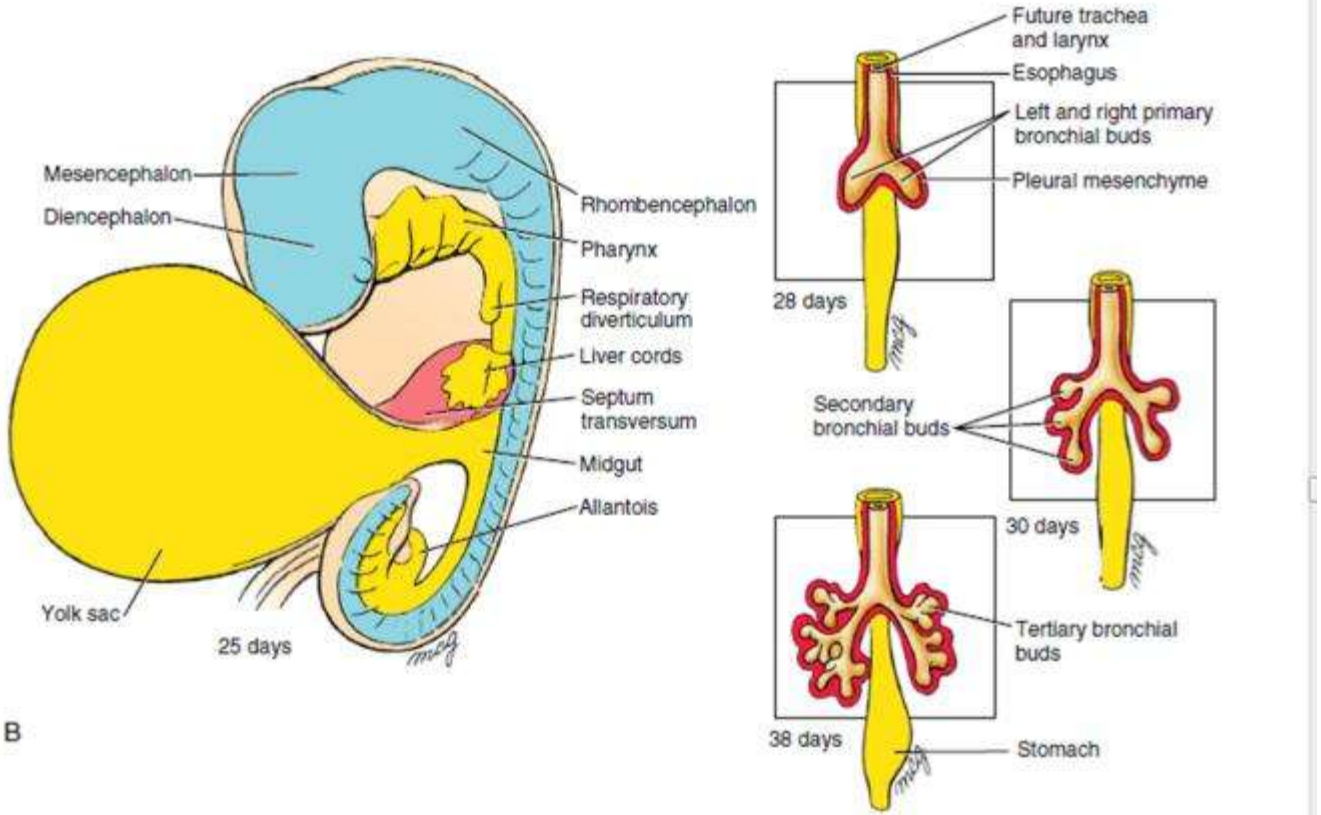
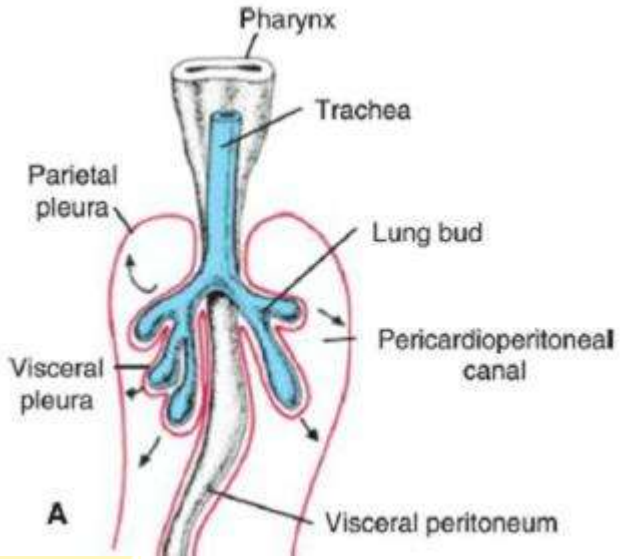


Figure 11-1. Development of the respiratory diverticulum. *A*, Four stages in development of the mouse foregut, showing origins of the esophagus, trachea, lungs, and stomach. The foregut epithelium has been stained with an antibody to E-cadherin. The branching pattern of the mouse respiratory tree differs from that of the human, which is described in the text. *B*, The respiratory diverticulum first forms as an evagination of the foregut on day twenty-two and immediately bifurcates into two primary bronchial buds between day twenty-six and day twenty-eight. Early in the fifth week, the right bronchial bud branches into three secondary bronchial buds, whereas the left bronchial bud branches into two. By the sixth week, secondary bronchial buds branch into tertiary bronchial buds (usually about ten on each side) to form the bronchopulmonary segments.

TRACHEA, BRONCHI, AND LUNGS

- With subsequent growth in caudal and lateral directions, the lung buds expand into the body cavity (pericardioperitoneal canals)



By the end of **the sixth month**, approxrmately 17 generations of subdivisions have formed.

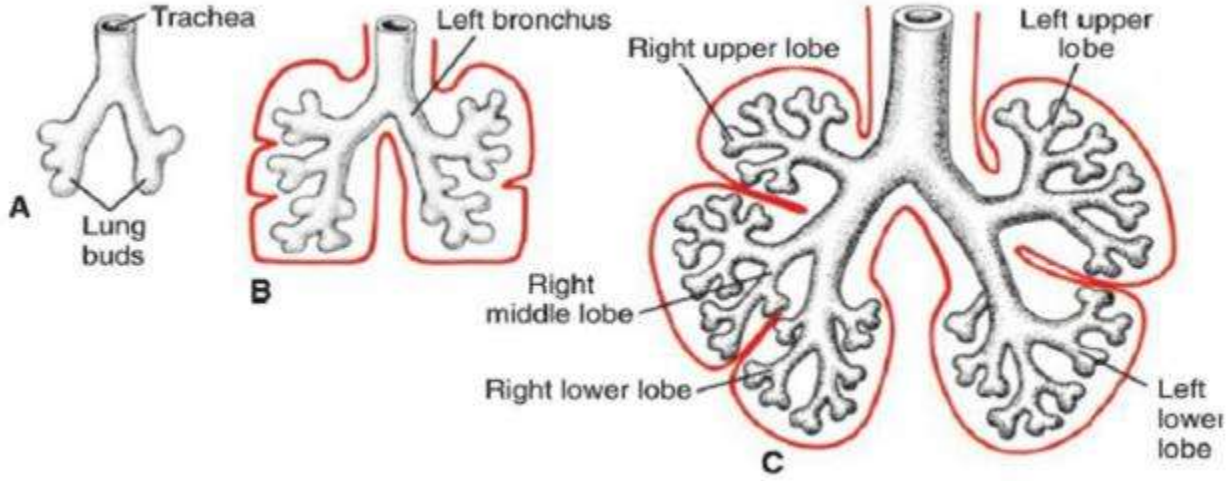


FIGURE 14.5 Stages in development of the trachea and lungs. **A.** 5 weeks. **B.** 6 weeks. **C.** 8 weeks.

Before the bronchial tree reaches its final shape, however, an additional six divisions form during postnatal life

Branching is regulated by epithelial-mesenchymal interactions between the endoderm of the lung buds and splanchnic mesoderm that surrounds them

By the time of birth, the bifurcation of the trachea is opposite the fourth thoracic vertebra.

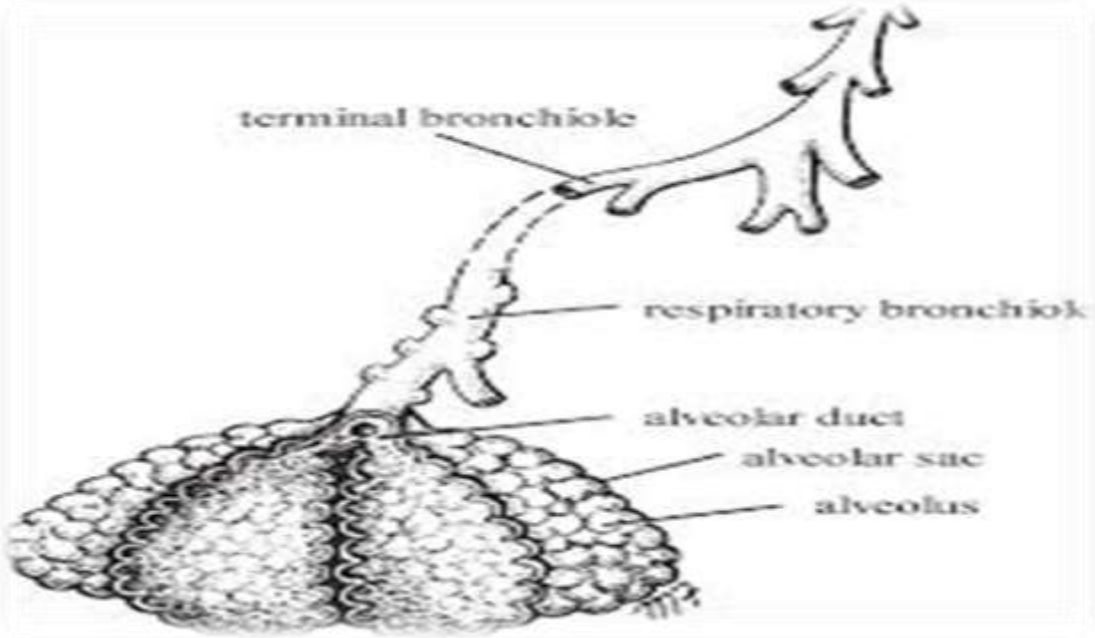


TABLE 11-1 STAGES OF HUMAN LUNG DEVELOPMENT

Stage of Development	Period	Events
Embryonic	Twenty-six days to six weeks	Respiratory diverticulum arises as a ventral outpouching of foregut endoderm and undergoes three initial rounds of branching, producing the primordia successively of the two lungs, the lung lobes, and the bronchopulmonary segments; the stem of the diverticulum forms the trachea and larynx
Pseudoglandular	Six to sixteen weeks	Respiratory tree undergoes fourteen more generations of branching, resulting in the formation of terminal bronchioles
Canalicular	Sixteen to twenty-eight weeks	Each terminal bronchiole divides into two or more respiratory bronchioles. Respiratory vasculature begins to develop. During this process, blood vessels come into close apposition with the lung epithelium. The lung epithelium also begins to differentiate into specialized cell types (ciliated, secretory, and neuroendocrine cells proximally and precursors of the alveolar type II and I cells distally)
Saccular	Twenty-eight to thirty-six weeks	Respiratory bronchioles subdivide to produce terminal sacs (primitive alveoli). Terminal sacs continue to be produced until well into childhood
Alveolar	Thirty-six weeks to term	Alveoli mature

Additional terminal sacs continue to form and differentiate in craniocaudal progression both before and after birth. The process is largely completed by two years.

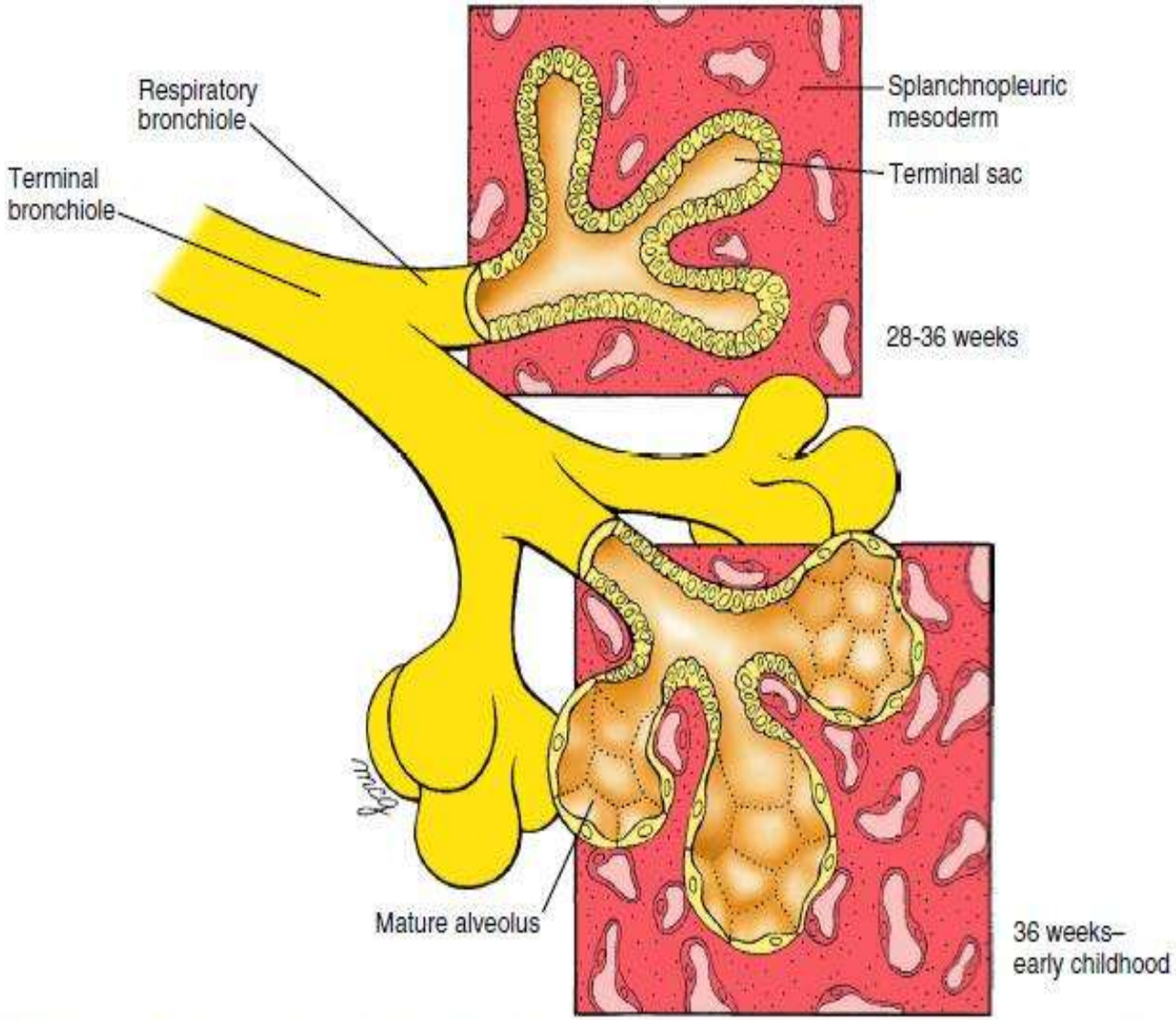
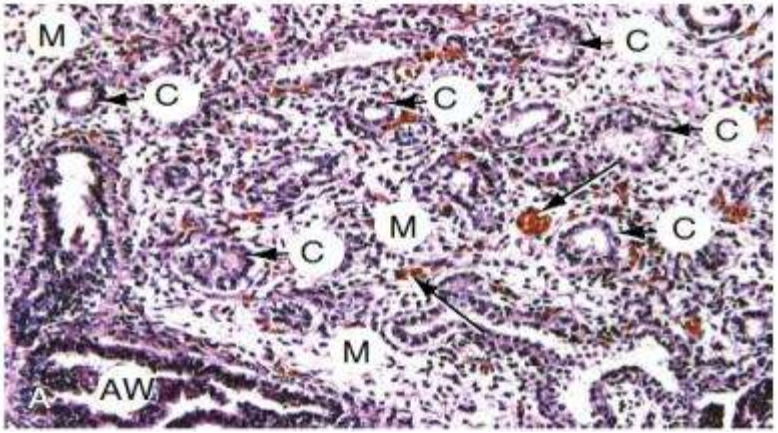
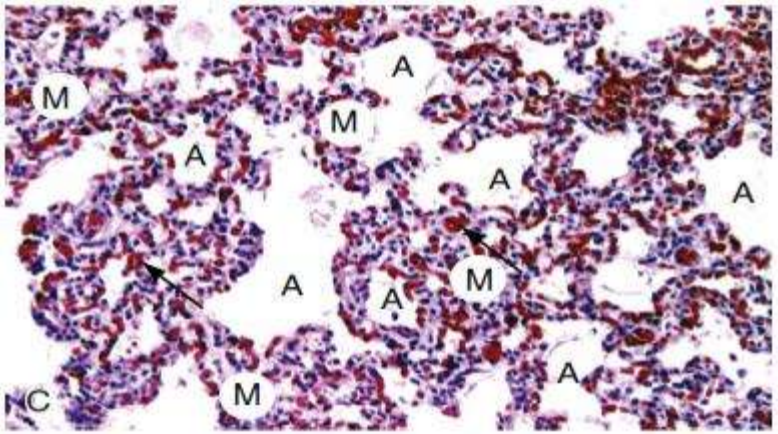


Figure 11-2. Maturation of lung tissue. Terminal sacs (primitive alveoli) begin to form between weeks twenty-eight and thirty-six and begin to mature between thirty-six weeks and birth. However, only 5% to 20% of all terminal sacs eventually produced are formed before birth. Subsequent septation of the alveoli is not shown.

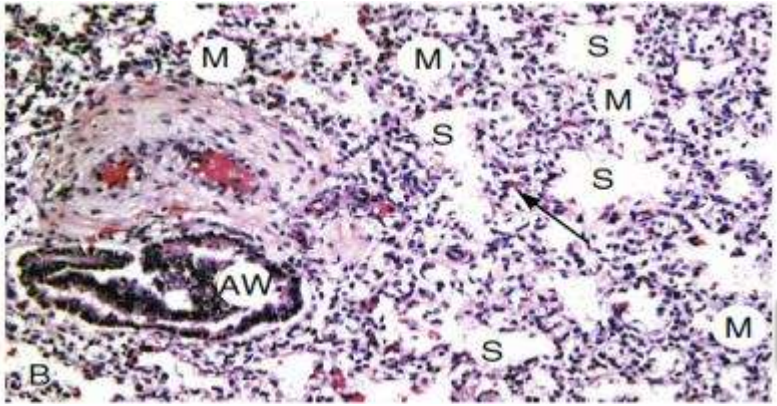
- About twenty-million to seventy-million terminal sacs are formed in each lung before birth; the total number of alveoli in the mature lung is three-hundred million to four-hundred million.
- Continued thinning of the squamous epithelial lining of the terminal sacs begins just before birth, resulting in the differentiation of these primitive alveoli into mature alveoli
- The alveolar phase begins shortly before birth, typically around the beginning of the ninth month of gestation, and continues into postnatal life.



Canalicular stage



Alveolar stage



Saccular stage

By the end of the seventh month, suffcient numbers of mature alveolar sacs and capillaries are present to guarantee adequate gas exchange, and the premature infant is able to survive

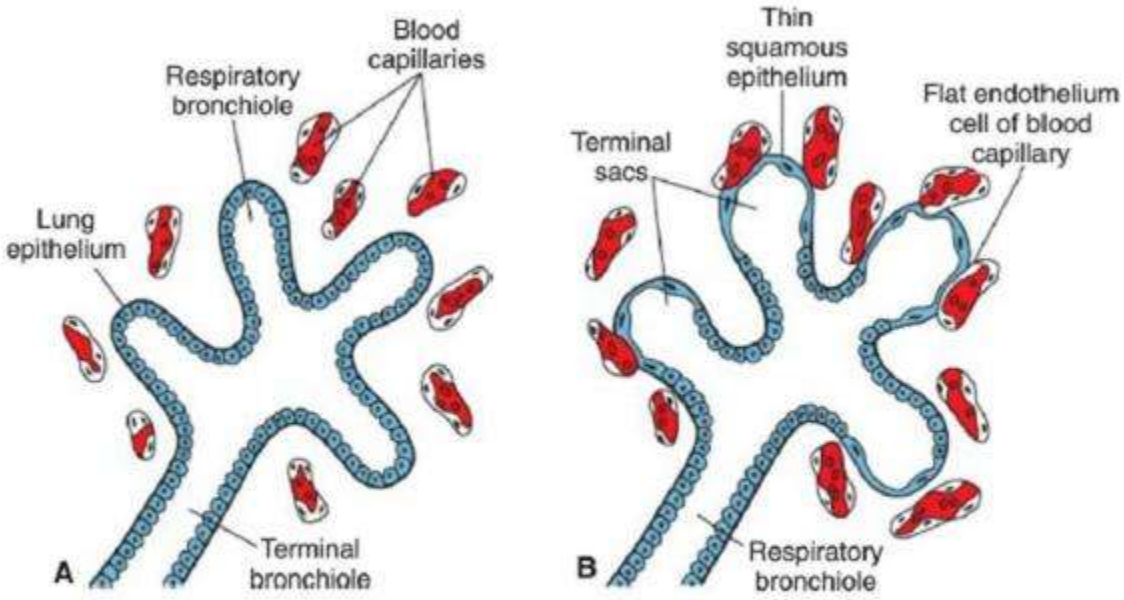


FIGURE 14.8 Histological and functional development of the lung. **A.** The canalicular period lasts from the 16th to the 26th week. Note the cuboidal cells lining the respiratory bronchioli. **B.** The terminal sac period begins at the end of the sixth and beginning of the seventh prenatal month. Cuboidal cells become very thin and intimately associated with the endothelium of blood and lymph capillaries or form terminal sacs (primitive alveoli).

An important process of septation, which further subdivides the alveoli, occurs after birth. Each septum formed during this process contains smooth muscle and capillaries

The lung is a composite of endodermal and mesodermal Tissues:

- The endoderm of the respiratory diverticulum gives rise to the mucosal lining of the bronchi and to the epithelial cells of the alveoli.

- The remaining components of the lung, including muscle and cartilage supporting the bronchi and the visceral pleura covering the lung, are derived from the splanchnopleuric mesoderm, which covers the bronchi as they grow out from the mediastinum into the pleural space

Mature alveoli are not present before birth

In addition to endothelial cells and flat alveolar epithelial cells, another cell type develops at the end of the sixth month.

The amount of surfactant in the fluid increases, particularly during the last 2 weeks before birth.

- Although the alveoli increase somewhat in size, growth of the lungs after birth is due primarily to an increase in the number of respiratory bronchioles and alveoli.
- It is estimated that only one-sixth of the adult number of alveoli are present at birth. The remaining alveoli are formed during the first 10 years of postnatal life through the continuous formation of new primitive alveoli.

PARTITIONING OF COELOM AND FORMATION OF DIAPHRAGM

Intraembryonic coelom

At the beginning of the fourth week of development, before body folding, the intraembryonic coelom forms a horseshoe-shaped space that partially encircles the future head end of the embryo

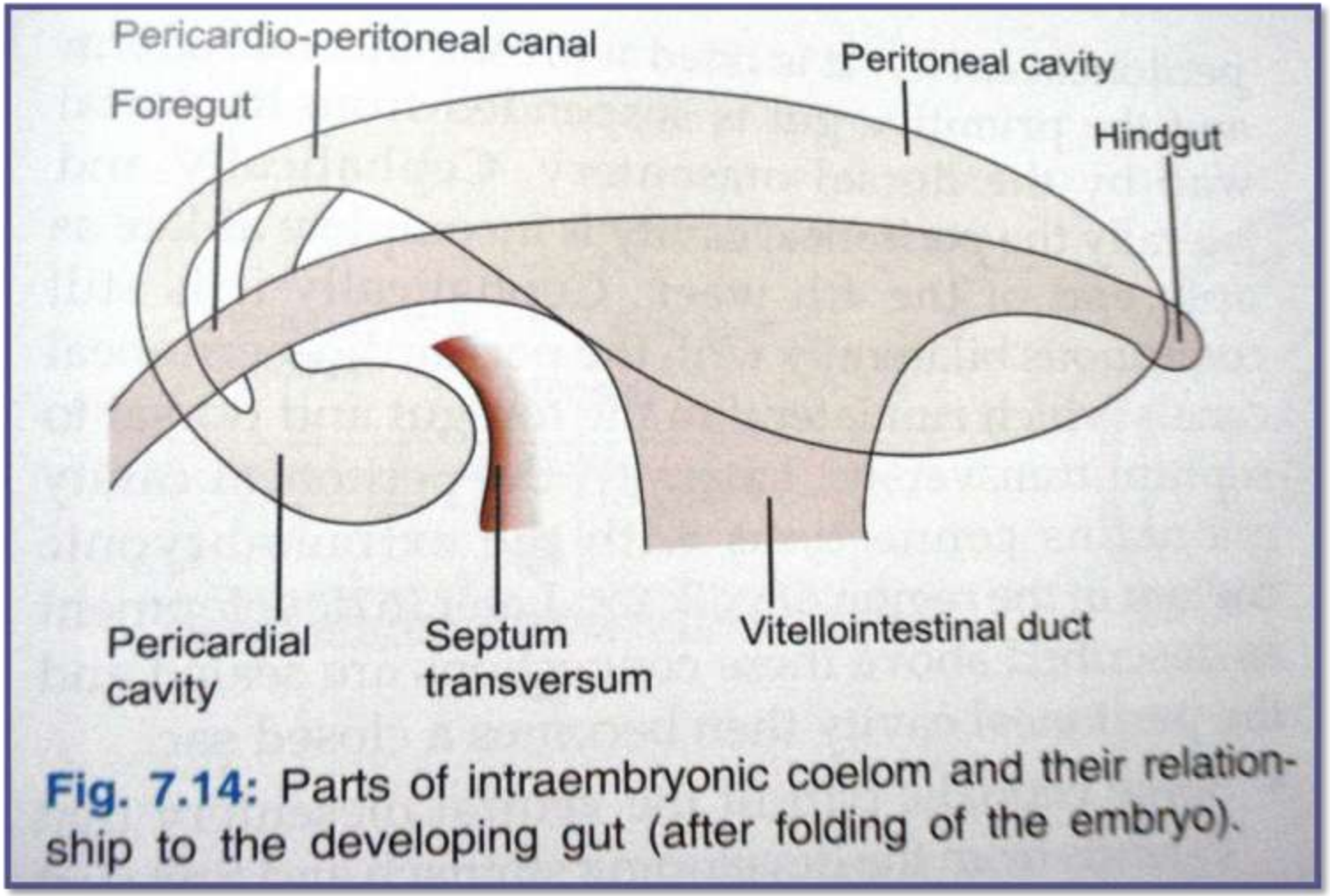
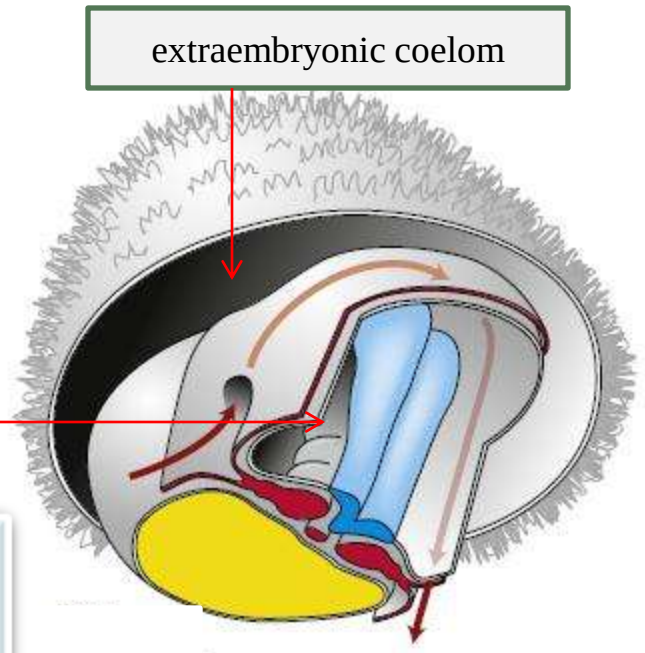
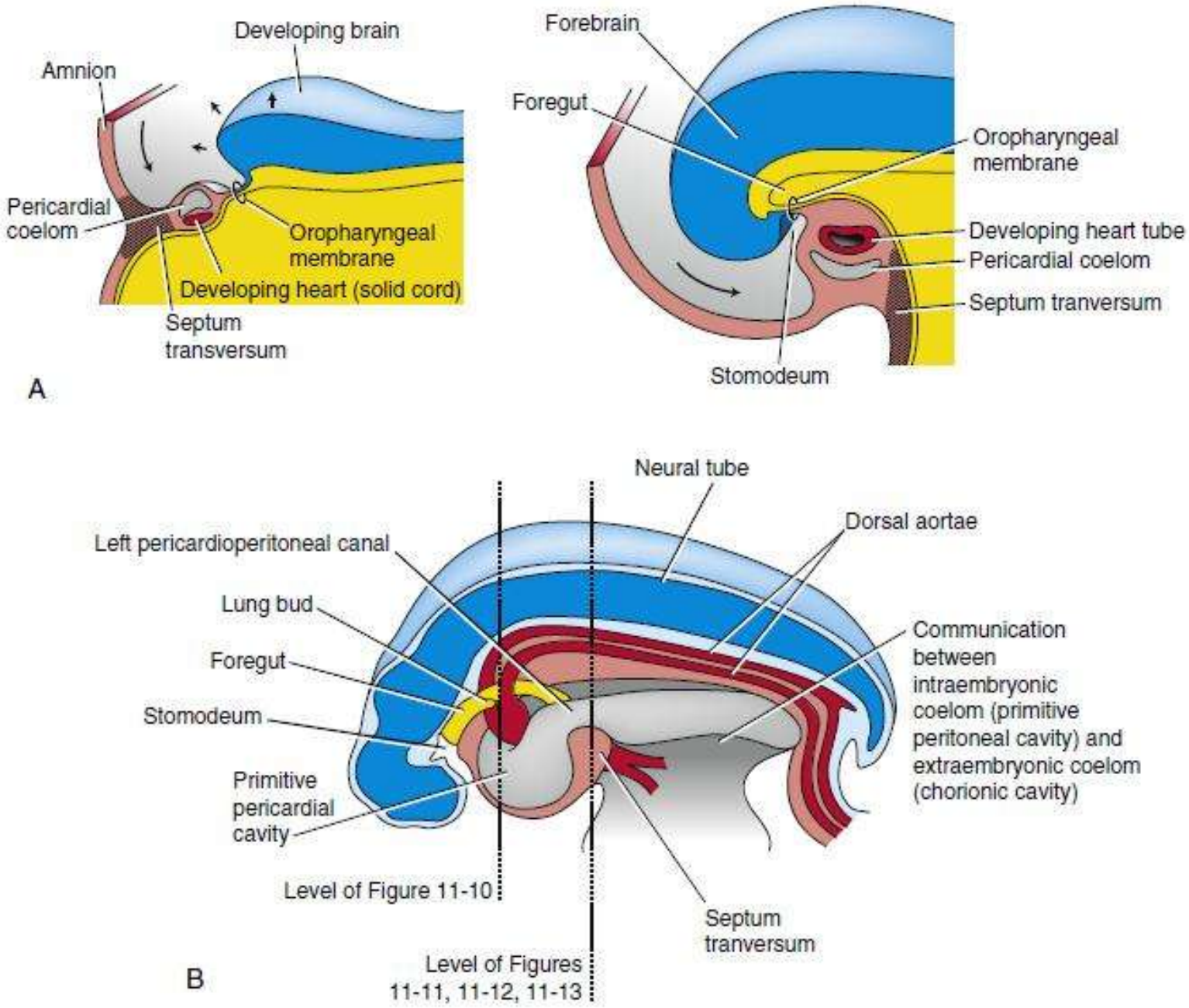


Fig. 7.14: Parts of intraembryonic coelom and their relationship to the developing gut (after folding of the embryo).

At about the mid-trunk and more caudal levels, the intraembryonic coelom on each side is continuous with the extraembryonic coelom or chorionic cavity.

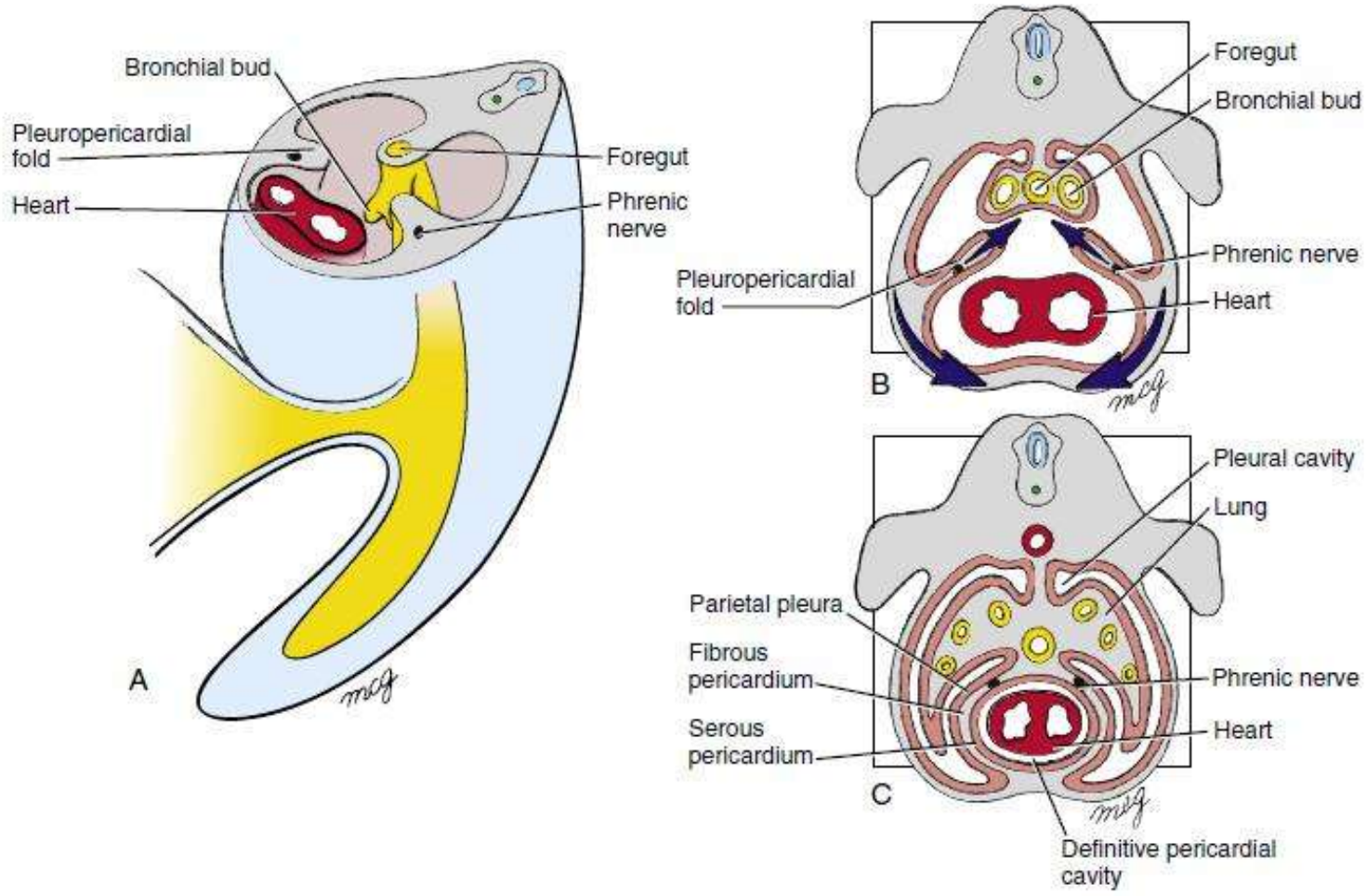


- The head fold moves the future pericardial cavity caudally and repositions it on the anterior (ventral) side of the developing head
- The septum transversum, which initially constitutes a partition that lies cranial to the future pericardial cavity, is repositioned by the head fold to lie caudal to the future pericardial cavity.
- The developing heart , which initially lies ventral to the future pericardial cavity, is repositioned dorsally and quickly begins to bulge into the pericardial cavity.


Developing brain
Amnion
Pericardial coelom
Oropharyngeal membrane
Developing heart (solid cord)
Septum transversum
A
Forebrain
Foregut
Oropharyngeal membrane
Developing heart tube
Pericardial coelom
Septum tranversum
Stomodeum
Neural tube
Dorsal aortae
Left pericardioperitoneal canal
Lung bud
Foregut
Stomodeum
Primitive pericardial cavity
Communication between intraembryonic coelom (primitive peritoneal cavity) and extraembryonic coelom (chorionic cavity)
Level of Figure 11-10
Septum tranversum
Level of Figures 11-11, 11-12, 11-13
B

During the fifth week, the pleural and pericardial cavities are divided from each other by ***pleuropericardial folds*** that originate along the lateral body walls in a coronal plane

At the end of the fifth week, the folds meet and fuse with the foregut mesenchymethus subdividing the primitive pericardial cavity into three compartments: a fully enclosed, ventral definitive pericardial cavity and two dorsolateral pleural cavities



Recall that the septum transversum is repositioned by the head fold to lie ventral to the paired pericardioperitoneal canals.

- At the beginning of the fifth week, a pair of membranes, the pleuroperitoneal membranes, arise along an oblique line connecting the root of the twelfth rib with the tips of ribs twelve through seven
- These membranes grow ventrally to fuse with the septum transversum, thus sealing off the pericardioperitoneal canals
- After they fuse with the septum transversum, they separate the definitive pleural cavities from the peritoneal cavity.

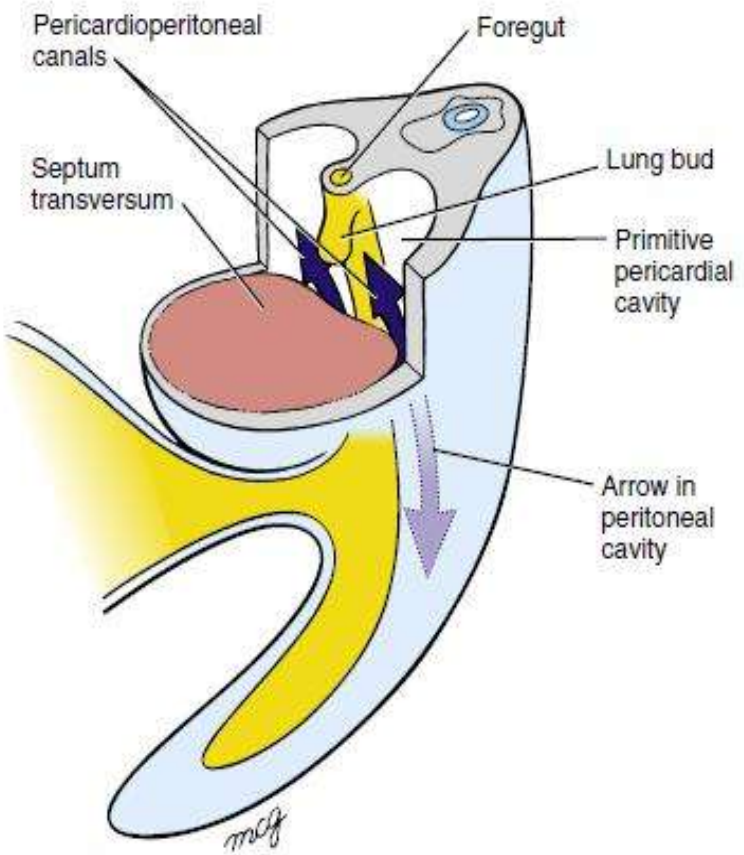


Figure 11-11. In the future thoracic region, the septum transversum forms a ventral partition beneath the paired pericardioperitoneal canals (*arrows*), which interconnect the primitive pericardial cavity cranially and peritoneal cavities caudally.

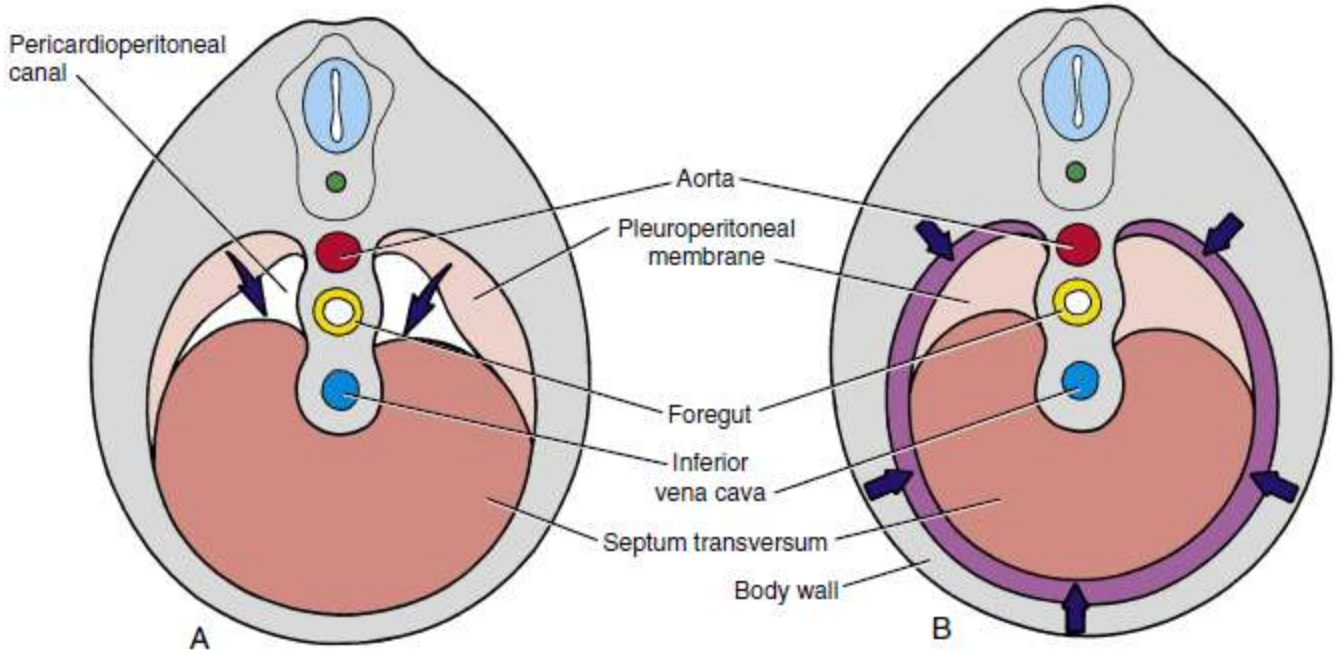
In the adult, the pleuropericardial membranes form the fibrous pericardium

DIAPHRAGM IS A COMPOSITE DERIVED FROM FOUR EMBRYONIC STRUCTURES

The definitive musculotendinous diaphragm incorporates derivatives of four embryonic structures:
(1) septum transversum
(2) pleuroperitoneal membranes,
(3) mesoderm of the body wall
(4) esophageal mesoderm

- Some of the myoblasts that arise in the septum transversum emigrate into the pleuroperitoneal membranes, pulling their phrenic nerve branches along with them.

- Most of the septum transversum then gives rise to the non-muscular central tendon of the diaphragm



- ✓ At 7th week, they fuse with the mesentery of the esophagus and with the septum transversum
- ✓ this rim is established: myoblasts originating from somites at cervical segments 3 to 5 (C3–5) penetrate the membranes to form the muscular part of the diaphragm

Position and innervation of diaphragm

- ❑ 4th week: septum transversum lies opposite cervical somites; nerve components of 3-5 cervical segments grow into the septum (phrenic nerves) through pleuropericardial folds
- ❑ 6th week: diaphragm is at the level of thoracic somites because of rapid growth of the dorsal part of the embryo (vertebral column), compared with that of the ventral part
- ❑ beginning of the 3rd month: some of the dorsal bands of the diaphragm originate at the level of the 1 rst lumbar vertebra

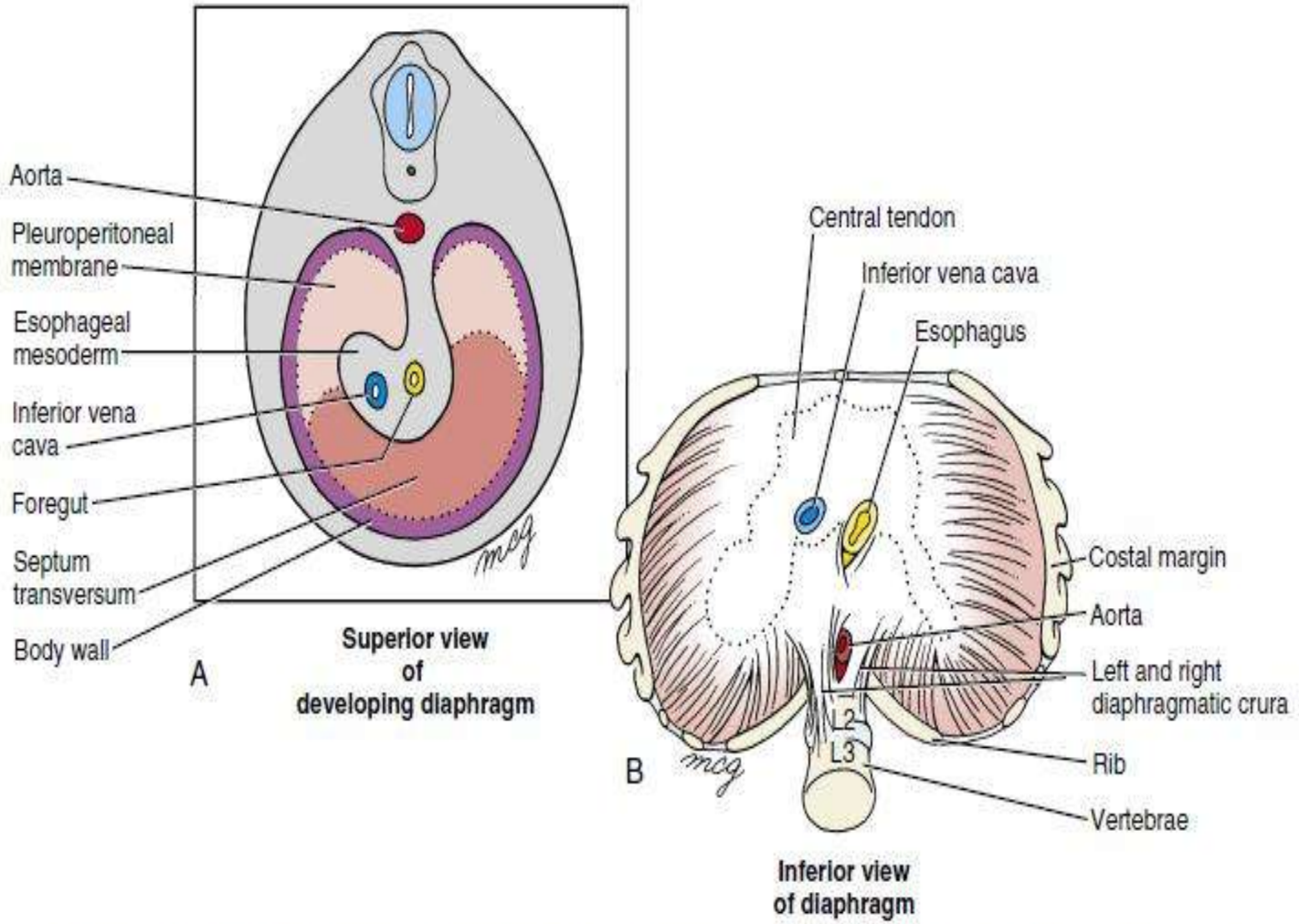
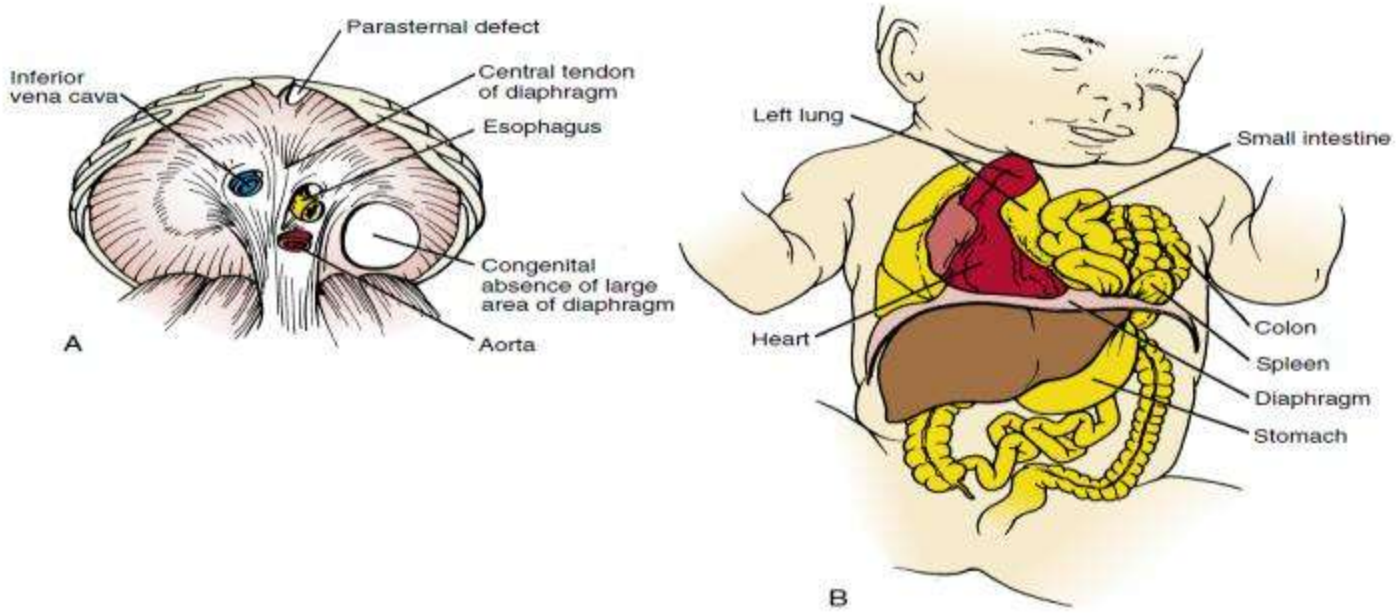


Figure 11-13. Formation of the diaphragm. The definitive diaphragm is a composite structure, including elements of the septum transversum, pleuroperitoneal membranes, and esophageal mesenchyme, as well as a rim of body wall mesoderm. *A*, Superior view. *B*, Inferior view.

Diaphragmatic herinas

congenital diaphragmatic hernia

- caused by failure of one or both of the pleuroperitoneal membranes to close the pericardioperitoneal canals
- peritoneal and pleural cavities are continuous with one another along the posterior body wall abdominal viscera enter the pleural cavity
- In 85% to 90% of cases, the hernia is one the left side
- A large defect is associated with a high rate of mortality (75%) from pulmonary hypoplasia and dysfunction



- small part of the muscular fibers of the diaphragm fails to develop and a hernia may remain undiscovered until the child is several years old
- frequently seen in the anterior portion of the diaphragm:

parasternal hernia:

A small peritoneal sac containing intestinal loops may enter the chest between the sternal and costal portions of the diaphragm

esophageal hernia

due to congenital shortness of the esophagus
Upper portions of the stomach are retainedin the thorax
stomach is constricted at the level of the diaphragm


Any question?