NAME: **BASHIR AL-AMIN MOHAMMED**

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DEPARTMENT: **PHYSIOLOGY**

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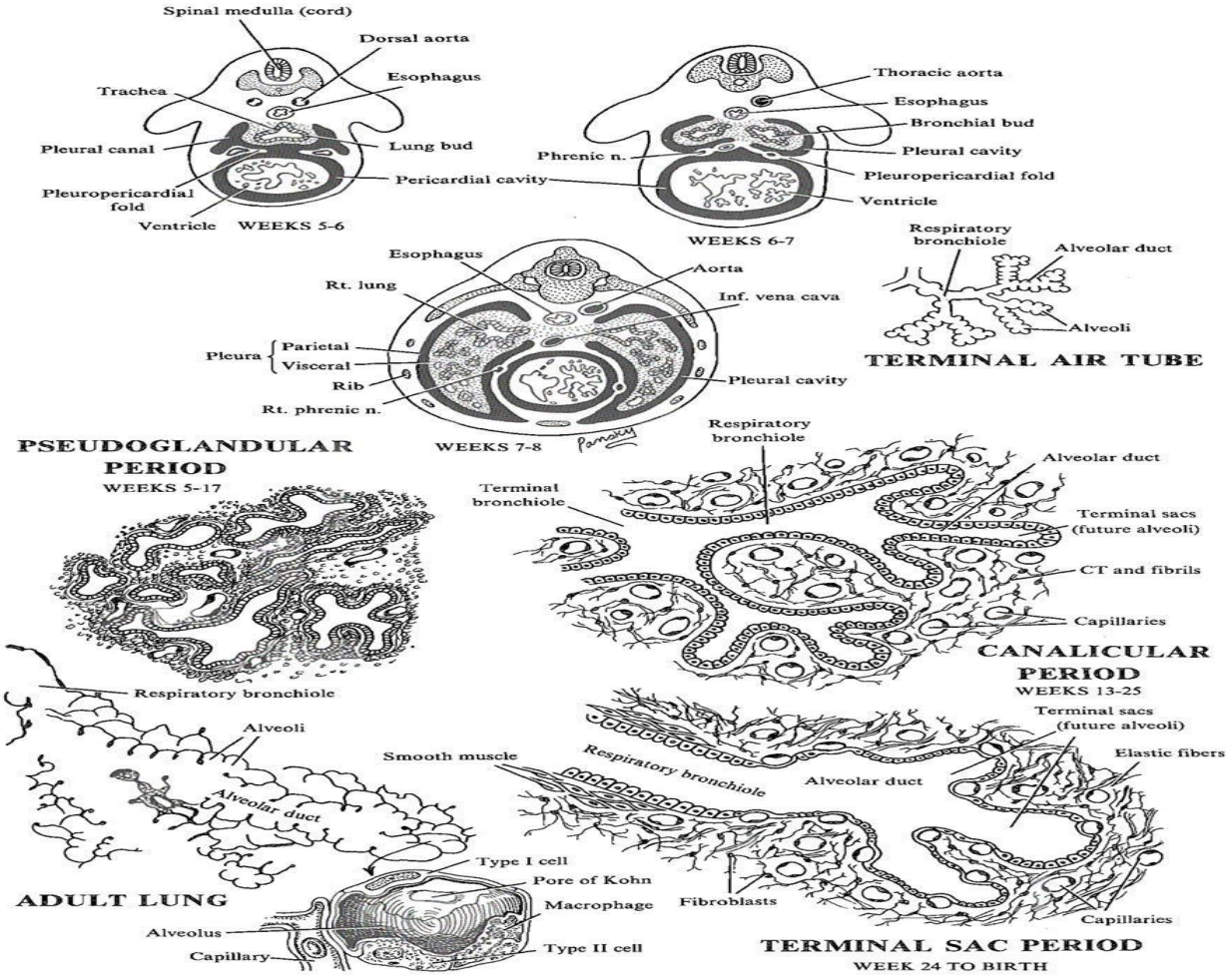
ASSIGNMENT

- WRITE NOTES ON THE DEVELOPMENT OF LUNGS
- ROTATION OF STOMACH AND FORMATION OF OMENTAL BURSA
- DEVELOPMENT OF ESOPHAGUS

DEVELOPMENT OF LUNGS

The development of lungs requires integration of multiple regulatory factors that mediate pattern of cell proliferation, differentiation and death. This process is continuous during embryogenesis.

It has five developmental stages based on anatomical and histological characteristics. These include the: Early embryonic and pseudoglandular stages elaborate the conducting airways; the latter canalicular, saccular and alveolar stages are characterized by reduction of mesenchyme and vascularization to from a thin air-blood barrier. At birth, the newborn infant, with approximately 50 million alveoli, has the potential to add another 250 million alveoli and increase surface area from approximately 3 to 70 m^2. There are more than 40 different cell types in the lung, with different functions.



EMBRYONIC STAGE

At around 3–4 weeks of embryonic life, the human fetal lung develops as an outgrowth of the ventral wall of the primitive foregut, the laryngotracheal groove. During the embryonic stage, the trachea branches into the right and left main bronchi and subsequently into lobar and segmental bronchi. Lobar and segmental bronchi appear at about the 5th week and by the end of this stage, 18 major lobules are recognisable. The lung bud grows into adjacent splanchnic mesoderm where it is induced to branch repeatedly, giving rise to the future respiratory tree. This primitive lung bud is lined by endodermally derived epithelium, which differentiates into specialized cells that line both the conducting and respiratory airways. Mesenchymal cells condensed around the primitive airways give rise to blood vessels, smooth muscle, cartilage, and other connective tissues of the lung

PSEUDOGLANDULAR STAGE: During the pseudoglandular stage, there is rapid proliferation of the primitive airways so that all airway divisions are more or less completed

by 16 weeks. This translates into 12 to 17 branches in the upper lobes, 18 to 23 branches in the middle lobes, and 14 to 23 branches in the lower lobes. The developing lungs histologically resemble exocrine glands, branching continues to form terminal bronchioles. By 16wks, all major elements of the lungs have formed except those involved with gas exchange (respiratory bronchioles and alveoli). The columnar epithelial cells that line the tubules contain cytoplasmic glycogen; a few become ciliated as early as 8 weeks while others begin to differentiate into goblet cells. During this period, cartilage begins to form around the larger airways and smooth muscle forms around airways and major blood vessels

CANALICULAR STAGE

The canalicular stage is so named because the potential air spaces are being "canalized" and approximated by a network of capillaries. It overlaps pseudoglandular stage because cranial segments of the lungs mature faster than the caudal ones. The lumina of the bronchi and terminal bronchioles become larger and lung tissue becomes highly vascular, each terminal bronchiole divides into 2 or more respiratory bronchioles which in turn divide into 3-6 passages-primordial alveolar ducts. The conducting airways have fully developed smooth muscle, and lymphatic structures now begin to appear. The developing pulmonary arteries and veins follow the development of the branching airways but lag behind it somewhat. Respiration is possible at the end of this stage b/c some thin-walled terminal sacs are present

TERMINAL SAC OR SACCULAR STAGE

The term "saccule" derives from the saclike appearance of the most peripheral air spaces, which represent the future alveolar ducts and alveoli, further compression of the intervening interstitium, thinning of the epithelium, and the beginning of alveolar septation, with the formation of small mesenchymal ridges. There is lengthening and widening of saccules distal to the terminal bronchioles and the addition of the last generations of future alveolar spaces.

Many more terminal sacs or saccules develop and their epithelium becomes very thin Capillaries establish close contact with the sacs. This intimate contact between epithelial and endothelial cells establishes the blood-air barrier which permits adequate gas exchange for survival By 26wks, the terminal sacs are lined mainly by squamous epithelial cells of endodermal origin called type 1 pneumocytes across which gas exchange occurs Scattered among the squamous epithelial cells are rounded secretory epithelial cells, type 2 pneumocytes, which secrete pulmonary surfactant (a complex mixture of phospholipids and proteins) capable of lowering surface tension at the air-alveolar interface Surfactant production starts at 20wks in small amount but increases during the terminal stages of pregnancy particularly in the last 2wks. By 26-28wks, sufficient alveolar sacs and surfactant are present to permit survival of prematurely born infants.

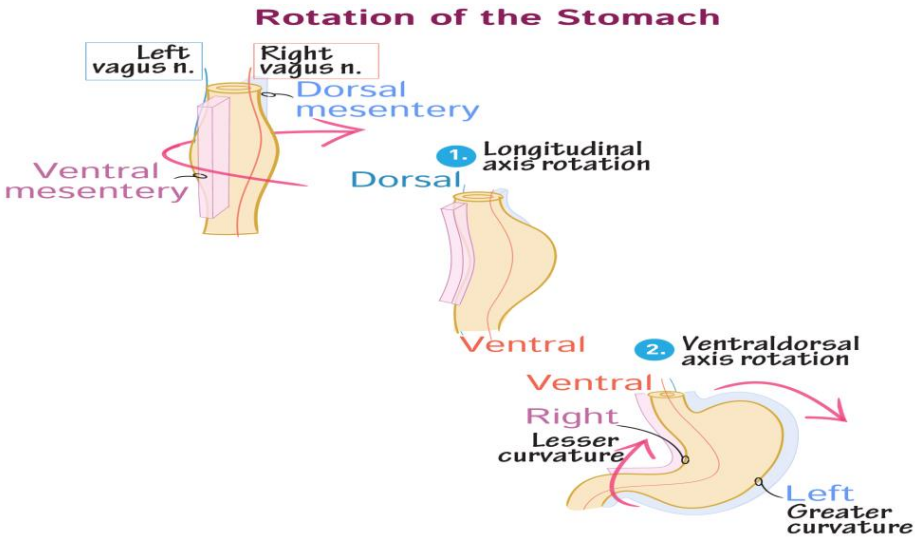
ALVEOLAR STAGE

At the beginning of this stage, each respiratory bronchiole terminates in a cluster of thin-walled alveolar sacs The epithelial lining of the terminal sacs attenuates to a thin squamous epithelial layer. Type 1 pneumocytes become so thin that adjacent capillaries bulge into the alveolar saccules. Terminal saccules become invaginated by protrusions from the wall of epithelial cells and contain a double-walled capillary system. These protrusions elongate and thin, forming primitive alveoli that at first resemble shallow cups and then become deeper as development continues. Gradually, low ridge like projections, also with double capillary network appear in the airspaces, which eventually divide the airspaces into alveoli. This process of formation of double capillary walled secondary septa and multiplication of alveoli continue rapidly up to the age of at least 2 years in humans.
The lungs are capable of respiration by the late foetal period because the alveolocapillary membrane (pulmonary diffusion barrier or respiratory membrane) is sufficiently thin to allow gas exchange.

ROTATION OF STOMACH AND FORMATION OF OMENTAL BURSA

As the stomach enlarges and acquires its final shape, it rotates 90^{o} clockwise around its longitudinal axis. This rotation has several effects, some of which are: the movement of the ventral border (lesser curvature) to the right and the dorsal border (greater curvature) to the left, the ventral surface becoming the left side and the dorsal surface becoming the right side.

There is a change in position of the cranial and caudal ends initially in median plane; cranial moves to the left and slightly inferior and caudal moves to right and superiorly. The long axis of the stomach is almost transverse to the long axis of its body after rotation. The rotation and growth of the stomach explains why the left vagus nerve supplies the anterior wall while the right vagus innervates its posterior wall. At this stage of development, the stomach is attached to the posterior and anterior body wall by the dorsal and ventral mesogastrium respectively.



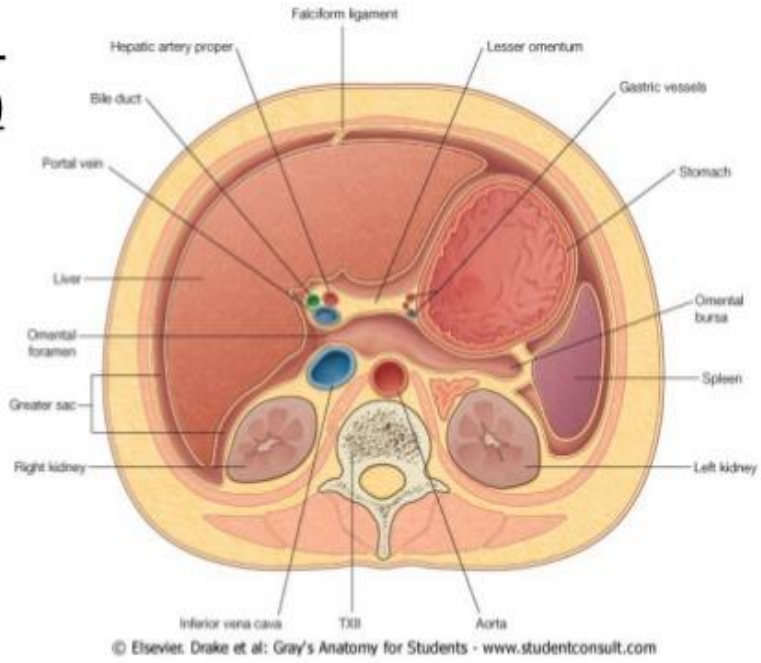
The omental bursa is a space behind the stomach formed by the rotation around the longitudinal axis pulling the dorsal mesogastrium thus the omental bursa. Isolated clefts that develop in the mesenchyme forming the thick dorsal mesogastrium to form the single cavity, i.e. the omental bursa.

The omental bursa communicates with the main part of peritoneal cavity through an opening, the omental foramen, which is located posterior to the free edge of the lesser omentum in adult

Omental Bursa

(lesser peritoneal sac)

- Result from stomach taking 90 degree clockwise turn
- Anterior: liver, stomach, & **lesser omentum**
- Posterior: diaphragm
- Right side: liver
- Left side: gastrosplenic and splenorenal ligs.



•Communicates with greater peritoneal sac through the **omental foramen (of Winslow)** [Omental=Epiploic]

•Posterior= IVC covered by parietal peritoneum; Anterior= **Portal Triad** in hepatoduodenal lig.; Inferior= 1st part duodenum; Superior= caudate lobe in visceral peritoneum

DEVELOPMENT OF ESOPHAGUS

At approximately 4 weeks of development, the respiratory diverticulum (tracheobronchial diverticulum) appears at the ventral wall of the foregut at the border with the pharyngeal gut. The tracheoesophageal septum formed between the respiratory diverticulum gradually partitions this diverticulum from the dorsal part of the foregut separating these two portions. The foregut divides into ventral and dorsal portions, the respiratory primordium and the

oesophagus respectively.

Initially, the esophagus is short but lengthens rapidly with the descent of heart and lungs

It reaches its final relative length by 7th week. The epithelial lining and glands are endodermal in origin. The epithelium proliferates and partly or completely obliterates the lumen which becomes recanalized by the end of 8th week. Its muscular coat formed by splanchnic mesenchyme is striated in the upper 2/3rds and innervated by the vagus. The muscle coat is smooth in the lower 3rd and is innervated by splanchnic plexus, The development of the esophagus is characterized by lengthening, widening, thickening, and histological changes (9, 12).