OBSTRUCTIVE LUNG DISEASES

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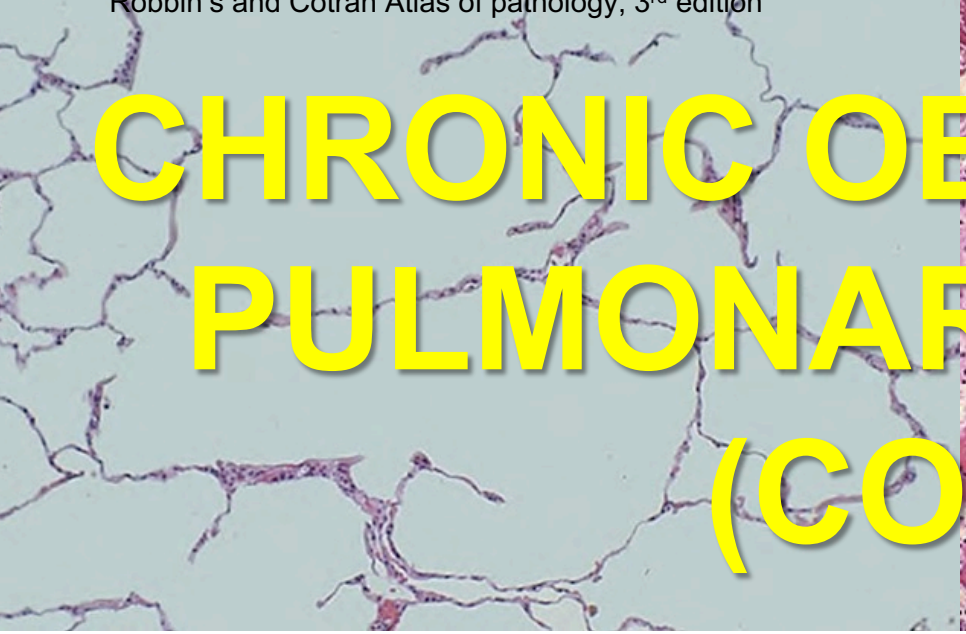
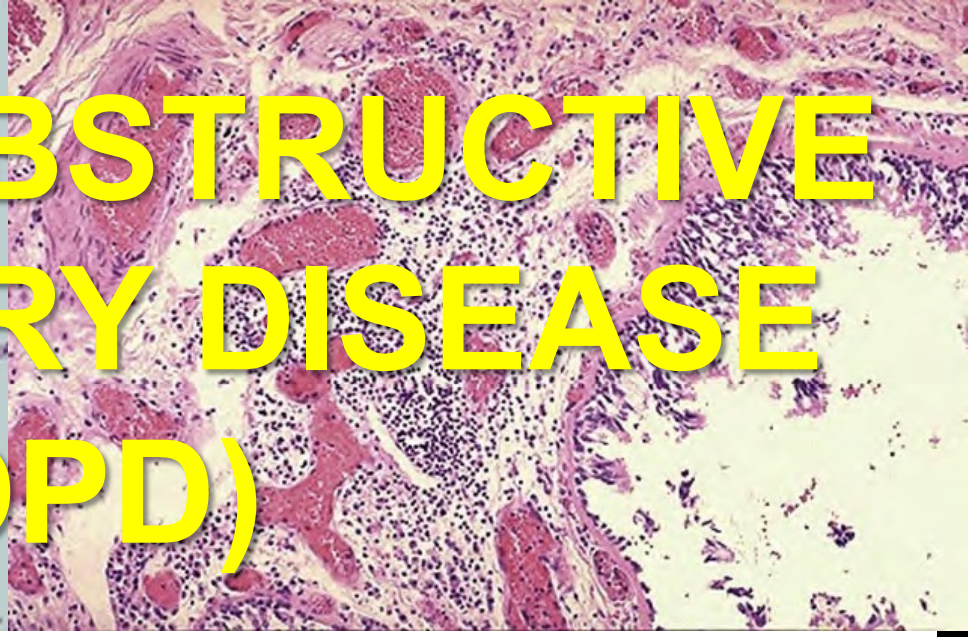
Robbin's and Cotran Atlas of pathology, 3rd edition

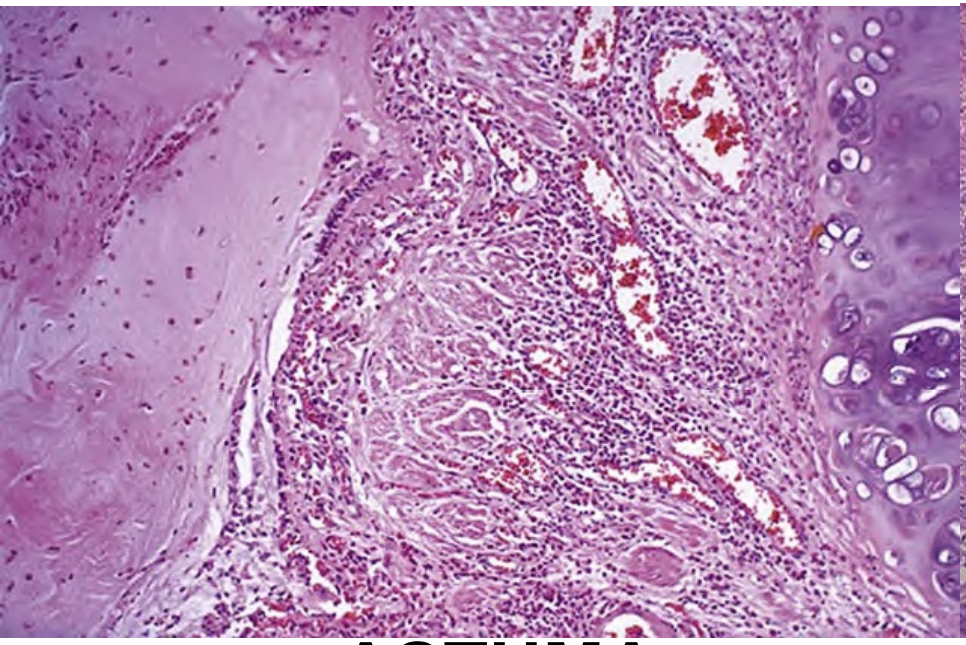
CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)



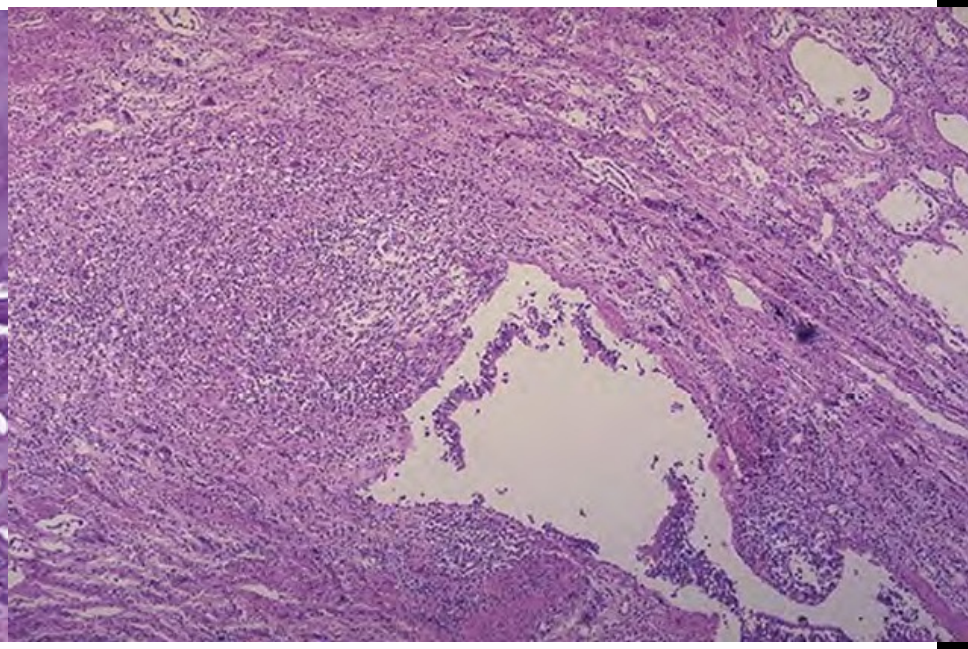
EMPHYSEMA



CHRONIC BRONCHITIS



ASTHMA



BRONCHIECTASIS

It’s hard to get the air OUT

It’s hard to EXHALE

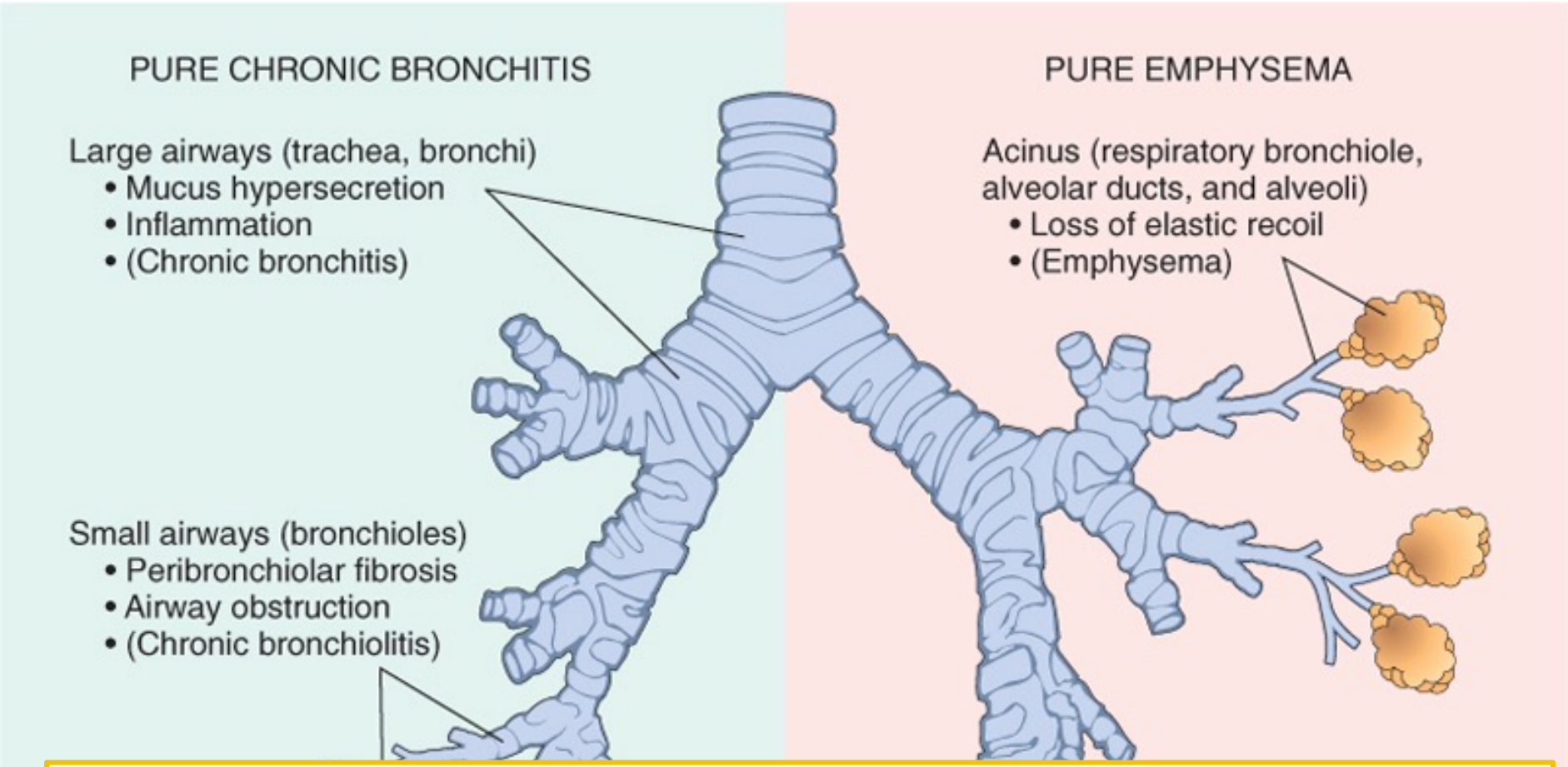
Lungs are hyperinflated

- Total lung capacity: (TLC) is the volume of air in the lungs upon the maximum effort of inspiration.
- lung compliance is a measure of the lung’s ability to stretch or expand

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

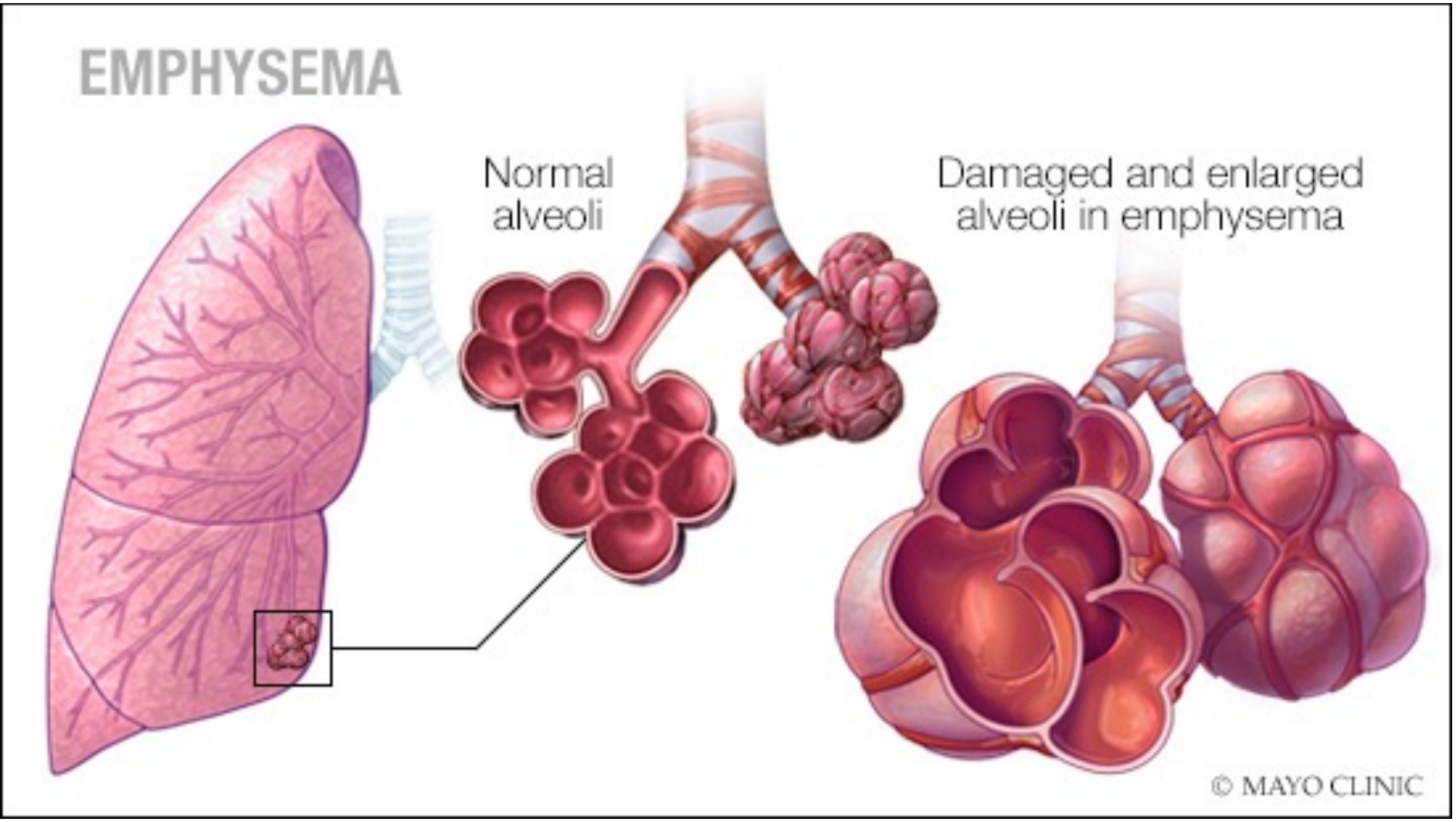
COPD:

- **defined by the WHO as** "a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities caused by exposure to noxious particles or gases."
- 4th leading cause of death in the world
- There is a strong association between heavy cigarette smoking and COPD.
  - 35% to 50% of heavy smokers develop COPD.
  - 80% of COPD is attributable to smoking.



ANATOMIC DISTRIBUTION

DEFINITION


EMPHYSEMA
Normal alveoli
Damaged and enlarged alveoli in emphysema
© MAYO CLINIC

1. EMPHYSEMA

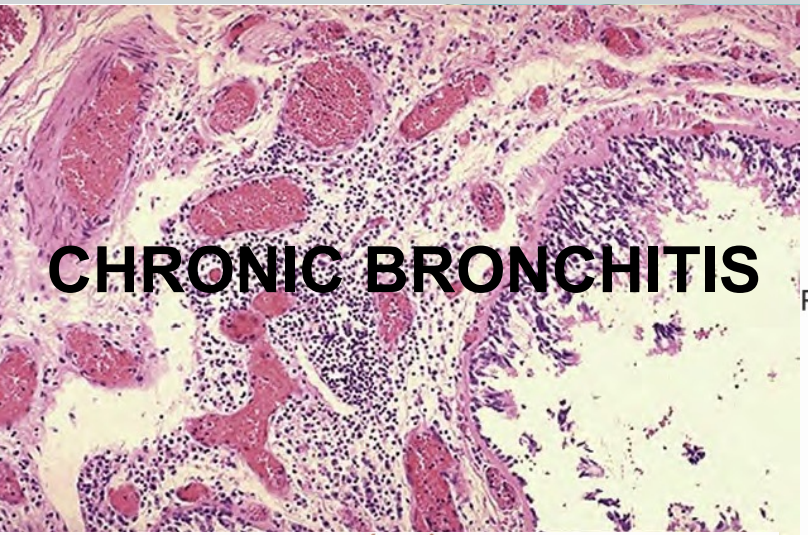
- **Permanent** (irreversible) enlargement of the airspaces **distal** to the terminal bronchioles with destruction of their walls.
- Subtle but functionally important small airway fibrosis → significant contributor to airflow obstruction.
- Classified according to its anatomic distribution:

(1) centriacinar, (2) panacinar, (3) distal acinar, and (4) irregular

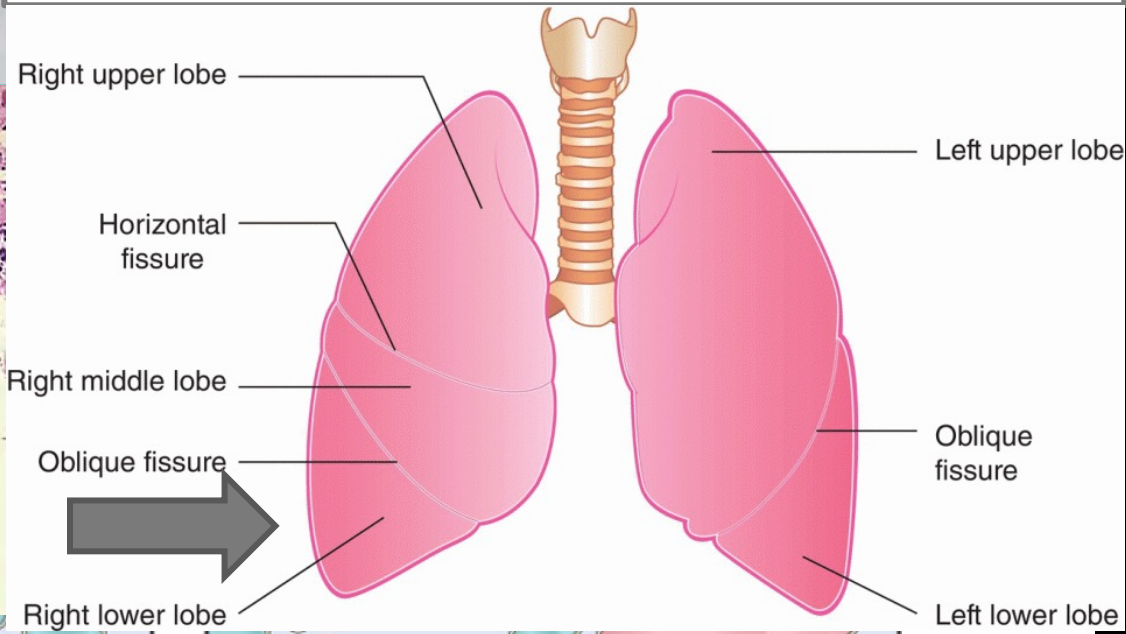
F EMPHYSEMA

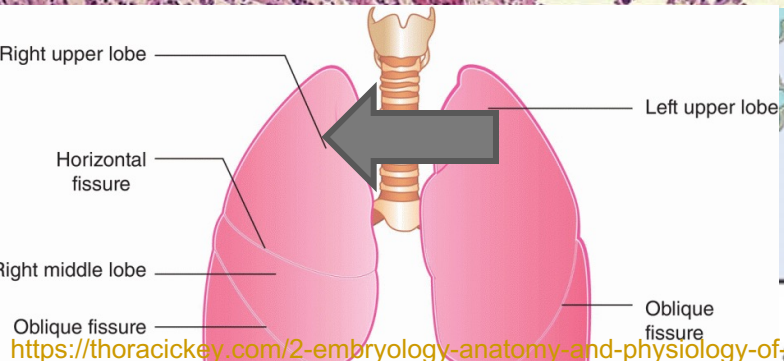
https://health.clevelandclinic.org/even-smoking-just-one-or-two-cigarettes-a-day-increases-your-risk-of-lung-disease/

α_1-antitrypsin deficiency

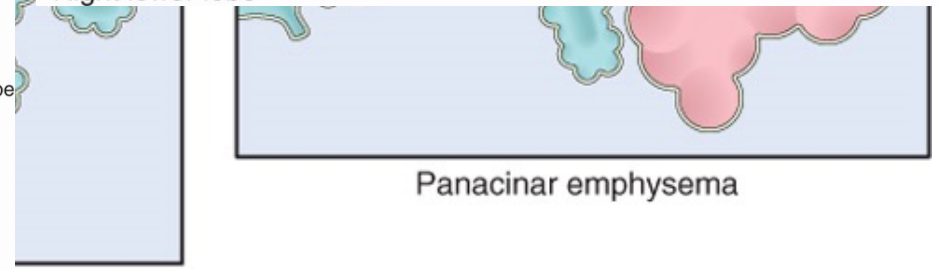


CHRONIC BRONCHITIS





https://thoracickey.com/2-embryology-anatomy-and-physiology-of-the-lung/



al: Robbins Basic Pathology 8e - www.studentconsult.com

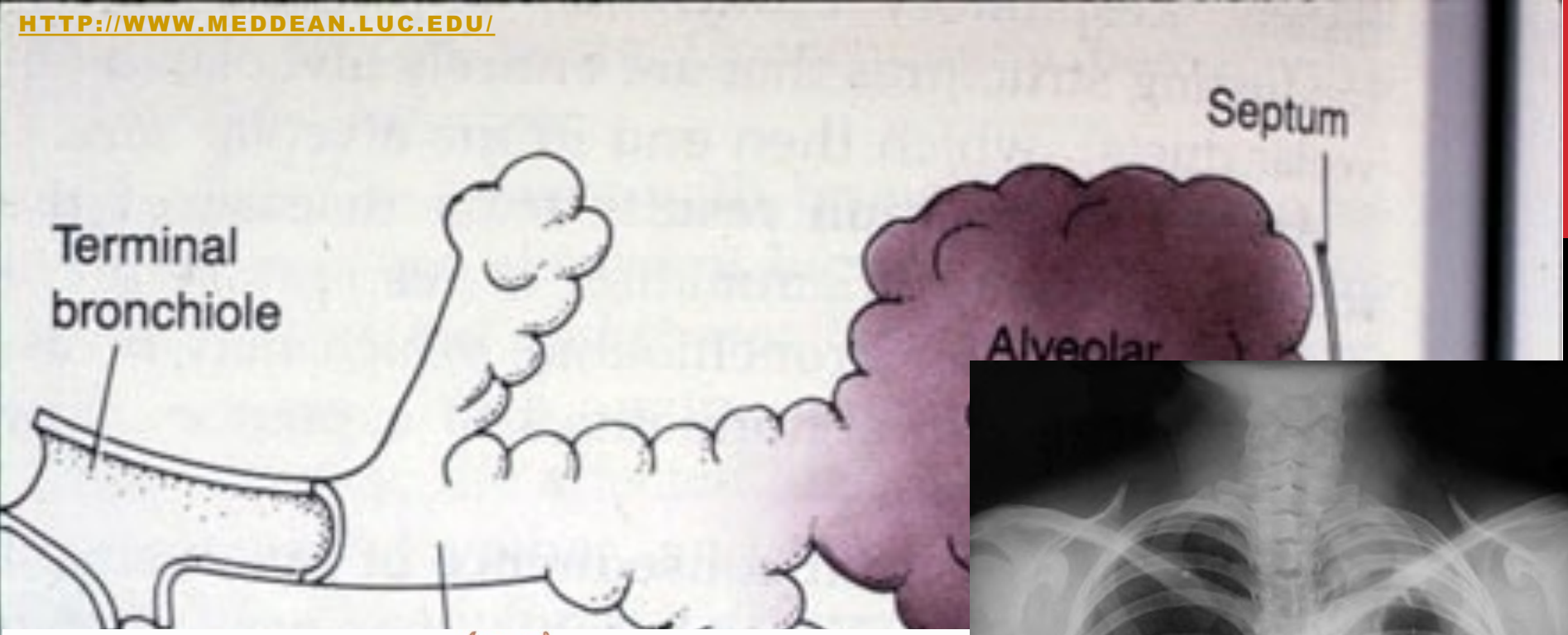
CENTRIACINAR (CENTRILOBULAR) EMPHYSEMA.

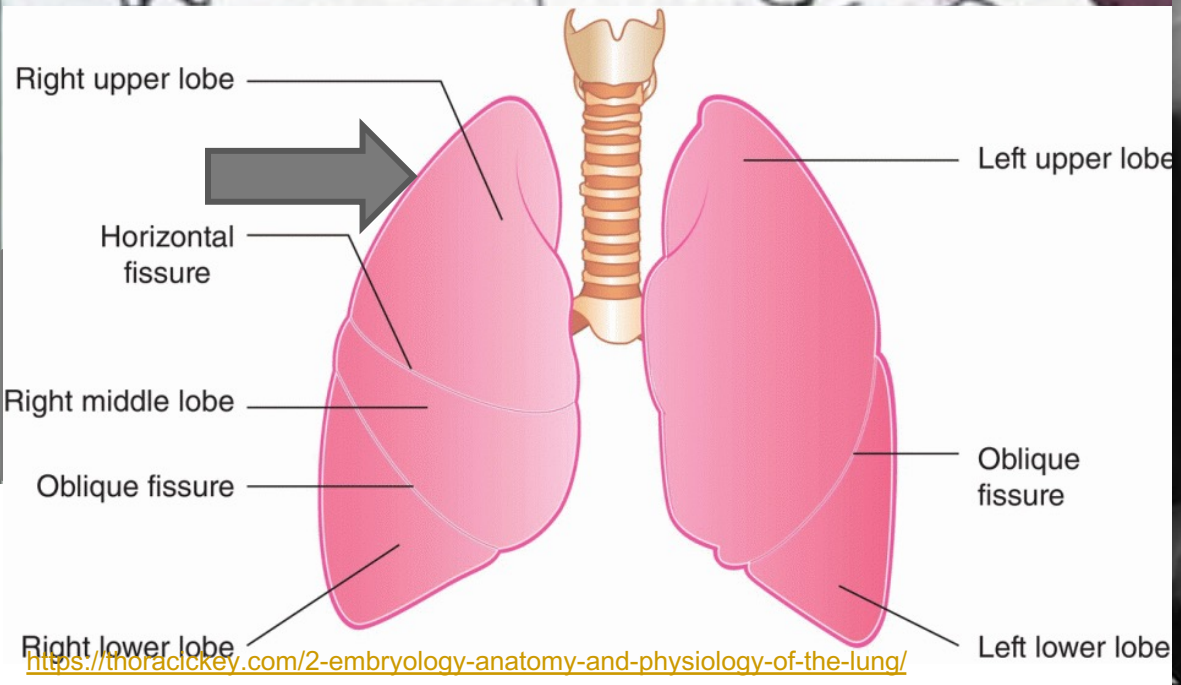
- the most common form > 95% of clinically significant cases.
- It occurs predominantly in heavy smokers with COPD.
- the central or proximal parts of the acini, formed by respiratory bronchioles, are affected, whereas distal alveoli are spared .
- both emphysematous and normal airspaces exist within the same acinus and lobule.
- The lesions are more common and more pronounced in the upper lobes, particularly in the apical segments.
- In severe centriacinar emphysema, the distal acinus may also be involved, making differentiation from panacinar emphysema difficult.

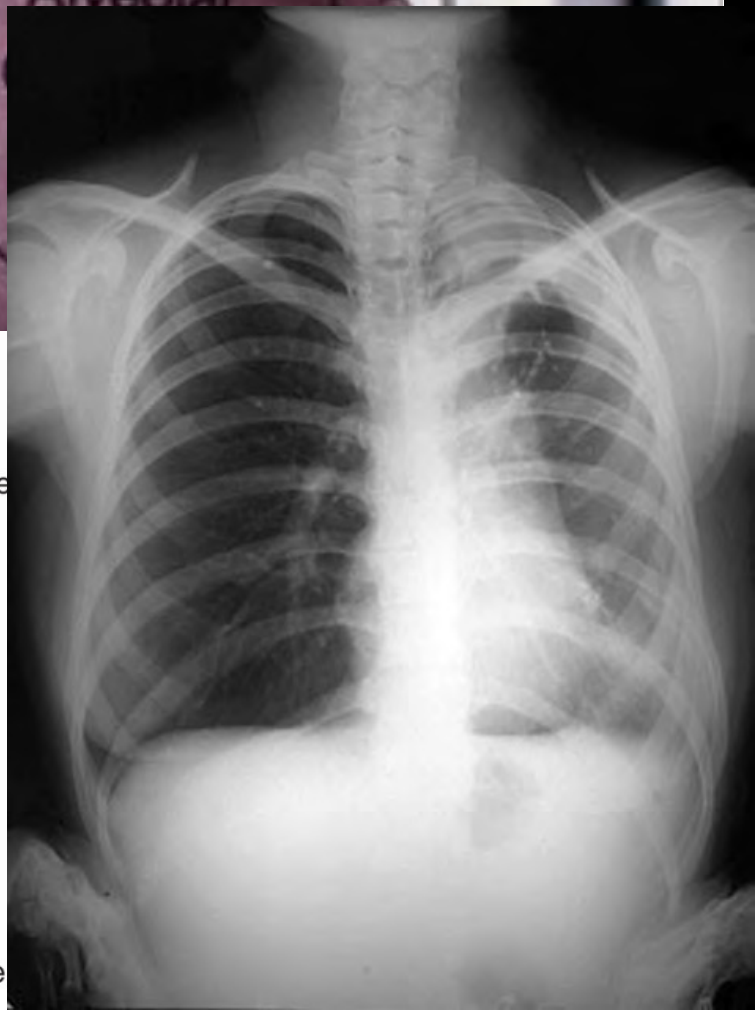
PANACINAR (PANLOBULAR) EMPHYSEMA.

- is associated with α1-antitrypsin deficiency
- exacerbated by smoking.
- the acini are uniformly enlarged from the level of the respiratory
- bronchiole to the terminal blind alveoli
- tends to occur more commonly in the lower zones and in the anterior margins of the lung, and it is usually most severe at the bases.

HTTP://WWW.MEDDEAN.LUC.EDU/







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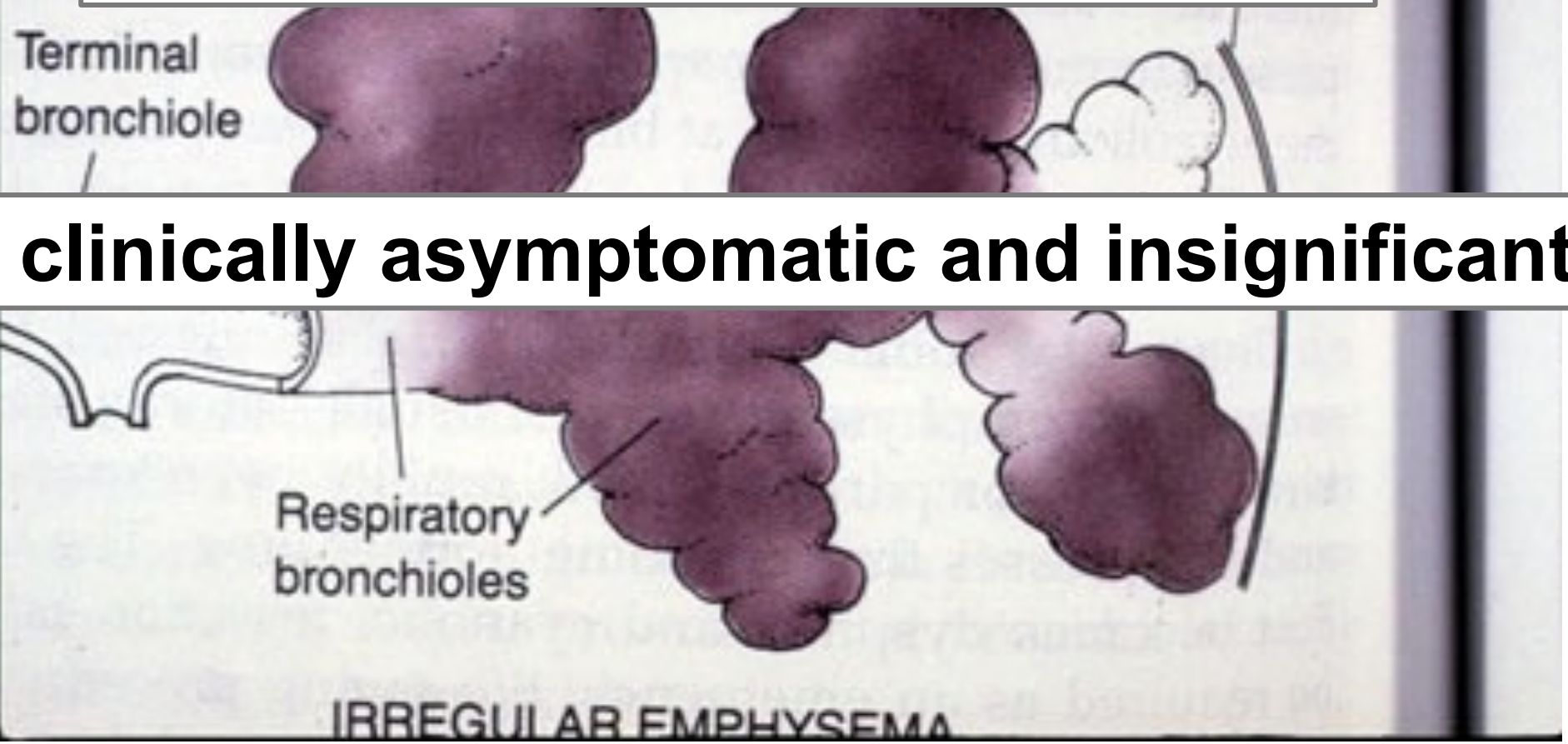
DISTAL ACINAR (PARASEPTAL) EMPHYSEMA.

- underlies many cases of spontaneous pneumothorax in young adults.
- the proximal portion of the acinus is normal, and the distal part is predominantly involved.
- The emphysema is more striking adjacent to the pleura, along the lobular connective tissue septa, and at the margins of the lobules.
- It occurs adjacent to areas of fibrosis, scarring, or atelectasis and is usually
- more severe in the upper half of the lungs.
- The characteristic finding is multiple enlarged airspaces, ranging from < 0.5 cm to >2.0 cm in diameter, which sometimes form cyst-like structures.

Almost invariably associated with scarring



clinically asymptomatic and insignificant

Irregular emphysema

(Airspace enlargement with fibrosis)

Airspace enlargement with fibrosis (irregular emphysema).

- the acinus is irregularly involved,
- almost invariably associated with scarring.
- occurs in small foci and is clinically insignificant.

PATHOGENESIS

infections

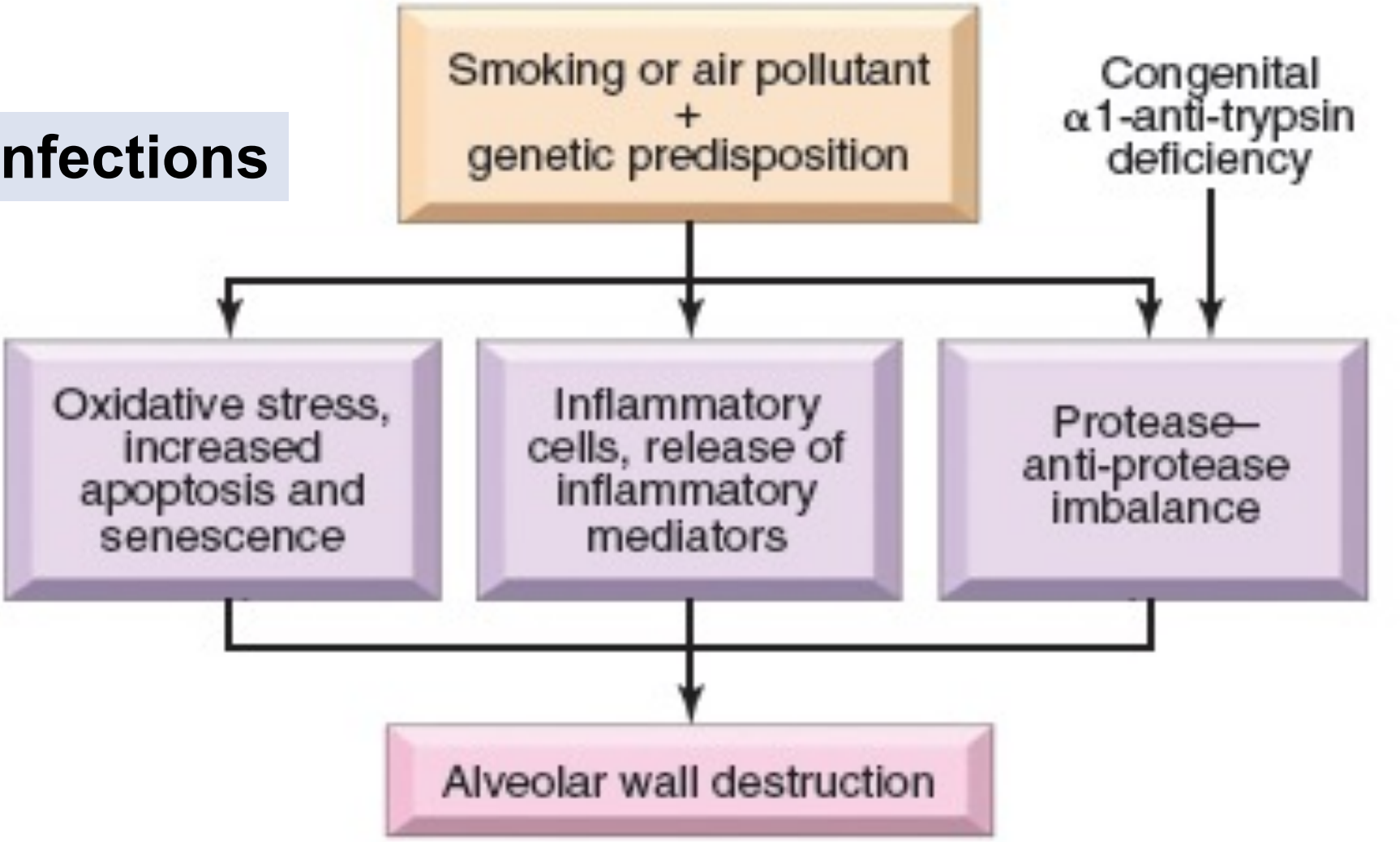


Fig. 13.6 Pathogenesis of emphysema. See text for details.

,ROBBINS BASIC PATHOLOGY, 10TH EDITION

PATHOGENESIS

Clinically significant emphysema is largely confined to smokers and to patients with α1-antitrypsin deficiency,

1- **Toxic injury and inflammation:**

- Inhaled cigarette smoke and other noxious particles→ damage respiratory epithelium and cause inflammation
- leukotriene B4, interleukin [IL]-8, TNF are increased .
- These mediators are released by resident epithelial cells and macrophages and attract inflammatory cells from the circulation and amplify the inflammatory process

2- Protease-antiprotease imbalance.

- Several proteases are released from the inflammatory cells and epithelial cells that break down connective tissue components.
- In patients who develop emphysema, there is a relative deficiency of protective antiproteases
- patients with a genetic deficiency of the antiprotease α1-antitrypsin have a markedly enhanced tendency to develop emphysema that is compounded by smoking.
- About 1% of all patients with emphysema have this defect.
- α1-Antitrypsin, normally present in serum, tissue fluids, and macrophages, is a major inhibitor of proteases (particularly elastase) secreted by neutrophils during inflammation.

- any injury like that induced by smoking → increases the activation and influx of neutrophils into the lung → local release of proteases(in the absence of α1-antitrypsin activity) →excessive digestion of elastic tissue →emphysema.

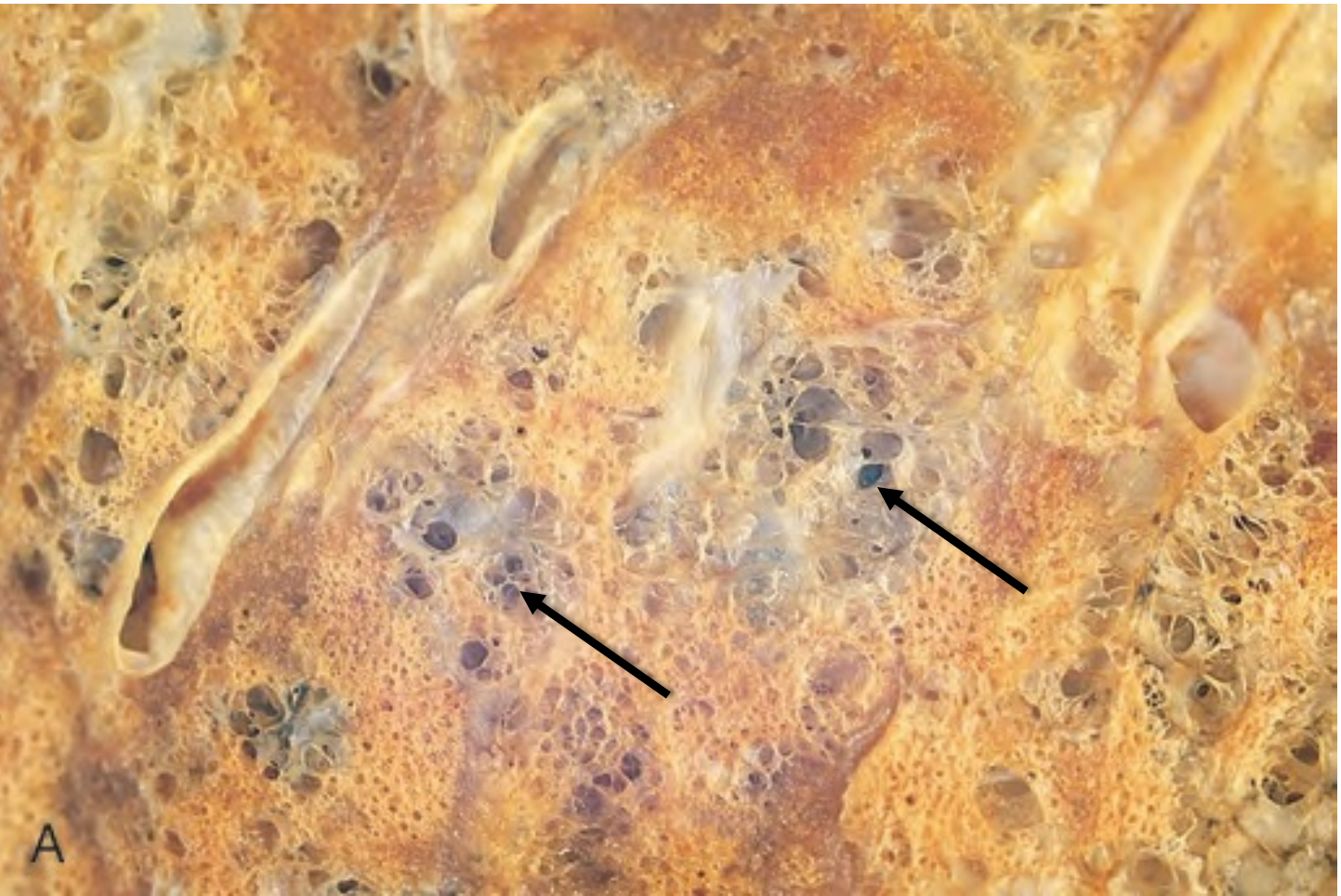
3- <u>Oxidative stress.</u>

- Substances in tobacco smoke, alveolar damage, and inflammatory cells all produce oxidants → tissue damage, endothelial dysfunction, and inflammation.

- • **Infection.**
- It's not an initiating factor in the tissue destruction
- But bacterial and/or viral infections may acutely exacerbate existing disease.

MORPHOLOGY

Macroscopic: **Advanced emphysema→ voluminous lungs**



Centriacinar emphysema
Central areas show marked emphysematous damage (arrows) surrounded by relatively spared alveolar spaces.

Panacinar emphysema involving the entire pulmonary lobule.

- **Microscopic examination of the lung:**
- abnormally large alveoli are separated by thin septa with only focal centriacinar fibrosis.

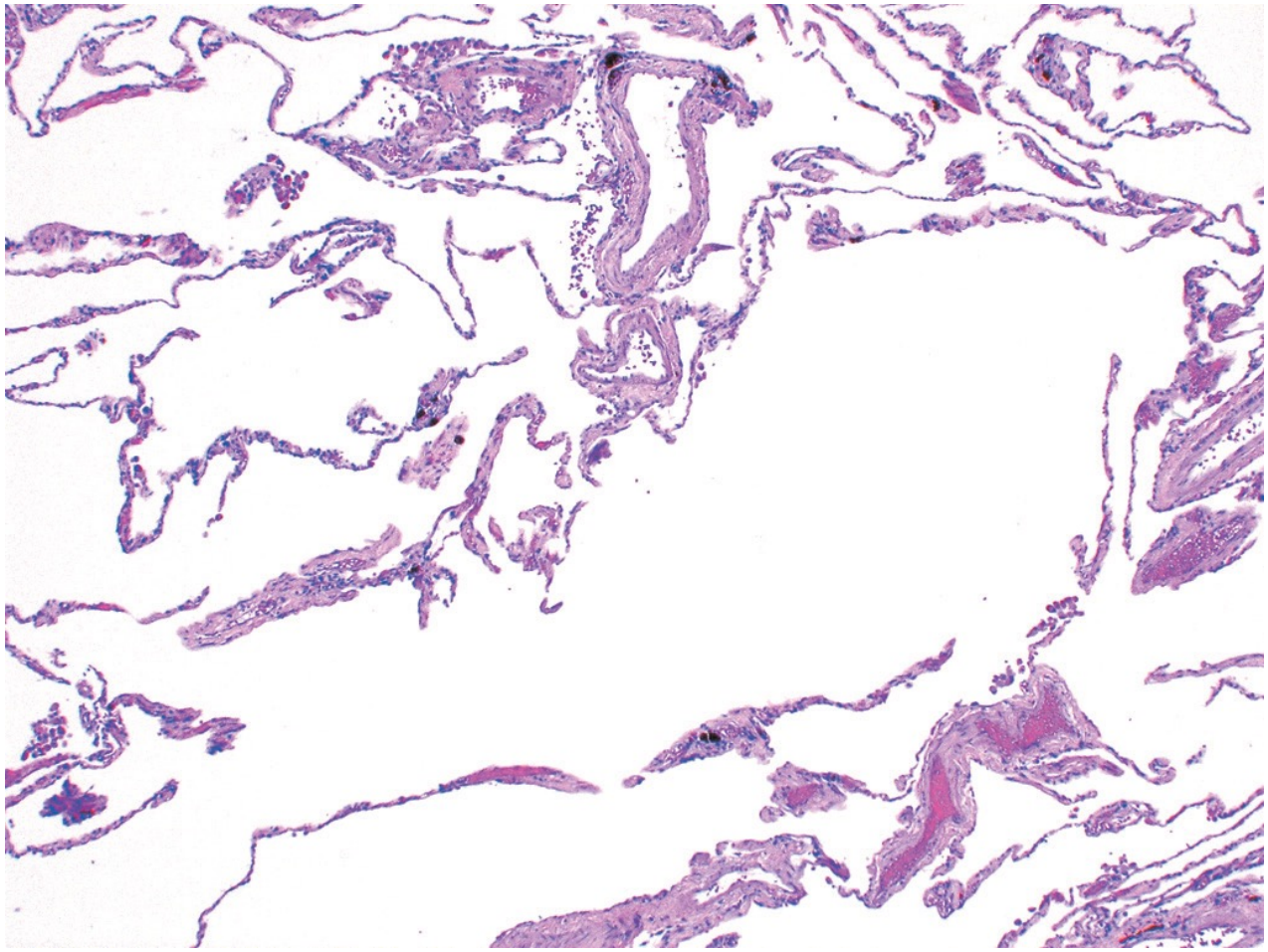


Figure 13.5 ROBBINS BASIC PATHOLOGY, 10TH EDITION

EMPHYSEMA, PRESENTATION:

- **Symptoms do not appear until at least 1/3 of the functioning pulmonary parenchyma is damaged**
- **Dyspnea: appears first, beginning insidiously but progressing steadily**
- **Weight loss; common**
- **barrel-chested**

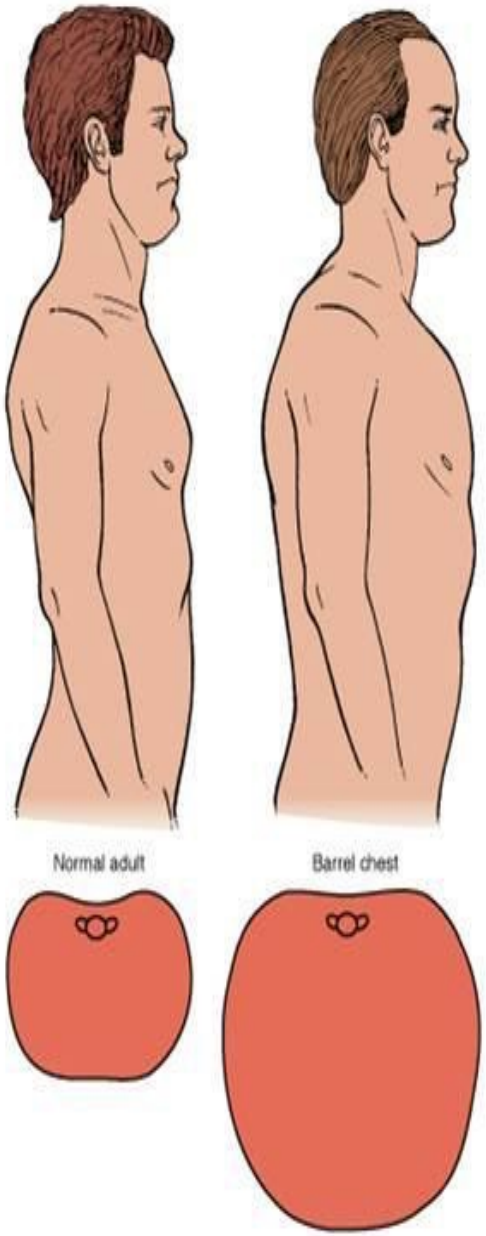


Figure 25-31 Profile and anteroposterior diameter of normal adult chest and barrel chest.

https://ratedmedicine.wordpress.com/barrel-chest/

- prolonged expiration
- sitting forward in a hunched-over Position
- breathes through pursed lips
- Hyperventilation
- adequate oxygenation of Hemoglobin especially at rest and prominent dyspnea

→ "pink puffers."

- Cough and wheezing if Coexistent asthma & chronic bronchitis.

https://www.visualizepicture.com/c/emphysema-mnemonic_fWuJVQlShnPF2GEM1xUt3lRVdSQhKF4s22ZDS23ni8Q/

CONDITIONS RELATED TO EMPHYSEMA

These conditions are associated with lung overinflation or focal emphysematous change

- **Compensatory hyperinflation:**
  - Compensatory dilation of alveoli in response to loss of lung substance elsewhere.

Example: hyper-expansion of residual lung parenchyma following surgical removal of a diseased lung

- **Obstructive overinflation:**

  - Lung expands because air is trapped within it.

  - A common cause is subtotal obstruction by a tumor or foreign object.

  - Can be Life-threatening emergency if distends sufficiently to compress the remaining normal lung.

- **Obstructive overinflation:**

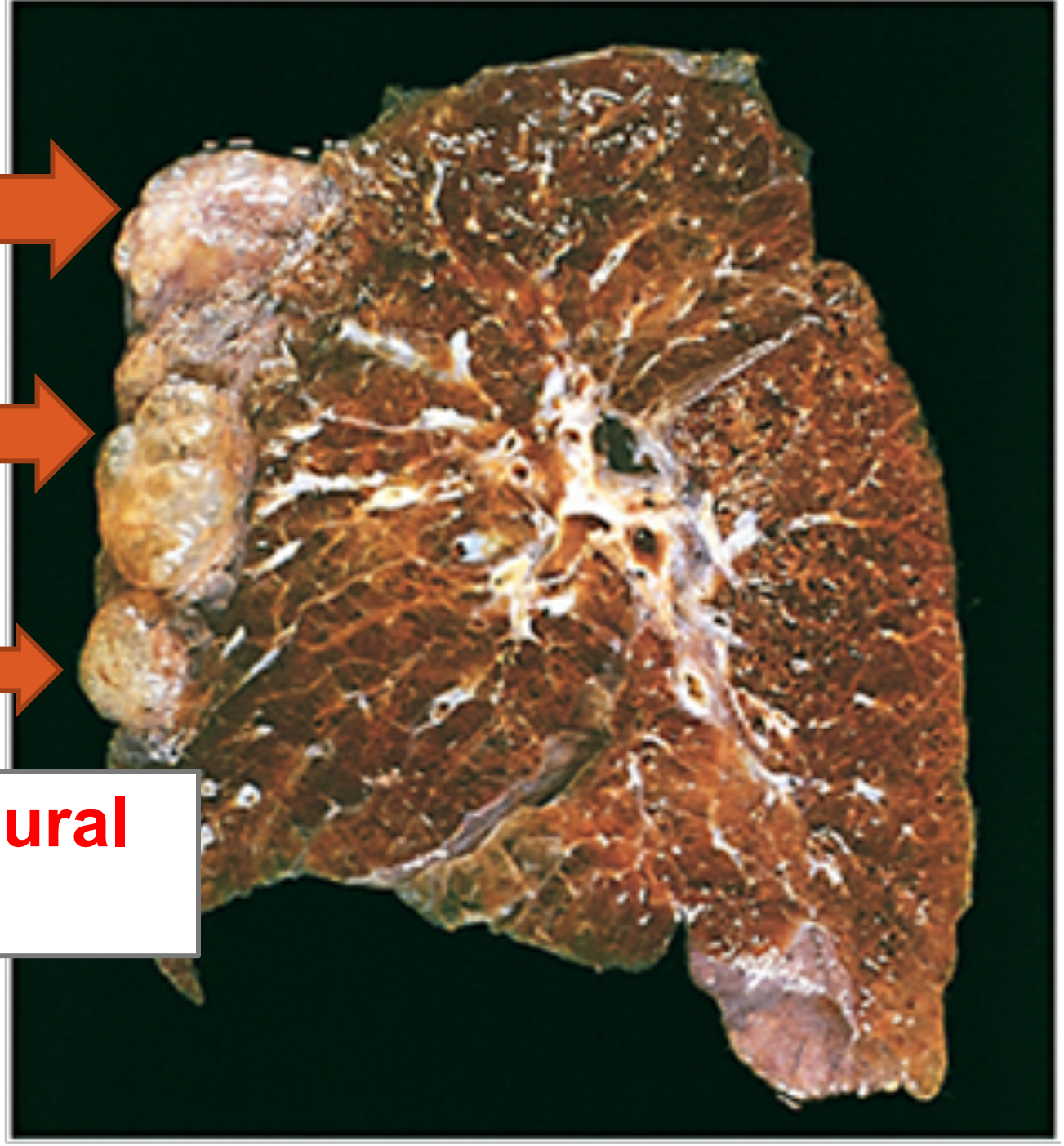
Overinflation in obstructive lesions occurs either because:

1. the obstructive agent acts as ball valve, allowing air to enter on inspiration while preventing its exodus on expiration

or

2. because collaterals bring in air behind the obstruction. (collaterals consist of the pores of Kohn and other direct accessory bronchioloalveolar connections (the canals of Lambert).

- **Bullous emphysema:**
  - Any form of emphysema, Most are subpleural
  - Large subpleural blebs or bullae
  - Pneumothorax if rupture



Subpleural bullae

Robbins and Cotran pathologic basis of disease, 9th edition

- **interstitial emphysema:**

➢ Due to entrance of air into the connective tissue stroma of the lung, mediastinum, or subcutaneous tissue

OUTCOME:

- Decreased capillary bed area due to:
  - ✓ Destruction of alveolar walls
  - ✓ Compression of the respiratory bronchioles and lung vasculature by the enlarged airspaces (bullae and blebs) in advanced disease.
  - ✓ Inflammatory changes in small airways
- Decreased capillary bed area→ hypoxia

- Hypoxia-induced pulmonary vascular spasm →gradual development of secondary pulmonary hypertension → in 20-30% right-sided congestive heart failure (cor pulmonale).

PROGNOSIS:

- Poor prognosis is associated with development of secondary pulmonary hypertension →cor pulmonale and congestive heart failure
- Death from emphysema is related to either respiratory failure or right-sided heart failure.

II. CHRONIC BRONCHITIS

Defined clinically as Persistent productive cough for AT LEAST 3 consecutive months in AT LEAST 2 consecutive years in the absence of any other identifiable cause.

- 90% **cigarette smokers**; air pollutants also contribute.

- chronic bronchitis is one end of the spectrum of COPD, with emphysema being the other.

- When chronic bronchitis persists for years:
  - decline in lung function, leading to cor pulmonale
  - cause atypical metaplasia and dysplasia of the respiratory epithelium, providing a rich soil for cancerous transformation.

- In early stages airflow is not obstructed.

- May coexist with hyper-responsive airways with intermittent bronchospasm and wheezing→ asthmatic bronchitis

PATHOGENESIS

The primary factor in the genesis of chronic bronchitis is exposure to irritating inhaled substances such as tobacco smoke (90%of pt) and dust from grain, cotton, and silica.

- **hypersecretion of mucus**:
  - The earliest feature of chronic bronchitis
  - beginning in the large airways.
  - cigarette smoking, other air pollutants:
    - hypertrophy of submucosal glands in the trachea and bronchi
    - increase in goblet cells in the epithelial surfaces of smaller bronchi and bronchioles

- **Acquired cystic fibrosis transmembrane conductance regulator (CFTR) dysfunction.**

✓ smoking leads to acquired CFTR dysfunction→ secretion of abnormal dehydrated mucus→ increases the severity of chronic bronchitis.

- **Inflammation.**
  - ✓ Due to the Inhalants
  - ✓ acute and chronic inflammatory responses involving neutrophils, lymphocytes, and macrophages without eosinophils
  - ✓ Long-standing inflammation and fibrosis involving small airways (small bronchi and bronchioles, less than 2 to 3 mm in diameter) →chronic airway obstruction.

- **Infection.**
  - ✓ Infection does not initiate chronic bronchitis but is probably significant in maintaining it
  - ✓ Produces acute exacerbations.

- **airflow obstruction in chronic bronchitis** results from:

1. **Small airway disease**

chronic bronchiolitis: results in early and **mild airflow obstruction**. Induced by mucus plugging of the bronchiolar lumen, inflammation, and bronchiolar wall fibrosis

2. **Coexistent emphysema**: The cause of **significant airflow obstruction.**

MORPHOLOGY

Macroscopic:

- **Mucosal lining is hyperemic and swollen**

- **Layers of mucinous or mucopurulent secretions**

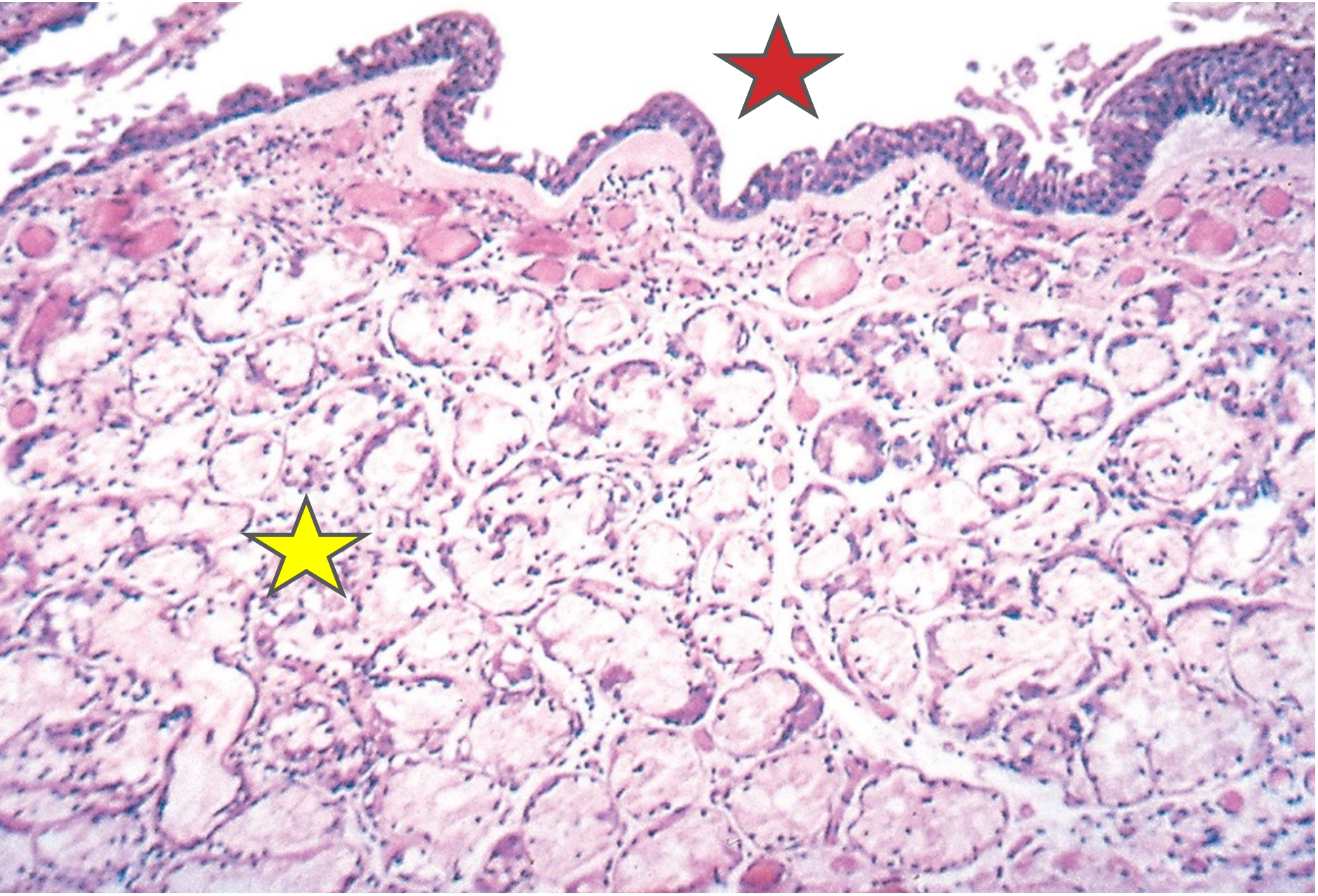


Fig. 13.9 Chronic bronchitis. The lumen of the bronchus is above. Note the marked thickening of the mucous gland layer (approximately twice-normal) and squamous metaplasia of lung epithelium. *(From the Teaching Collection of the Department of Pathology, University of Texas, Southwestern Medical School, Dallas, Texas.)*

MICROSCOPIC:

- The characteristic features are:

➢ mild chronic inflammation of the airways (predominantly lymphocytes)

➢ Enlargement (hyperplasia) of the mucus-secreting glands of the trachea and bronchi

➢ squamous metaplasia and dysplasia of the bronchial epithelium

- Changes of emphysema often co-exist

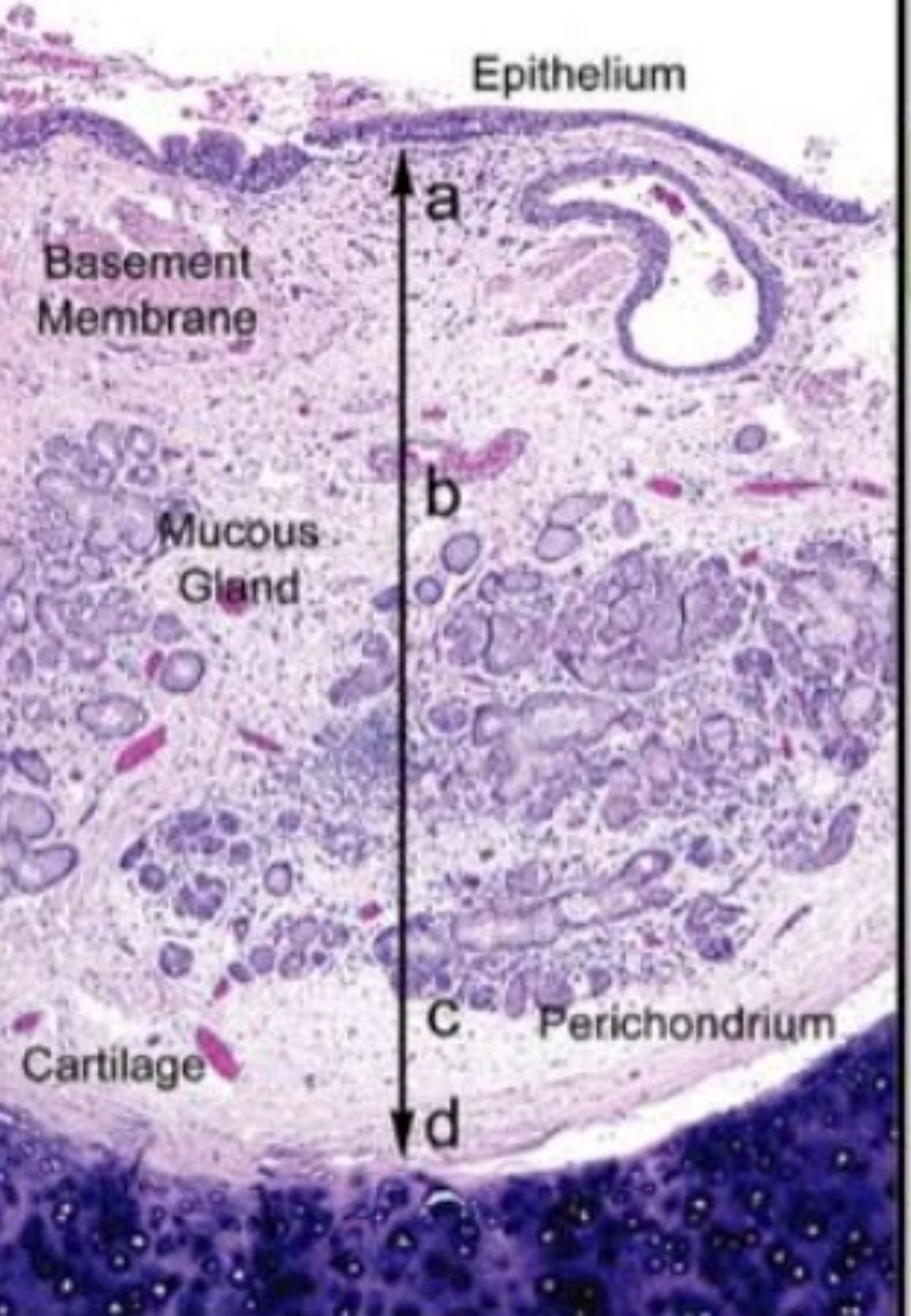
MICROSCOPIC:

- Chronic bronchiolitis (small airway disease) characterized by marked narrowing of the bronchioles due to goblet cell metaplasia, mucous plugging, inflammation, and submucosal fibrosis

- Bronchiolitis obliterans: happens in severe cases when there is complete obliteration of the lumen due to fibrosis

MICROSCOPIC:

- The increase in the size of mucus glands (hyperplasia) is assessed by the **(Reid index).**
- **Reid index:** is the ratio of the thickness of the mucous gland layer to the thickness of the wall between the epithelium and the cartilage
- normal Reid index is 0.4
- **Reid index is increased in chronic bronchitis**, usually in proportion to the severity and duration of the disease.



Reid index = bc/ad

Max. thickness of bronchial mucous glands internal to cartilage (b to c)

Bronchial wall thickness (a to d)

CLINICAL FEATURES:

- The cardinal symptom is persistent cough with production of sparse sputum
- For many years no respiratory functional impairment is present, but eventually dyspnea on exertion develops.
- Long-standing severe chronic bronchitis commonly leads to cor pulmonale and cardiac failure.
- chronic bronchitis and COPD patients show frequent exacerbations, rapid disease progression, and poorer outcomes than emphysema alone

OUTCOME:

- .
- Progressive disease is marked by the development of pulmonary hypertension, cardiac failure, recurrent infections; and ultimately respiratory failure
- Death may also result from further impairment of respiratory function due to superimposed acute infections.

THE OTHER END OF THE SPECTRUM: EMPHYSEMA WITH PRONOUNCED CHRONIC BRONCHITIS AND A HISTORY OF RECURRENT INFECTIONS.

- **Less dyspnea**
- absence of increased respiratory drive → **hypoxic and cyanotic.**
- For unclear reasons, patients with chronic bronchitis tend to be **obese**

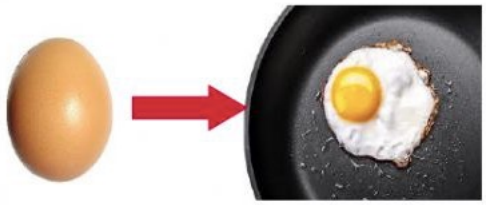
hence the designation **"blue bloaters"**

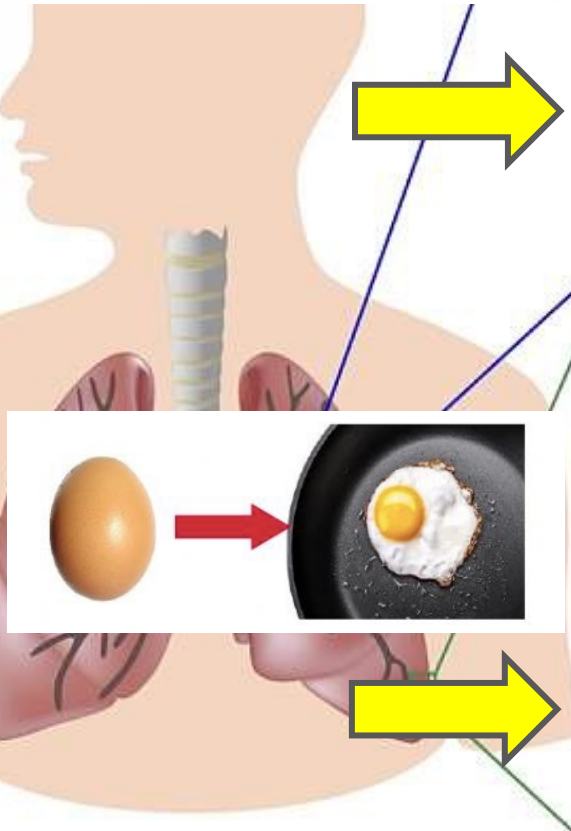
→carbon dioxide retention, hypoxia, and cyanosis

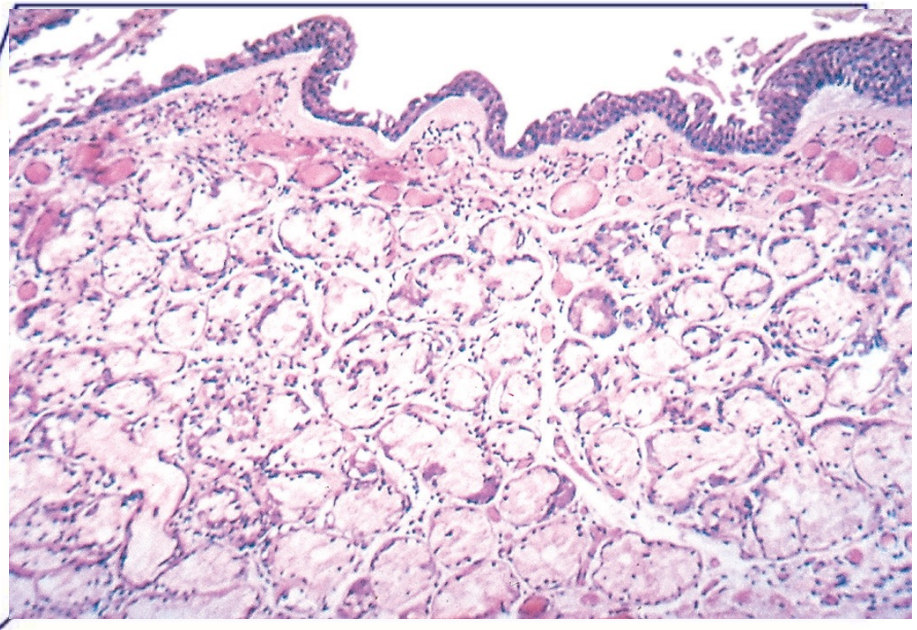
It's time to compare

https://meandmythrees.blogspot.com/2018/04/lets-compare.html

Chronic Obstructive Pulmonary Disease (COPD)







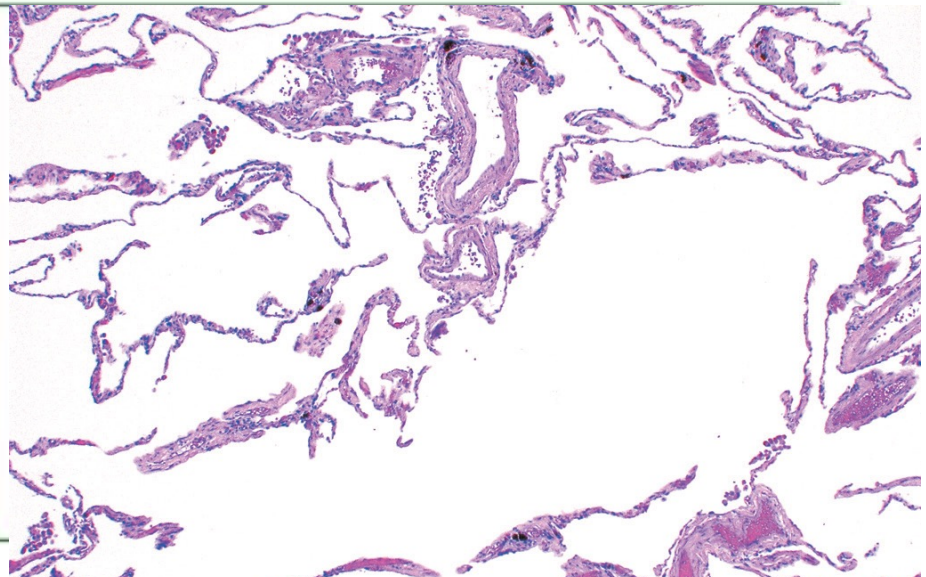


Table 15-4 Emphysema and Chronic Bronchitis

	Predominant Bronchitis	Predominant Emphysema
Age (yr)	40-45	50-75
Dyspnea	Mild; late	Severe; early
Cough	Early; copious sputum	Late; scanty sputum
Infections	Common	Occasional
Respiratory insufficiency	Repeated	Terminal
Cor pulmonale	Common	Rare; terminal
Airway resistance	Increased	Normal or slightly increased
Elastic recoil	Normal	Low
Chest radiograph	Prominent vessels; large heart	Hyperinflation; small heart
Appearance	Blue bloater	Pink puffer

THANK YOU!