Respiratory system – Pathology (Asthma)

Dr. Omar Hamdan

Gastrointestinal and liver pathologist
Mutah University
School of Medicine-Pathology Department
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ASTHMA

- Chronic inflammatory disorder of the airways
- Causes recurrent episodes of wheezing, Dyspnea, chest tightness and cough particularly at night and/or early in the morning

https://pixy.org/1266846/

- **its hallmarks are:**

a) Intermittent and reversible airway obstruction (bronchospasm)

b) Chronic bronchial inflammation with eosinophils,

c) Bronchial smooth muscle cell hypertrophy and hyper- reactivity.

d) increased mucus secretion.

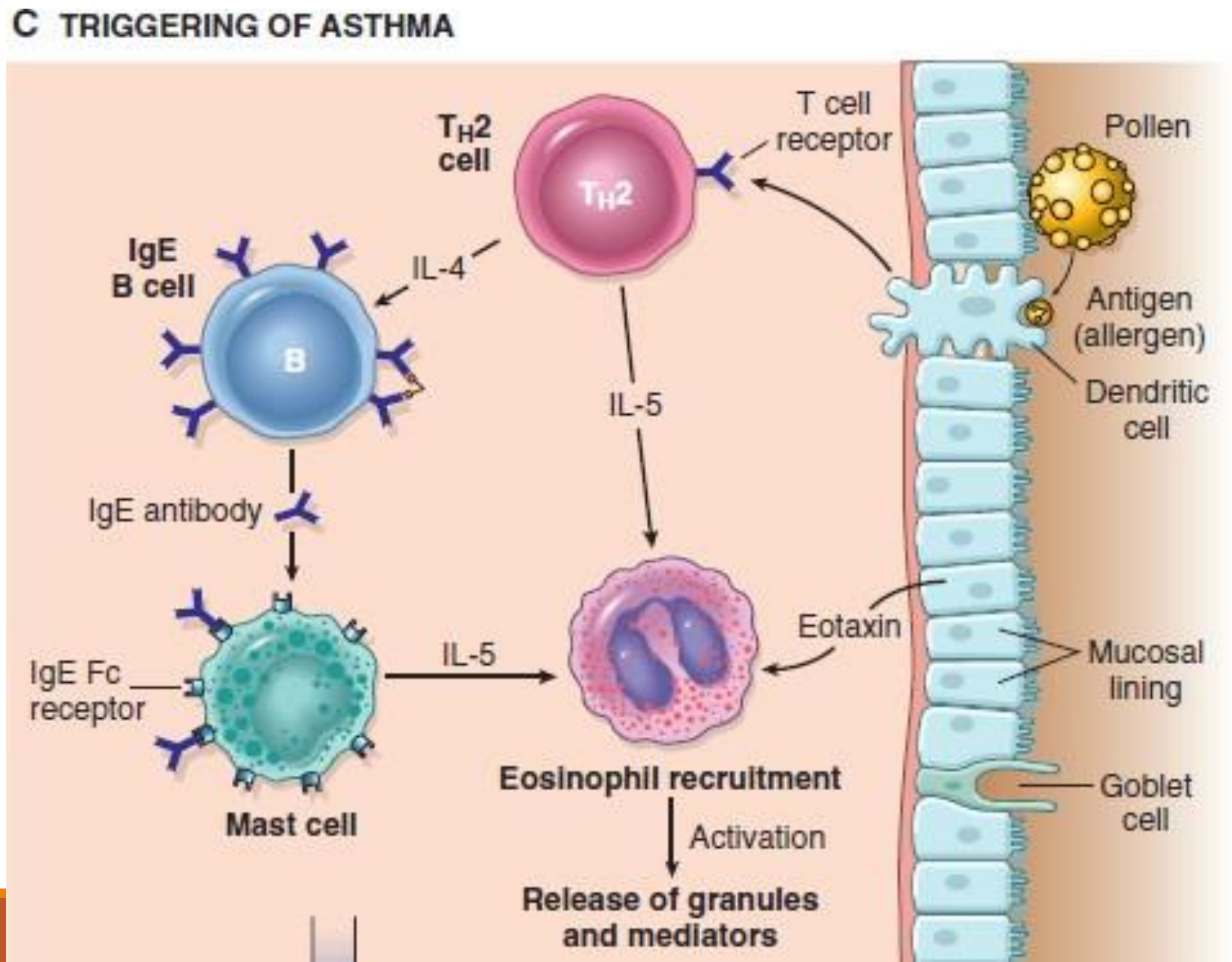
MAJOR FACTORS:

- ✓ Genetic predisposition to type I hypersensitivity (atopy)
- ✓ Acute and chronic airway inflammation
- ✓ Bronchial hyperresponsiveness to a variety of stimuli

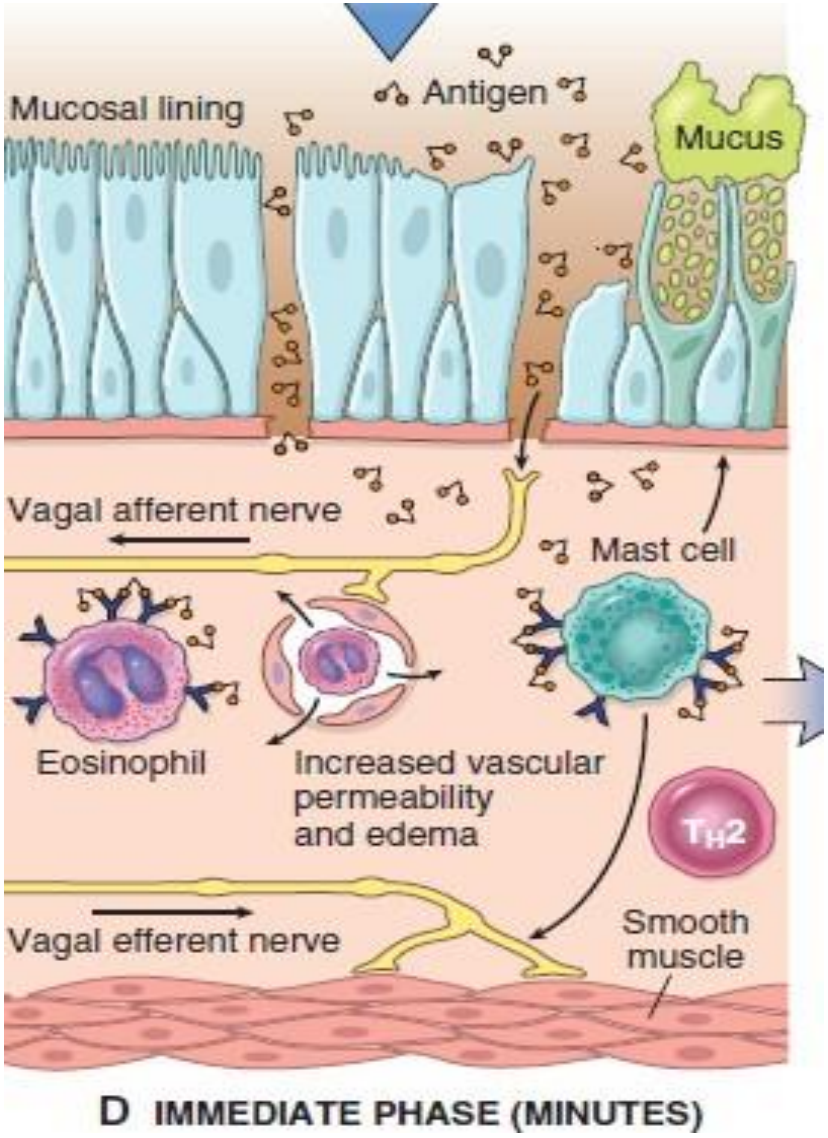
- **CAN BE TRIGGERED BY:**

- ✓ respiratory infections (especially viral)
- ✓ airborne irritants (smoke, fumes)
- ✓ cold air
- ✓ Stress
- ✓ exercise

PATHOGENESIS


C TRIGGERING OF ASTHMA
T_H2 cell
T_H2
T cell receptor
Pollen
IgE B cell
B
IL-4
Antigen (allergen)
Dendritic cell
IL-5
IgE antibody
Eotaxin
IgE Fc receptor
IL-5
Mucosal lining
Eosinophil recruitment
Goblet cell
Activation
Mast cell
Release of granules and mediators

- **The early-phase reaction is dominated by:**
  - ✓ bronchoconstriction
  - ✓ increased mucus production
  - ✓ vasodilation.



- on re-exposure to antigen (ag) ➡ immediate reaction

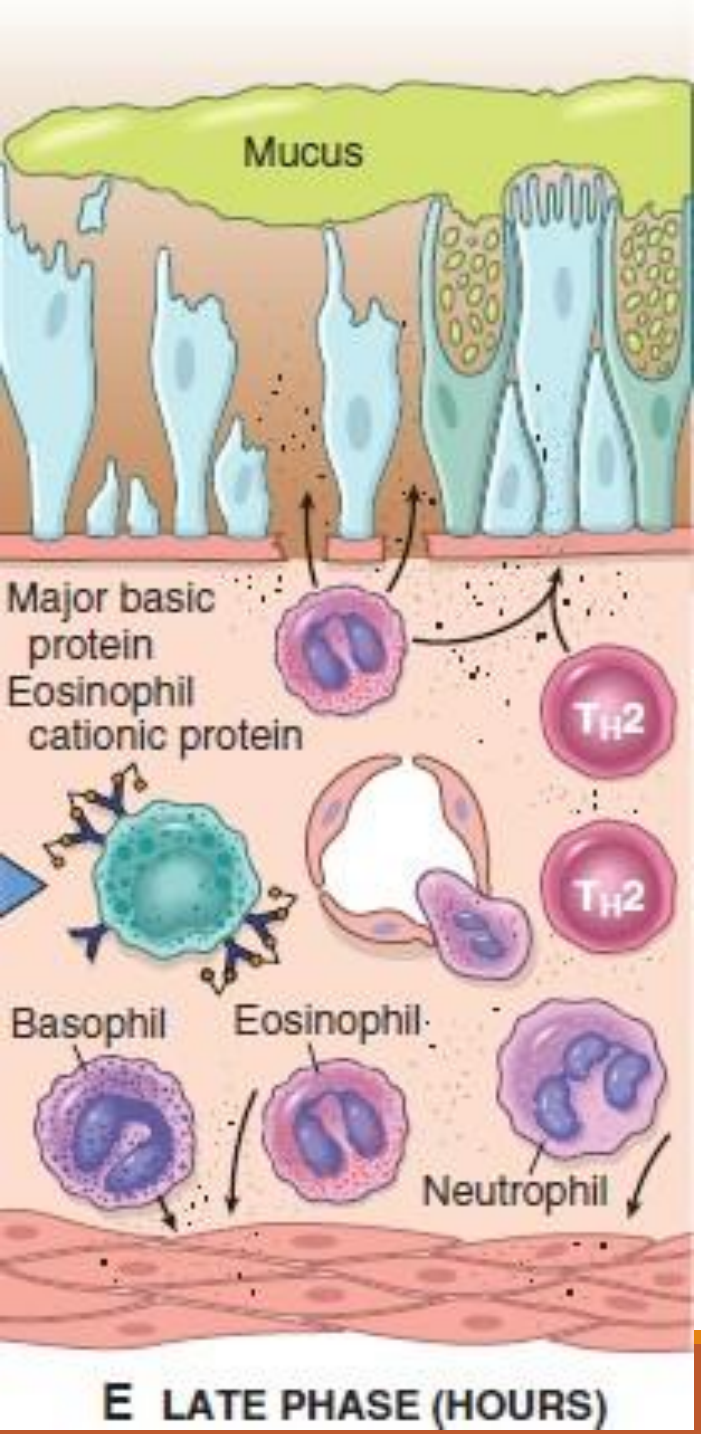
- triggered by Ag-induced cross-linking of IgE bound to Fc receptors on mast cells.

- mast cells release preformed mediators that directly and via neuronal reflexes induce:

1. bronchospasm
2. increased vascular permeability
3. mucus production
4. recruitment of leukocytes

- **<u>The late-phase reaction is inflammatory:</u>**

  Inflammatory mediators ➡ stimulate epithelial cells to produce chemokines (eotaxin) ➡ recruit TH2 cells, eosinophils, and other leukocytes ➡ amplifying the inflammatory reaction.



Leukocytes recruited to the site of reaction (neutrophils, eosinophils, and basophils; lymphocytes and monocytes) ➡ release mediators ➡ initiate the late phase of asthma.

eosinophils release major basic protein and eosinophil cationic protein that cause damage to the epithelium

- Repeated bouts of inflammation lead to structural changes in
- the bronchial wall ⇨ called airway remodeling, including:

✓ hypertrophy of bronchial smooth muscle

✓ hypertrophy of Mucus glands

✓ increased vascularity

✓ deposition of subepithelial collagen

increased number of mucus-secreting goblet cells

hypertrophy of submucosal glands

accumulation of mucus in the bronchial lumen

thickened basement membrane

intense chronic inflammation

hypertrophy and hyperplasia of smooth muscle cells

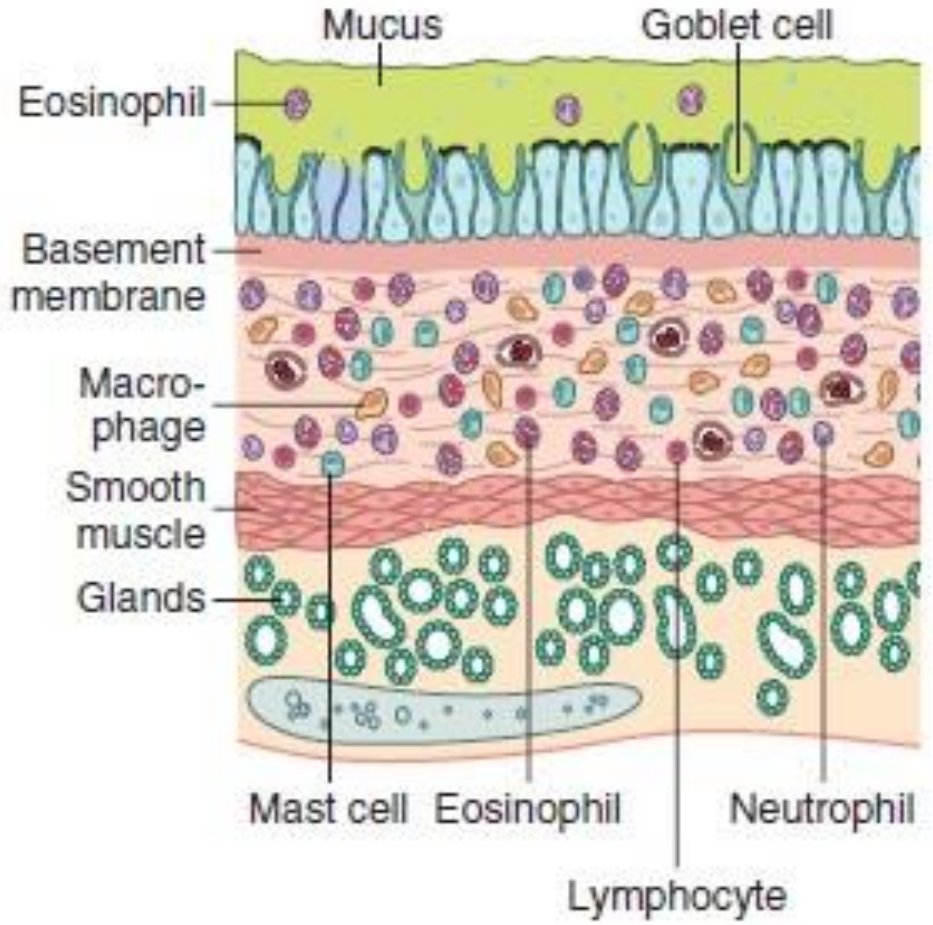
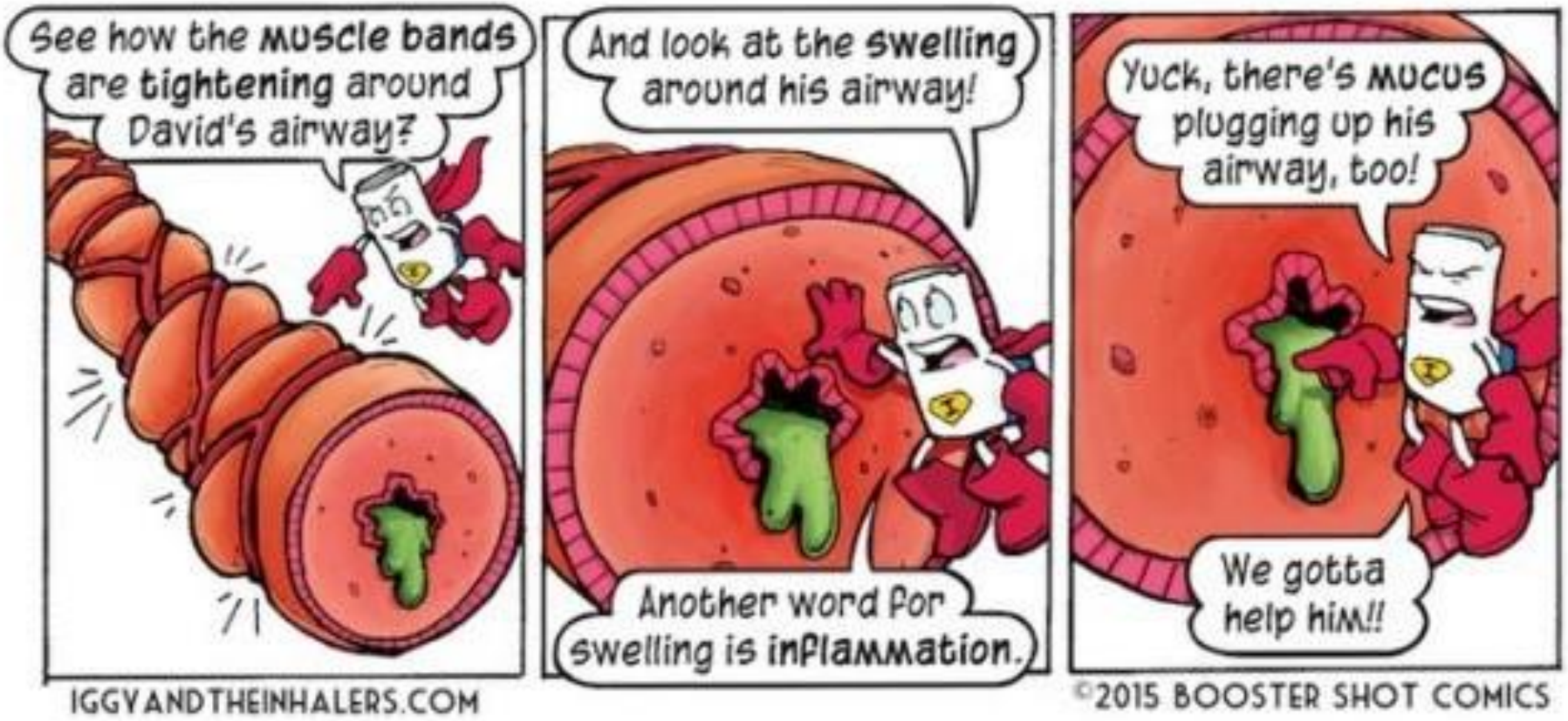


Figure 13.5 ROBBINS BASIC PATHOLOGY, 10TH EDITION



https://anonhq.com/doctor-creates-animation-videos-comic-books-make-asthma-less-scary-kids/

TYPES OF ASTHMA

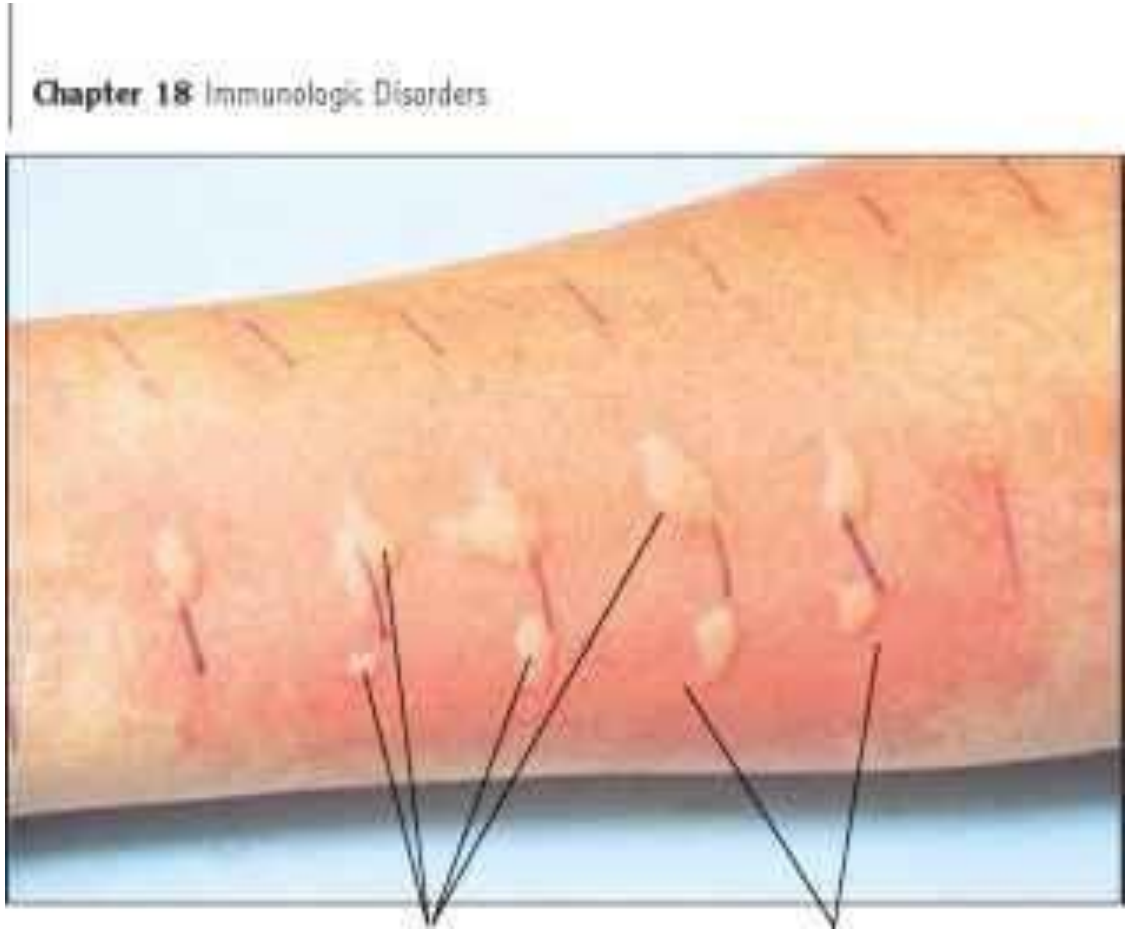
TYPES OF ASTHMA

ATOPIC ASTHMA :

- The most common
- Classic example of type I IgE–mediated hypersensitivity reaction
- beginning in childhood
- Positive family history of atopy and/or asthma attacks are preceded by allergic rhinitis, urticaria, or eczema
- Attacks are triggered by allergens in dust, pollen, animal dander, or food, or by infections.

- Exposure to the antigen ➡ excessive activation of type 2 helper cells ➡ Cytokines production ➡
  - IL-4 and IL-13 stimulate IgE production
  - IL-5 activates eosinophils
  - IL-13 also stimulates mucus production
- IgE coats submucosal mast cells ➡ release of Mast cell–derived mediators ➡ produce two waves of reaction:
  - early (immediate) phase of reaction
  - late phase of reaction

- Skin test with the antigen: immediate wheal-and-flare reaction



- Serum radioallergosorbent tests (RASTs)

https://www.alpfmedical.info/causative-agent/type-i-hypersensitivities-immediate-igemediated.html

2- NON-ATOPIC ASTHMA :

- No evidence of allergen sensitization
- Negative skin test
- A positive family history of asthma is less common.
- Triggered by:
- viral respiratory infections (rhinovirus, parainfluenza virus)
- inhaled air pollutants (sulfur dioxide, ozone, nitrogen dioxide).

3- DRUG-INDUCED ASTHMA:

- Eg: Aspirin induced asthma
  present with recurrent rhinitis ,nasal polyps , urticaria, and bronchospasm.

- The precise pathogenesis is unknown. involve some abnormality in prostaglandin metabolism from inhibition of
- cyclooxygenase by aspirin

https://en.wikipedia.org/wiki/Aspirin_exacerbated_respiratory_disease

4- OCCUPATIONAL ASTHMA

- triggered by fumes (epoxy resins, plastics), organic and chemical dusts (wood, cotton, platinum), gases (toluene), and other chemicals.
- Asthma attacks usually develop after repeated exposure to the antigen.

https://www.hopkinsmedicine.org/health/conditions-and-diseases/asthma/occupational-asthma

MORPHOLOGY

Figure 13.5 ROBBINS BASIC PATHOLOGY, 10TH EDITION

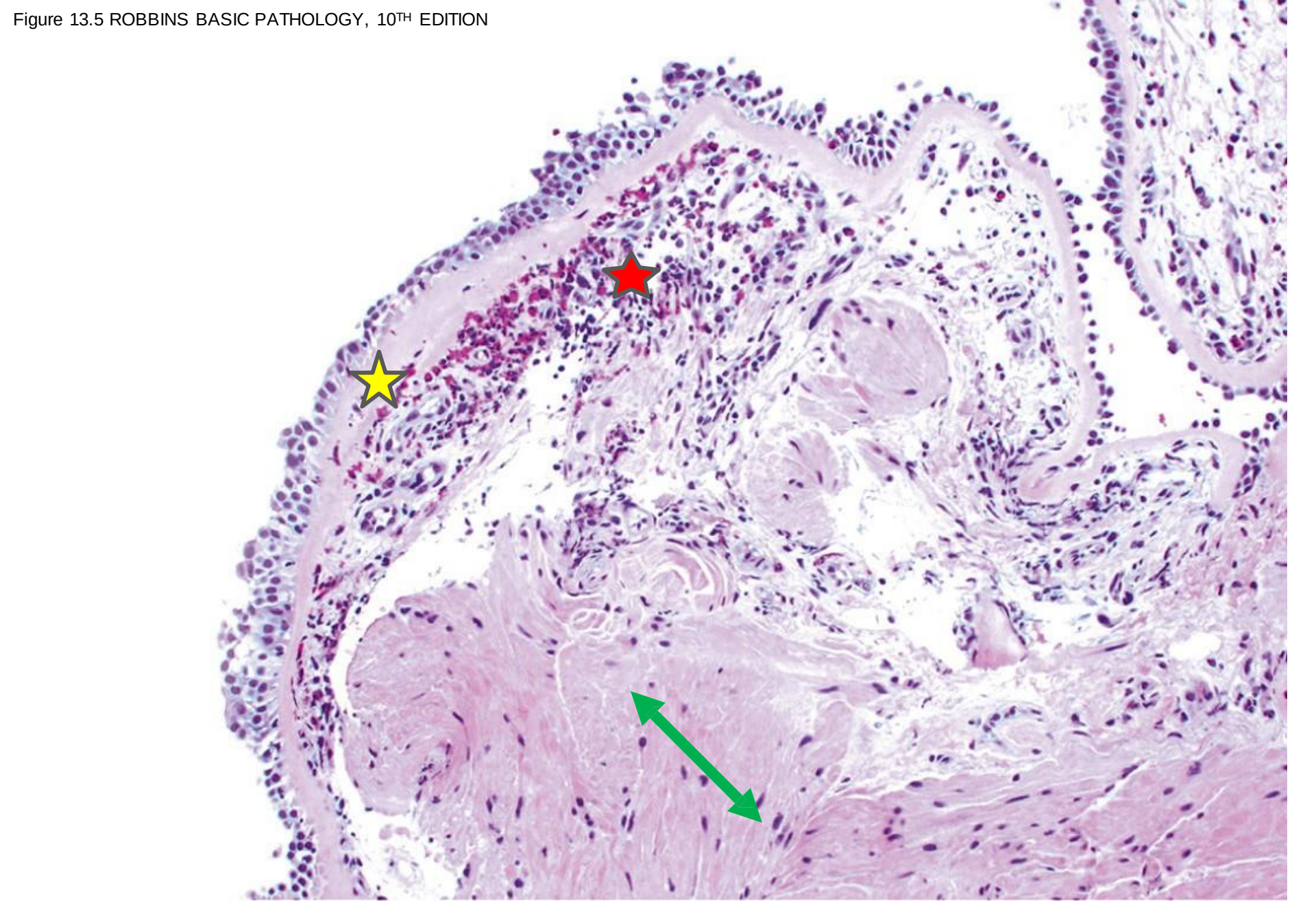
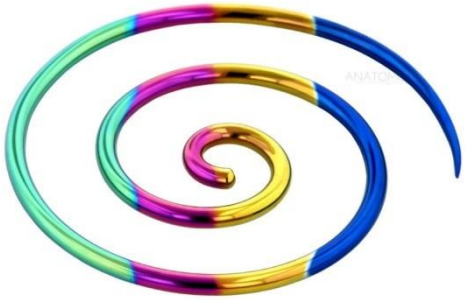


Fig. 13.11 Bronchial biopsy specimen from an asthmatic patient showing sub basement membrane fibrosis, eosinophilic inflammation, and smooth muscle hyperplasia

MORPHOLOGY

- occlusion of bronchi and bronchioles by thick mucous plugs
- mucous plugs contain whorls of shed epithelium called Curschmann spirals.

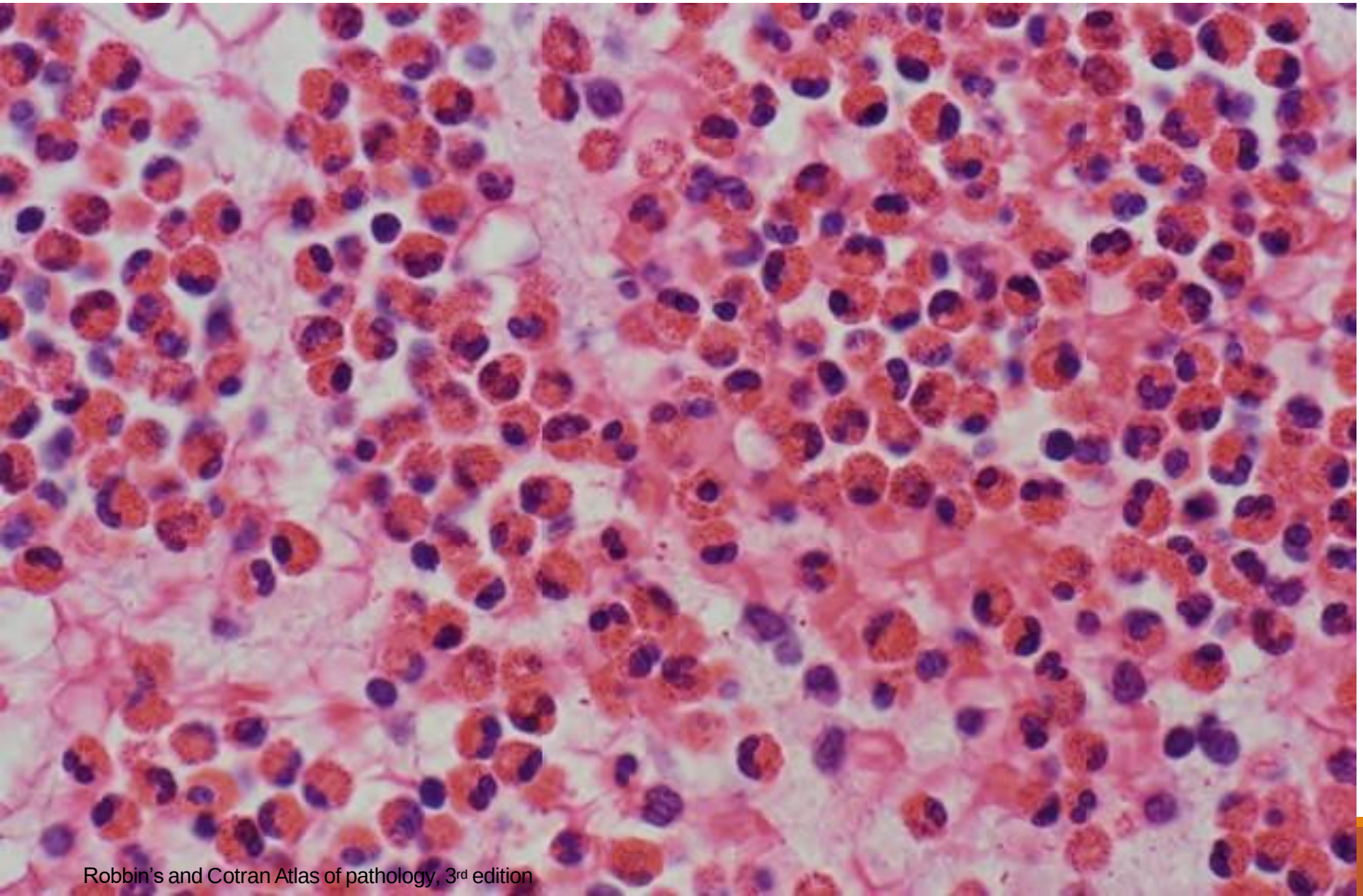
https://anatometal.com/jewelry/spirals/



Curschman Spirals in sputum

https://www.nikonsmallworld.com/galleries/1996-photomicrography-competition/curschmanns-spiral-in-sputum-specimen

- eosinophils



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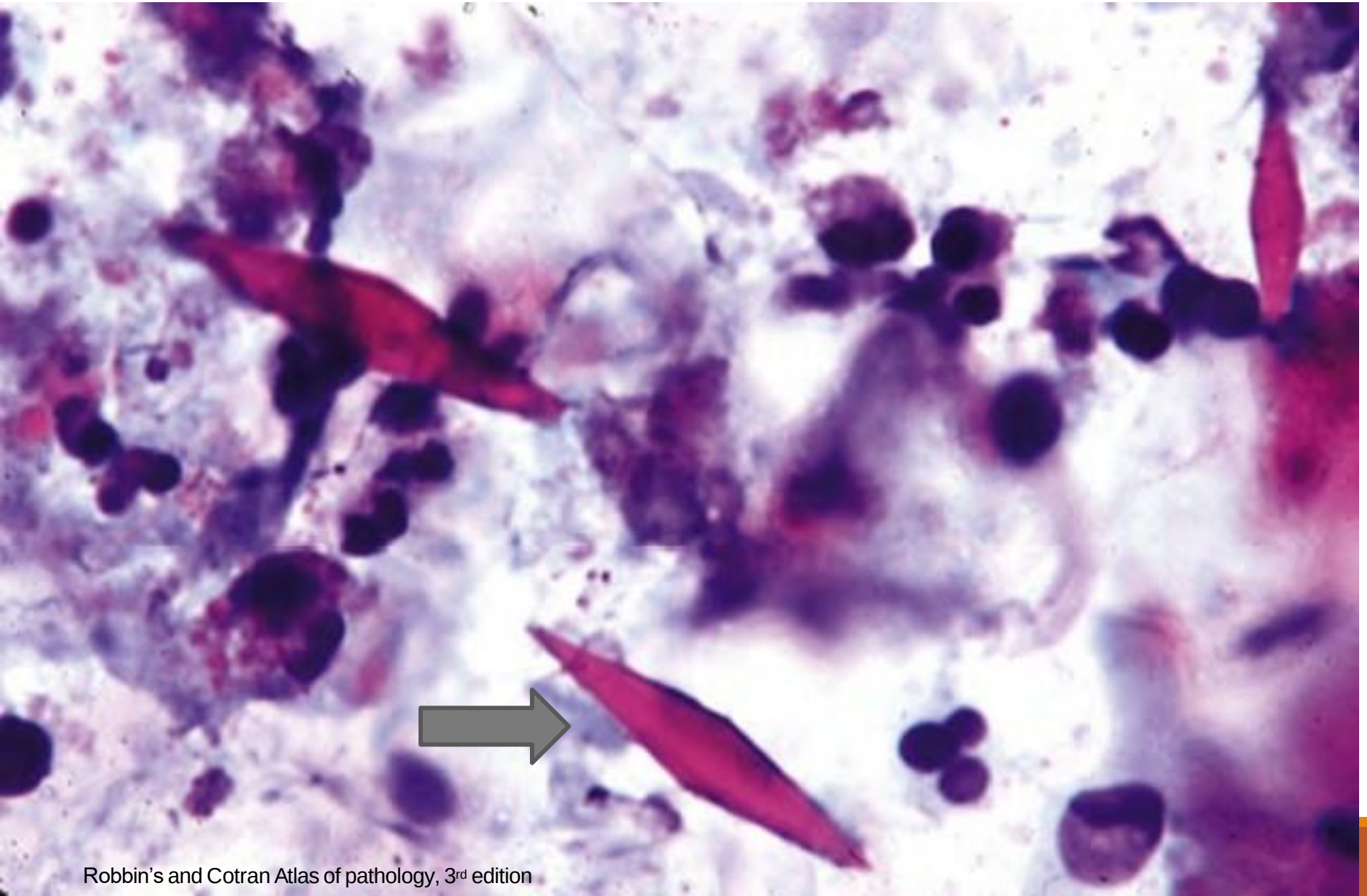
- **Charcot-Leyden crystals:** crystalloids made up of the eosinophil protein galectin-10



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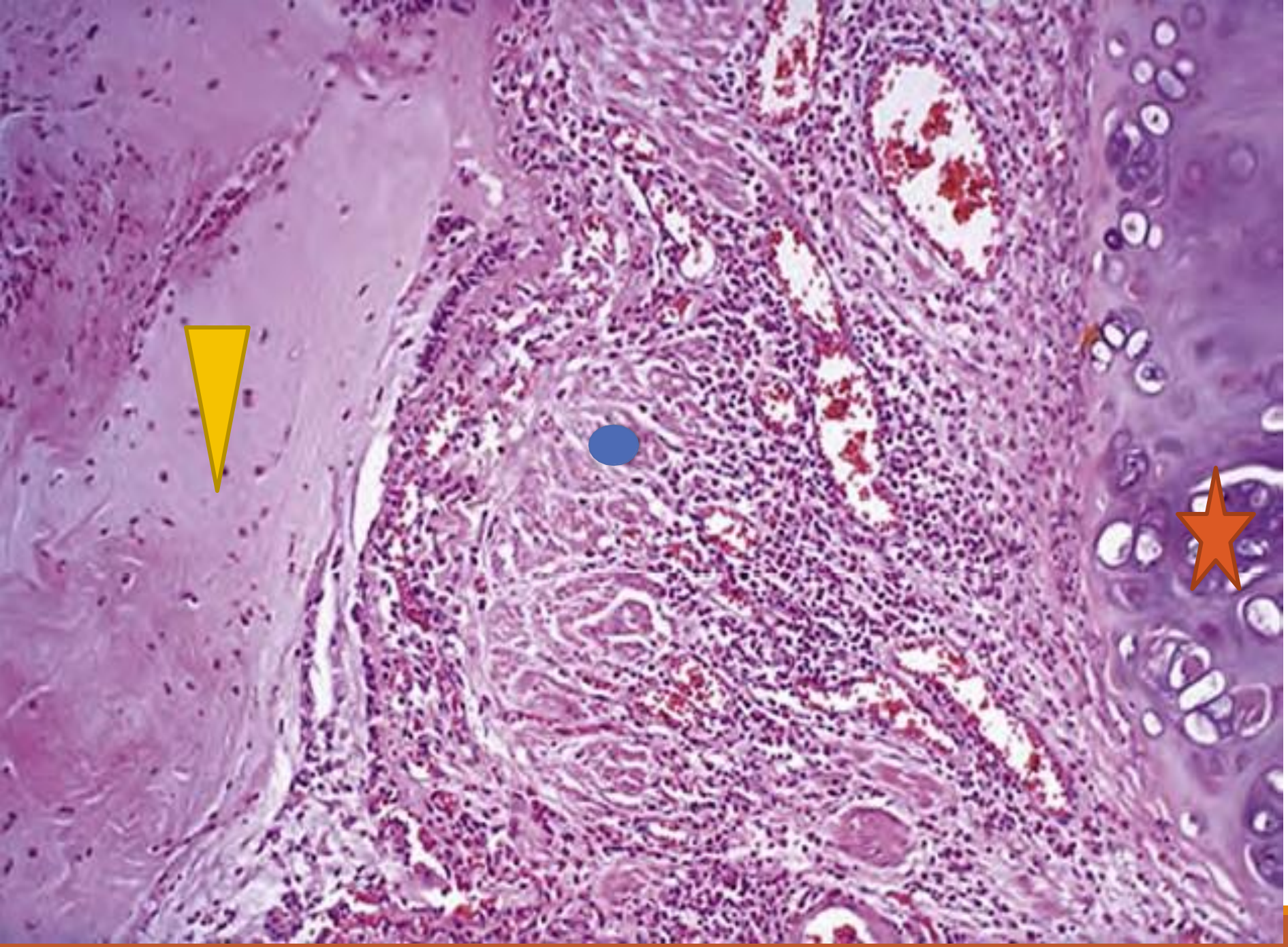
- airway remodeling, including:
  - Thickening of airway wall
  - Sub-basement membrane fibrosis
  - Increased submucosal vascularity
  - An increase in size of the submucosal glands and goblet cell metaplasia of the airway epithelium
  - Hypertrophy and/or hyperplasia of the bronchial muscle
  - In fatal cases ⇨ distension of lungs



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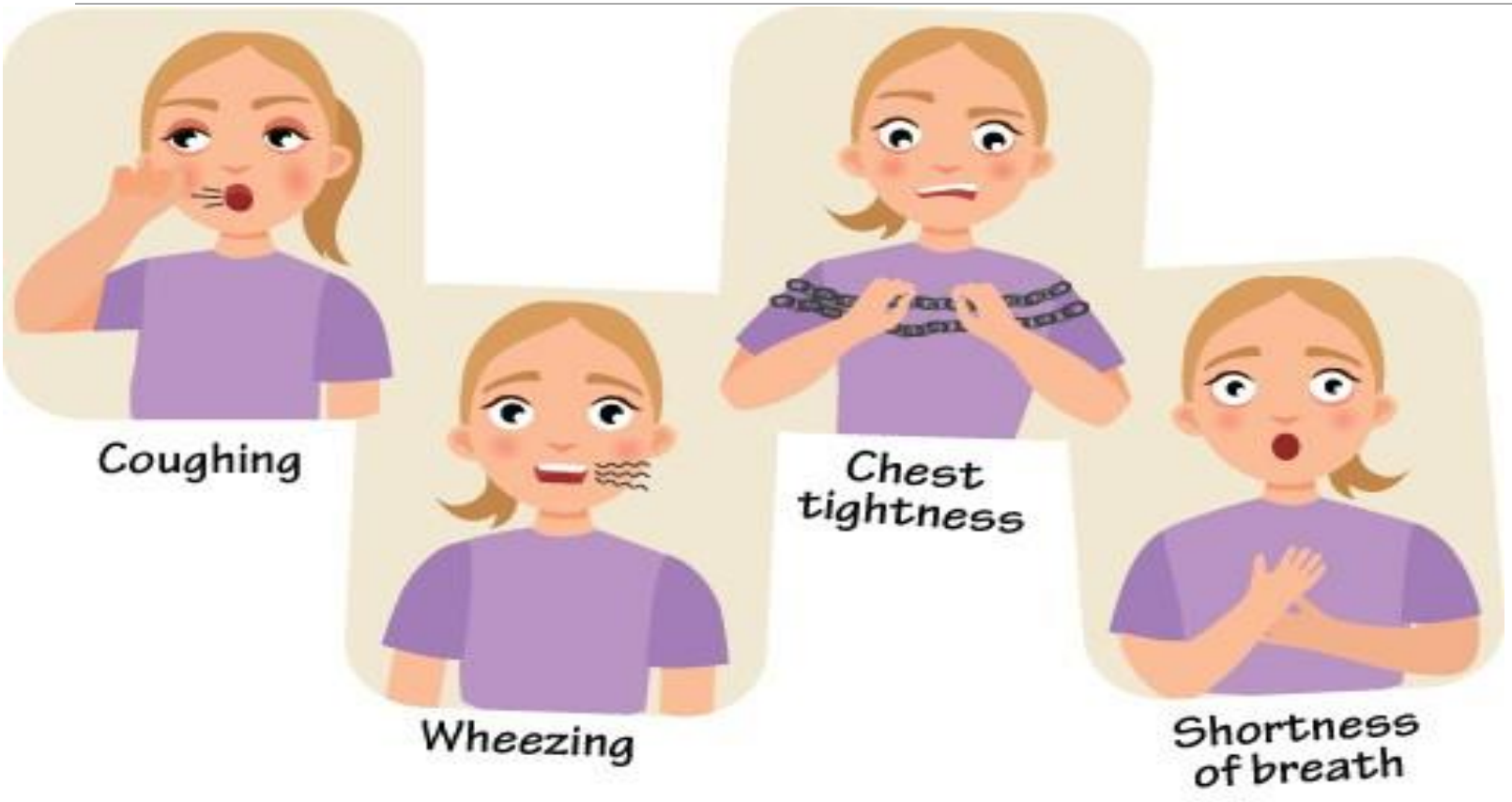
CLINICAL FEATURES



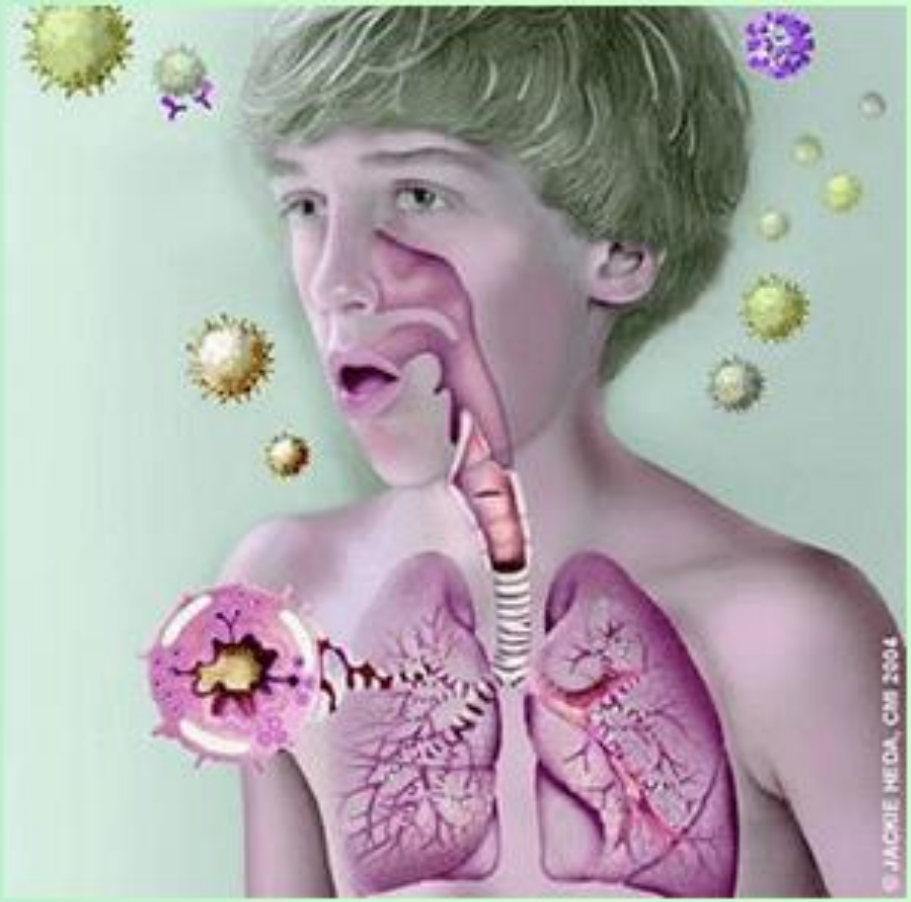
https://allergyasthmanetwork.org/what-is-asthma/asthma-symptoms/

WHEEZING

The link below is for a youtube video for the wheezing sound

https://www.youtube.com/watch?v=7oTfvJff7go

Status asthmaticus:



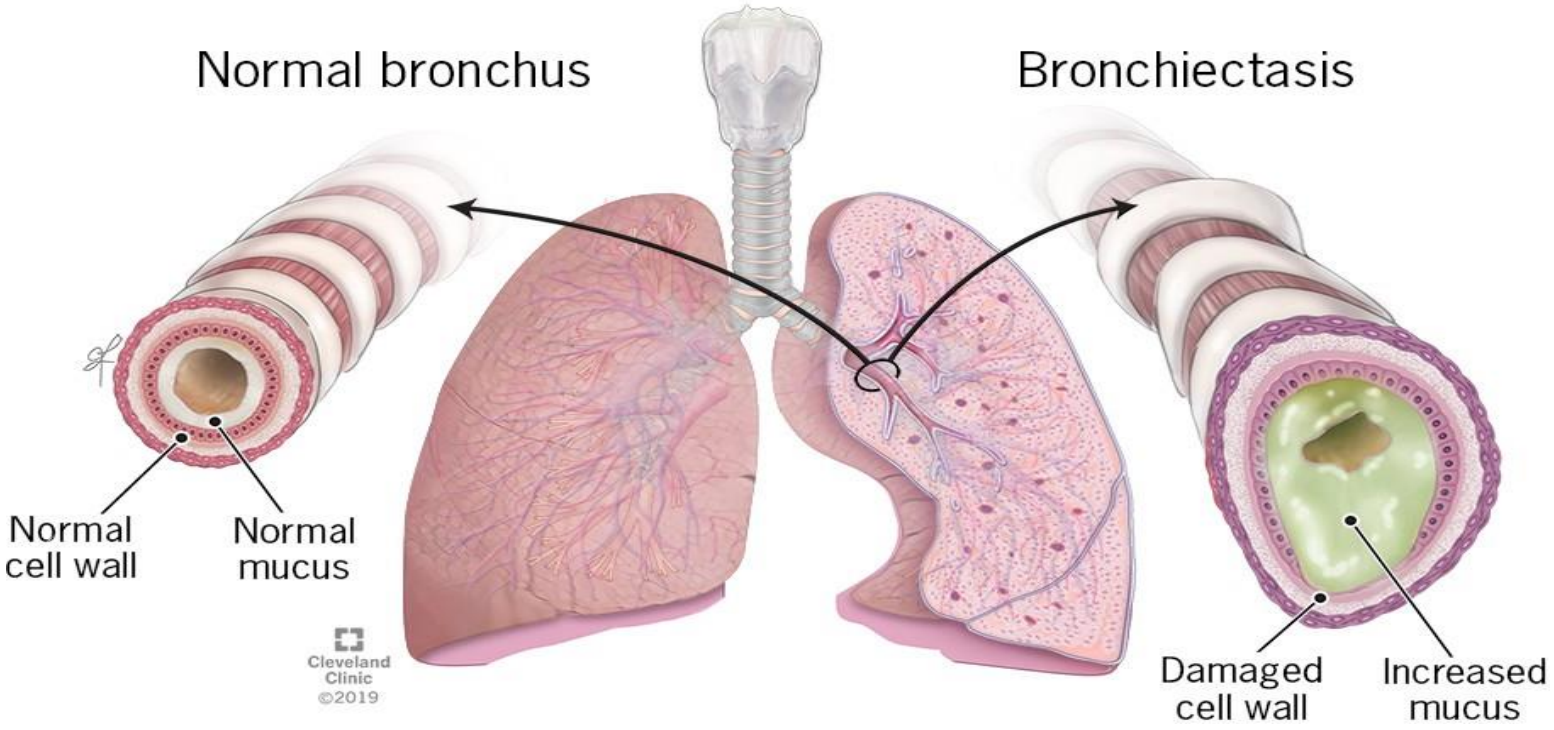
https://nurseslabs.com/status-asthmaticus-nursing-management/

- status asthmaticus is a severe paroxysm that does not respond to therapy and persists for days or weeks.
- The associated hypercapnia, acidosis, and severe hypoxia may be fatal

MANAGEMENT:

- Standard therapies include:
  - Anti-inflammatory drugs(glucocorticoids)
  - Bronchodilators (beta-adrenergic drugs)
  - Leukotriene inhibitors

IV- BRONCHIECTASIS



https://my.clevelandclinic.org/health/diseases/21144-bronchiectasis

IV- BRONCHIECTASIS

- Permanent dilation of bronchi and bronchioles caused by destruction of smooth muscle and the supporting elastic tissue.
- Typically results from or is associated with chronic necrotizing infections.
- It is not a primary disorder, as it always occurs secondary to persistent infection or obstruction

- cough and expectoration of copious amounts of purulent sputum.
- Diagnosis: appropriate history and radiographic demonstration of bronchial dilation.

The conditions that most commonly predispose to bronchiectasis include:

- Bronchial obstruction:
  - By tumors, foreign bodies, and impaction of mucus OR as a complication of atopic asthma and chronic bronchitis

- **Congenital or hereditary conditions:**

Cystic fibrosis:

- widespread severe bronchiectasis
- Due to obstruction caused by abnormally viscid mucus and
- secondary infections

Immunodeficiency states:

- Due to recurrent bacterial infections
- localized or diffuse

Primary ciliary dyskinesia (immotile cilia syndrome):

- rare autosomal recessive disorder ⇨ abnormalities of cilia ⇨ persistent infections.
- bronchiectasis + sterility in males

- **Necrotizing, or suppurative, pneumonia:**
  - particularly with virulent organisms such as Staphylococcus aureus or Klebsiella spp.

PATHOGENESIS

- **Two intertwined processes contribute to bronchiectasis:**
  - ✓ **obstruction**
  - ✓ **chronic infection**

- **OBSTRUCTION→** impairs clearance of secretions ➡ superimposed infection ➡ inflammatory damage to the bronchial wall + the accumulating exudate ➡ airways distention ➡ irreversible dilation.

- **PERSISTENT NECROTIZING INFECTION** ➡ in the bronchi or bronchioles ➡ poor clearance of secretions, obstruction, and inflammation with peribronchial fibrosis and traction on
- the bronchi ➡ irreversible dilation

MORPHOLOGY, MACROSCOPIC:

- Lower lobes bilaterally.
- most severe involvement in distal bronchi and bronchioles.
- The airways may be dilated to as much as four times their usual diameter

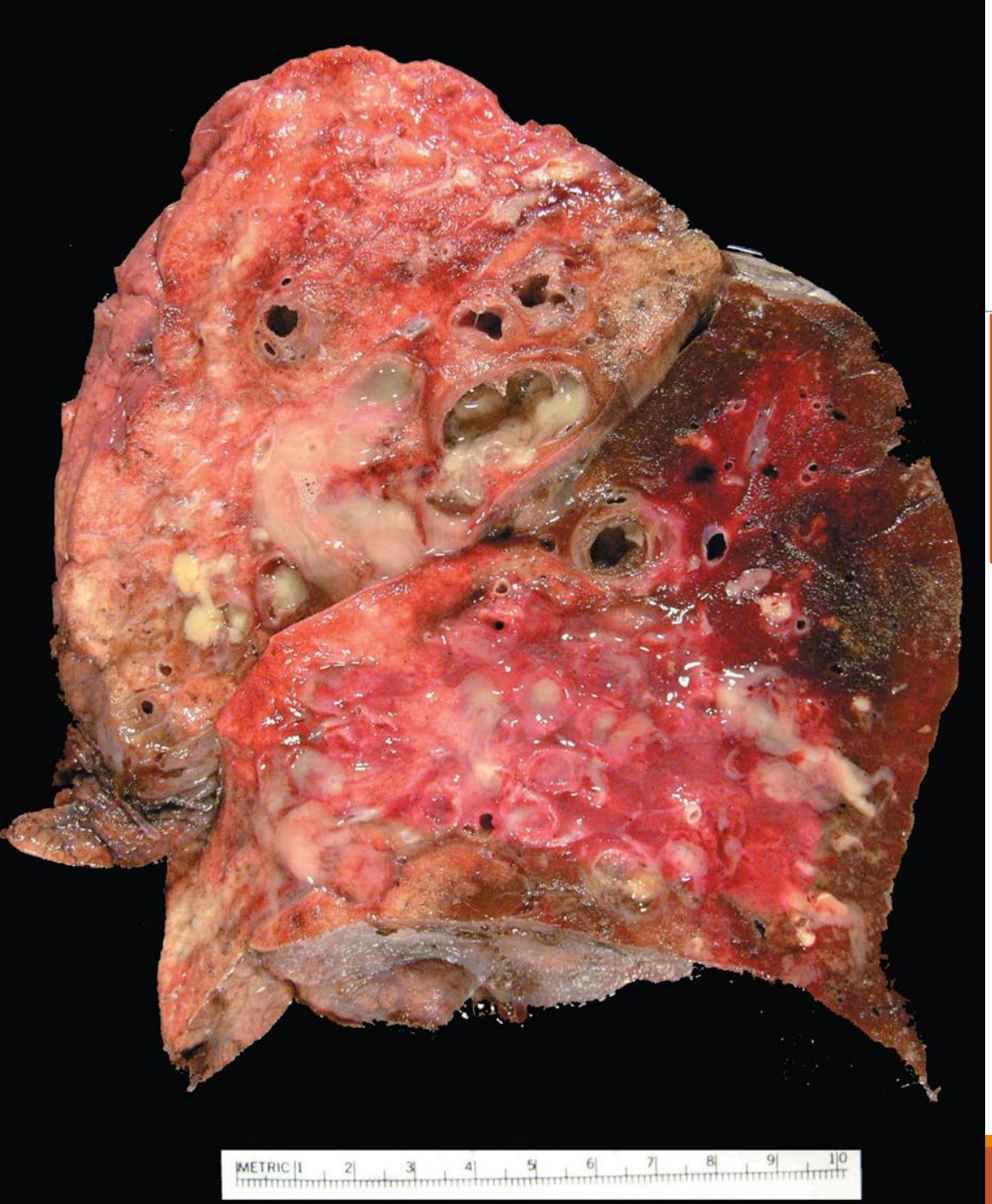


FIGURE 13.12,ROBBINS BASIC PATHOLOGY, 10TH EDITION

markedly dilated bronchi filled with purulent mucus

MORPHOLOGY, MICROSCOPIC:

- In full-blown active cases:
  - intense acute and chronic inflammatory exudate within the walls of the bronchi and bronchioles ⇨ desquamation of lining epithelium and extensive ulceration
  - mixed flora are cultured from the sputum.

MORPHOLOGY, MICROSCOPIC:

- **When healing occurs:**
  - the lining epithelium may regenerate completely abnormal dilation and scarring
  - fibrosis of bronchial and bronchiolar walls
  - peribronchiolar fibrosis
  - Abscess formation in some cases

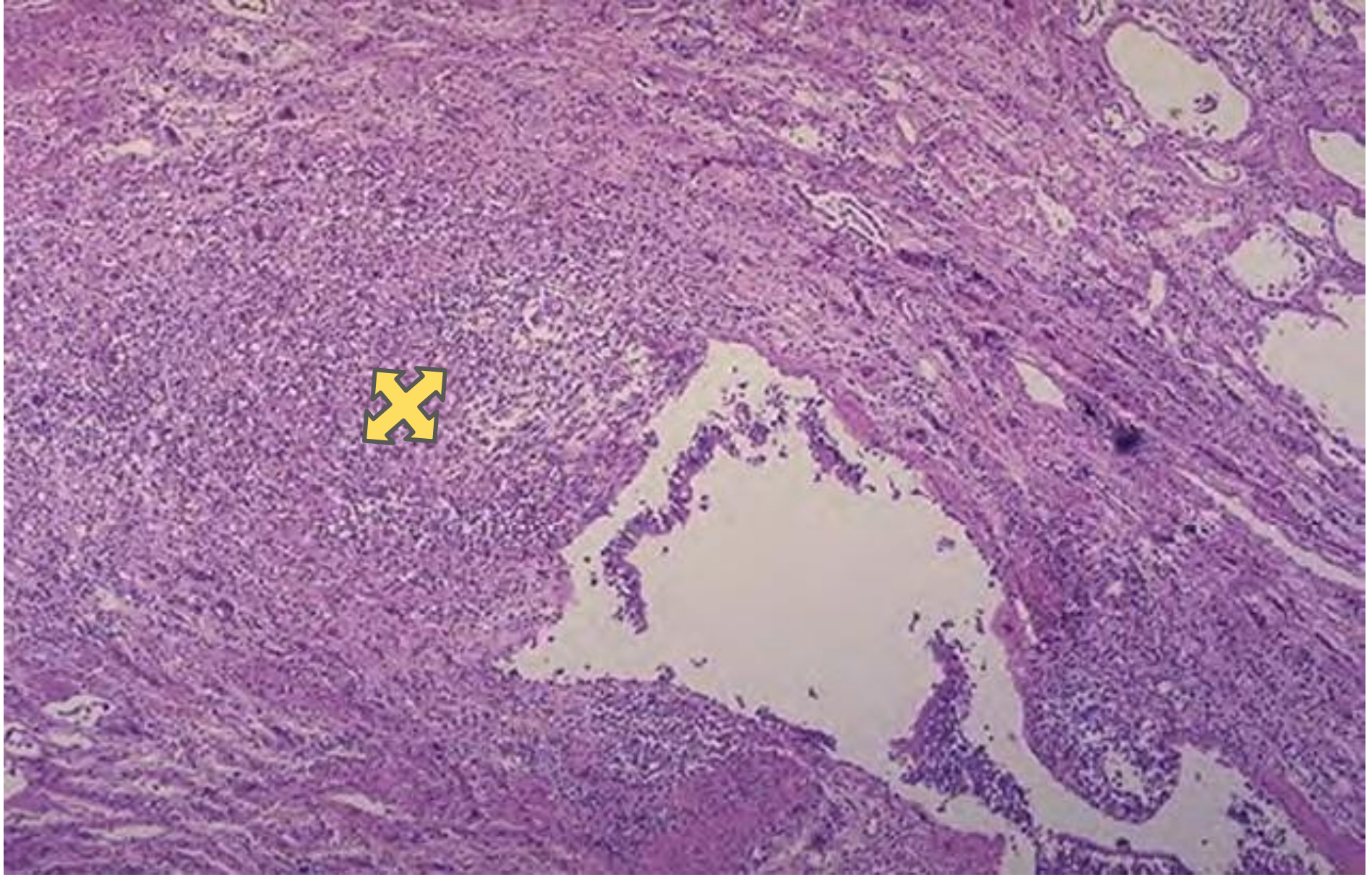


Figure 5-34 Bronchiectasis, microscopic dilated bronchus in which the mucosa and bronchial wall a not seen clearly because of the necrotizing inflammation with tissue destruction.

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CLINICAL FEATURES

- severe, persistent cough with mucopurulent sputum.
- Other symptoms: dyspnea, rhinosinusitis, and hemoptysis.
  - Episodic
  - precipitated by URTI.
  - Severe widespread bronchiectasis : significant obstructive ventilator defects, hypoxemia, hypercapnia, pulmonary hypertension, and cor pulmonale.

IN SUMMARY:

Table 13.1 Disorders Associated With Airflow Obstruction: The Spectrum of Chronic Obstructive Pulmonary Disease

Clinical Entity	Anatomic Site	Major Pathologic Changes	Etiology	Signs/Symptoms
Chronic bronchitis	Bronchus	Mucous gland hypertrophy and hyperplasia, hypersecretion	Tobacco smoke, air pollutants	Cough, sputum production
Bronchiectasis	Bronchus	Airway dilation and scarring	Persistent or severe infections	Cough, purulent sputum, fever
Asthma	Bronchus	Smooth muscle hypertrophy and hyperplasia, excessive mucus, inflammation	Immunologic or undefined causes	Episodic wheezing, cough, dyspnea
Emphysema	Acinus	Air space enlargement, wall destruction	Tobacco smoke	Dyspnea
Small airway disease, bronchiolitis*	Bronchiole	Inflammatory scarring, partial obliteration of bronchioles	Tobacco smoke, air pollutants	Cough, dyspnea

*Can be present in all forms of obstructive lung disease or by itself.

A 45-year-old gentleman smoked two packs of cigarettes per day for 20 yrs. For the past 4 years, he has had a chronic cough with copious mucoid expectoration. During the past year, he has had multiple respiratory tract infections. He has also developed difficulty breathing, tightness of the chest, and audible wheezing. His breathing difficulty is relieved by inhalation of a β-adrenergic agonist and disappears after the chest infection has resolved. Which of the following pathologic conditions is most likely responsible for his clinical condition?

A) α1-Antitrypsin deficiency with panlobular emphysema

B) Centrilobular emphysema with cor pulmonale

C) Chronic asthmatic bronchitis

D) Cystic fibrosis with bronchiectasis

THANK YOU!