5.4.3

COPD and Asthma

Chronic Obstructive Pulmonary Disease (COPD)

Smoking is destructive to all body organ systems but to none more so than the respiratory system. Smoking causes 80% of the cases of chronic obstructive pulmonary disease (COPD) which includes both **emphysema** and **chronic bronchitis.**

In **emphysema,** smoking, other chemicals, or hereditary factors damage the delicate walls of the alveoli, making them less elastic and enlarged. Remember that exhalation relies on the natural elastic recoil of the lungs to decrease volume and increase pressure. If the recoil is gone, muscles of expiration must be used even under resting conditions to force the thoracic cavity to become smaller to exhale the "trapped air" in the alveoli. The **dyspnea,** or labored breathing, leads to the development of "barrel chests". You might imagine how much extra energy it would take to constantly force yourself to expire - this becomes extremely exhausting. The damage to the alveoli leads to damage of pulmonary capillaries. This damage causes an increased resistance to blood flow through the pulmonary capillaries putting extra workload on the right ventricle, eventually leading to right-sided heart failure. It all becomes a vicious cycle of destruction.

Chronic bronchitis comes from long-term exposure of air passageways to irritants, especially cigarette smoke. The ciliated pseudostratified epithelium that lines the lower respiratory airways becomes damaged from smoke, pollution, or other irritants. The cilia become fewer and blunted and can no longer adequately clear the smoke and dust trapped mucus. Consequently, the mucus and debris build up and obstruct the air passages compromising one's ability to ventilate. The chronic hacking cough seen in smokers is evidence of this damage. Increased resistance to airflow also comes from a permanent thickening of bronchial walls resulting from hyperplasia of goblet cells. The resulting narrowed airway lumen makes it more difficult to breathe.

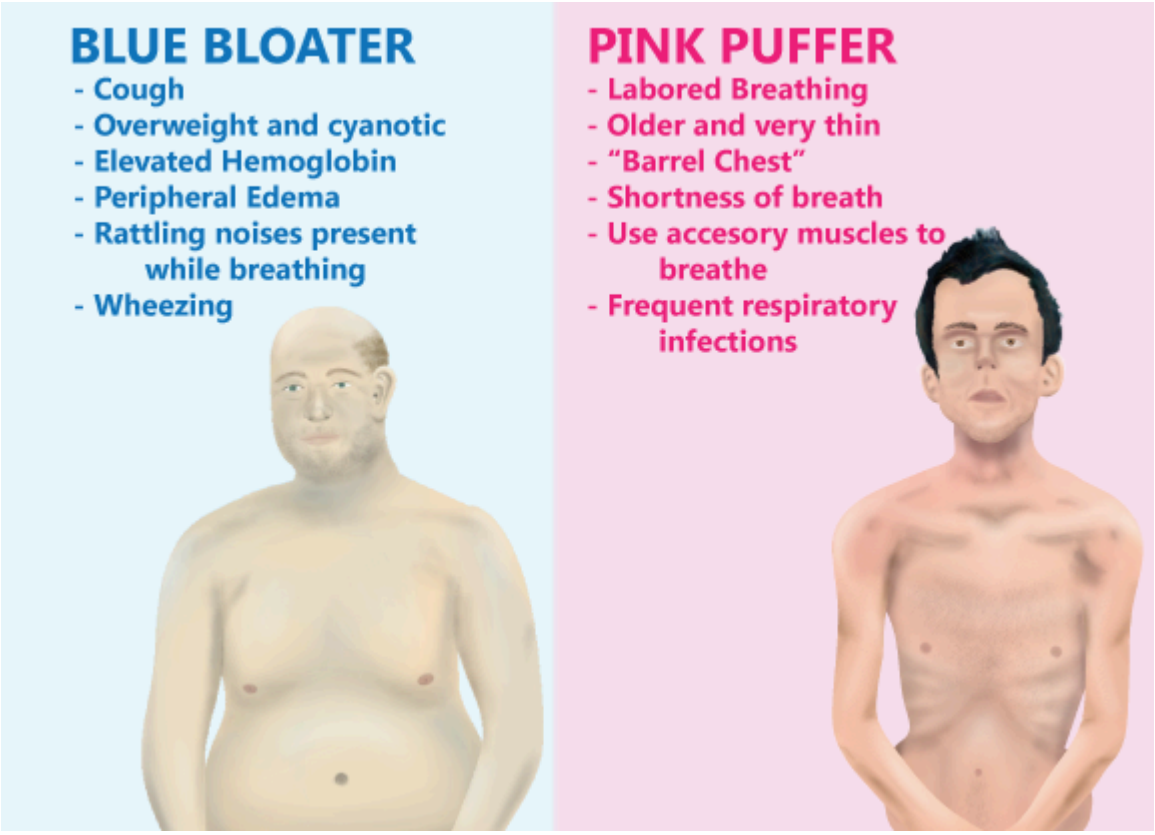


Image drawn by BYU-Idaho student Austin Dean, Spring 2016

In the past, those with emphysema have been referred to as **"pink puffers".** They spend a lot of energy "puffing" in an effort to exhale and are often thin from burning so many calories. Their main problem isn't inhaling so they are able to deliver sufficient oxygen to their blood giving their skin a pink appearance.

The term **"blue bloaters"** on the other hand, refers more often to those with chronic bronchitis. Since they are unable to inhale sufficient amounts of air, their arterial oxygen levels are often low so they become cyanotic. This gives their skin tone a blue appearance. **Hypoxia,** or having tissue that is deprived of oxygen, causes constriction of pulmonary vessels which increases the workload for the right ventricle posing a strong risk for developing right-sided heart failure.

Most patients with COPD don't fall exactly into the category "pink puffer" or "blue bloater" but are usually some combination of the two. It makes sense because smoking leads to both chronic bronchitis and emphysema.

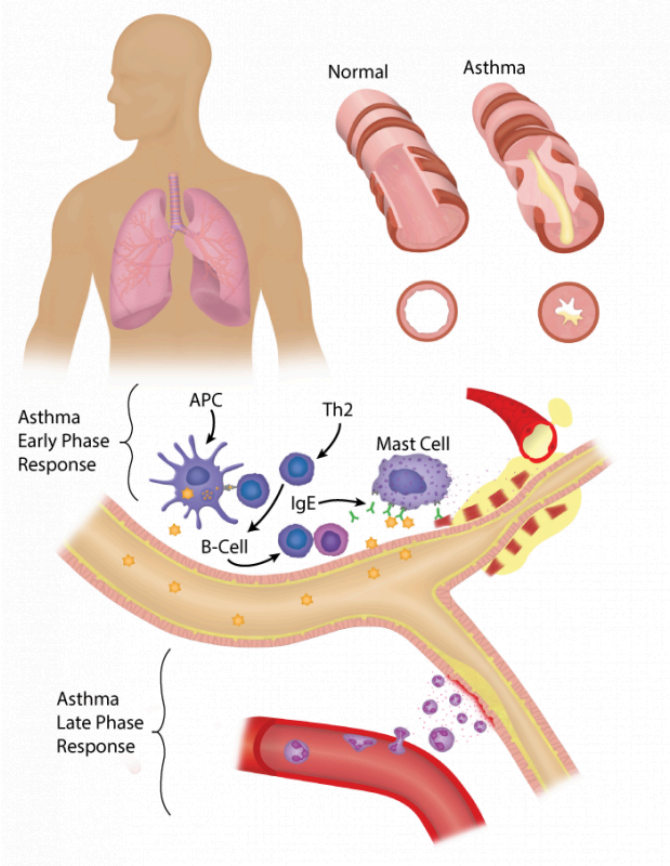
Asthma

Asthma is an inflammatory disorder characterized by symptoms such as dyspnea, chest tightness, coughing, and especially wheezing. Wheezing is the high-pitched sound that comes from turbulent airflow through restricted air passages. Asthmatic episodes come and go. An incident may be triggered by events or agents including: air pollution, exercise, allergens (esp. pollen or animal dander), cold air, smoke, certain drugs (NSAIDs, i.e. aspirin), food preservatives, and occupational exposures (flour dust, hay mold, dyes, rubber, plastics to name a few).

Epidemiologic research has demonstrated a strong genetic predisposition associated with developing the chronic inflammation of the airways seen in asthma. About 75% of one's risk for developing asthma is associated with genetic factors. Particularly, patients prone to atopy (genetic predisposition to develop hypersensitivity to allergens in the environment) have an increased risk. Higher ratios of Th2 (associated with allergies) vs Th1 (associated with fighting infections) lymphocytes in the cord blood of neonates may be a strong predictor for later development of asthma.

There are also environmental factors like second hand smoke exposure in utero, RSV infections, and: being "too clean" during childhood years (termed the "hygiene hypothesis"). Children exposed to decreased amounts of bacteria and endotoxins during the first two years of life, tend to develop less Th1 lymphocytes (associated with fighting infections) and more Th2 lymphocytes (associated with allergies). This balance shift favors the development of asthma. Evidence for this hypothesis is significant. Decreased incidence of developing asthma is seen in the following: children attending daycare in the first 6 months of life; children in larger families; children with older siblings; children having an early exposure to cats and dogs; and children given fewer antibiotics at a young age. Take home message - have lots of kids and leave them at daycare, let them get dirty, get them a pet when they're very young, and don't give them antibiotics. Would fewer baths help too? Moderation in all things and that includes hygiene. Pigpen from Charlie Brown clearly did not have asthma because if he did the dust would be killing him.

As described, asthma is an inflammatory disorder mediated by Th2 cells, a subclass of T-helper lymphocytes that can recruit immune cells like eosinophils. This enhanced inflammatory response results in mucus formation and an inflamed bronchial submucosal layer. Drug therapy focuses on preventing this enhanced immune response through administration of inhaled corticosteroids. A subcutaneously administered anti-IgE antibody has also been approved for treatment. In the works are drugs that inhibit eosinophilic inflammation, Th2 cell inhibitors, and inhibitors of allergen presentation. For acute asthma attacks inhaled B2-agonists like albuterol are drugs of choice since they quickly relax smooth muscle and consequently enlarge the lumen of the bronchioles.



Asthmatic Response. *Image drawn by BYU-Idaho student Nate Shoemaker Spring 2016*

The image above shows how the respiratory tubes can be affected by asthma in an early and a late response. The early phase of asthma is relatively easier to control and is rarely life threatening. Symptoms of this phase arise because of the release of histamine when IgE attaches to allergens and Mast cells. Histamine causes smooth muscle

contraction in the lungs and is what causes the constriction of the airways. Repeated exposure to allergens over a long time can result in the recruitment of eosinophils and other white blood cells. These recruited immune cells can release factors that damage tissue. Over time, continued inflammation and tissue damage can cause lung pathology. Treatment in the early phase of asthma often involves a beta-2 agonist that can help relax bronchial smooth muscle (similar to what epinephrine does). Treatment for the "late phase" of asthma may include inhaled steroids to try and reduce chronic inflammation.