Respiratory structure / function

The pulmonary system consist of the lungs, airways, chest wall, and pulmonary circulation. Its primary function is the exchange of gases between environmental air and the blood. The processes involved are ventilation, diffusion, & perfusion.

The lungs are protected by a series of mechanical barriers from exogenous contaminants (URT mucosa, nasal hair & turbinates, mucus blanket, cilia, alveolar macrophages, irritant receptors).

Alveoli are the primary gas exchange units of the lung. Type I alveolar cells provide support and type 2 provide surfactant.

Ventilation is the mechanical movement of gas or air into and out of the lungs. It is controlled by the brain respiratory center, which receives inputs from lung receptors and chemoreceptors.

Airways are controlled by the autonomic nervous system (ANS).

Structure / function of the pulmonary system

Structure / Function
- airways, chest wall & pleura, ventilation, breathing, gas transport, lung circulation

Clinical manifestations
- signs, symptoms and consequences of pulmonary disease

Pulmonary disorders
- restrictive and obstructive lung disease, infections, pulmonary vascular disease, respiratory tract malignancies

Case studies
- examples of case files on respiratory function disorders
Respiratory structure / function

Structure / Function
- airways, chest wall & pleura,
- ventilation, breathing, gas transport, lung circulation
- clinical manifestations
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- pulmonary disorders
  - restrictive and obstructive lung disease, infections,
  - pulmonary vascular disease, respiratory tract malignancies
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Structures of pulmonary system and upper airways

upper respiratory tract
- nasal cavity
- pharynx
- larynx
- bronchioles

lower respiratory tract
- trachea
- traquea
- nasal cavity
- pharynx
- larynx
- bronchioles

NASAL WALL

PHARYNX

TRAQUEA

LARYNX
Respiratory structure / function

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Case studies
eexamples of case files on respiratory function disorders

Structures of lower airways, their branching, alveoli
Respiratory structure / function

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Section through the alveolar septum (gas exchange membrane)
Respiratory structure / function

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Chest cavity, functional components, and spirogram

- trachea
- right primary bronchus
- larynx
- aorta
- right lung
- parietal pleura
- left primary bronchus
- mediastinum
- left lung
- pleural space
Respiratory structure / function

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Neurochemical respiratory control system

- voluntary and higher centers
- control centers
  - pneumotaxic (inspiration)
  - chemosensitive (H, O2, CO2)
  - apneustic (insp & exp)
- DRG (inspiration)
- VRG (inspiration & expiration)
- vagus n.
- carotid body
- aortic bodies (low PO2)

Blood-brain barrier
- capillary
- stretch irritant
- J receptors
- intercostal n.
- phrenic n. (to diaphragm)
Respiratory clinical manifestations

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**Pulmonary disease** is linked to many signs and symptoms. The most common are cough and dyspnea. Others are chest pain, abnormal sputum, hemoptysis, altered breathing patterns, cyanosis, and fever.

Dyspnea is a subjective sensation of uncomfortable breathing, as for example, dyspnea on exertion and orthopnea.

Common clinical manifestations include, abnormal breathing patterns (e.g. Kussmaul and Cheyne-Stokes respirations), hypo and hyperventilation, cyanosis, clubbing, cough, hemoptysis, abnormal sputum, and pain.

Conditions caused by pulmonary disease or injury include, hypercapnia, hypoxemia, acute respiratory failure, pulmonary edema, aspiration, atelectasis, bronchiectasis, bronchiolitis, pleural abnormalities, chest wall restrictions, and flat chest.

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**Common clinical manifestations of pulmonary alterations**

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**Respiratory clinical manifestations**

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**Clubbing caused by hypoxemia and v/q abnormalities**

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Respiratory clinical manifestations

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Pathogenesis of pulmonary edema
Restrictive lung diseases are characterized by decreased lung compliance and increased work of breathing. The most common examples are pulmonary fibrosis, inhalational disorders, allergic alveolitis, pneumoconiosis, and the acute respiratory distress syndrome (ARDS).

Obstructive lung diseases are characterized by airway obstruction that is worst with expiration. The most common examples are asthma, chronic bronchitis and emphysema. When the last two occur together, it is often called chronic obstructive pulmonary disease (COPD).

The most common respiratory tract infections involved the upper tract (common cold, pharingitis, laryngitis). Infections of the lower respiratory tract occur most often in individuals whose normal defenses mechanisms are impaired.

Pulmonary vascular disease is linked to pulmonary embolism, pulmonary hypertension, and cor pulmonale (right side failure).
Respiratory dysfunctions

Structure / Function
- Airways, chest wall & pleura, ventilation, breathing, gas transport, lung circulation

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Atelectasis (Kohn's pore), pneumothorax, flail chest are examples of restrictive disorders

PORES OF KOHN
- Low inspiratory volume (shallow breathing)
- High inspiratory volume (deep breathing)

EXAMPLES OF RESTRICTIVE DISORDERS

- Pneumothorax
- Flat chest
Respiratory dysfunctions

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**ARDS**
- acute insult
  (e.g. pneumonia, aspiration, smoke inhalation)

- Release of cytokines
  (e.g. IL, Tß, TNF)

- Influx of inflammatory cells to lung
  (e.g. neutrophils, macrophages, activated platelets)

- Release of ROS and cytokines
  Activation of complement system

- Damage to type II pneumocytes
- Disruption of alveolar capillary membrane
- Microthrombi in pulmonary circulation
- Release of fibroblast growth factors (e.g. TGFß, PDGF)

- Atelectasis and decreased lung compliance
- Non-cardiogenic pulmonary edema and intrapulmonary shunting
- Pulmonary hypertension
- Pulmonary fibrosis
Respiratory dysfunctions

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Examples of airway obstruction are those caused by emphysema, chronic bronchitis and asthma

Obstructive dysfunctions (B, C, D)
panlobular, centrilobular

NORMAL LUNG

EMPHYSEMA (destruction of alveolar walls)

CHRONIC BRONCHITIS (inflammation)

BRONCHIAL ASTHMA (obstruction)
Respiratory dysfunctions

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Pathophysiology of asthma, an airway obstruction dysfunction

ASTHMA

1. allergen or irritant exposure

2. immune activation (IL-4, IgE production)

3. mast cell degranulation

4. vasoactive mediators

5. chemotactic mediators

6. vasodilation
- Increased capillary permeability

7. bronchospasm
- vascular congestion
- mucus secretion
- impaired mucociliary function
- thickening of airway walls
- increased contractile response of bronchial smooth muscle

8. bronchial hyperresponsiveness
- Airway obstruction

9. cellular infiltration
- (neutrophils, lymphocytes, eosinophils)

10. autonomic dysregulation

11. release of toxic neuropeptides

12. epithelial desquamation and fibrosis
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Pulmonary disorders: restrictive and obstructive lung disease, infections, pulmonary vascular disease, respiratory tract malignancies.

Pathophysiology of chronic bronchitis and emphysema (COPD), another example of an obstructive respiratory dysfunction.

COPD
- tobacco smoke
- air pollution
- inflammation of the airway epithelium
- systemic effects (muscle weakness, weight loss)
- continuous bronchial irritation and inflammation
- chronic bronchitis (bronchial edema, hypersecretion of mucus, bacterial colonization of airways)
- airway obstruction, air trapping, loss of surface area for gas exchange, frequent exacerbations (infections, bronchospasms)

Inherited alpha 1 - antitrypsin deficiency
- inhibition of normal endogenous anti-proteases
- increased protease activity with breakdown of elastin in connective tissue of lungs (elastase, cathepsin)
- emphysema (destruction of alveolar septa and loss of elastic recoil of bronchial walls)
- dyspnea, cough, hypoxemia, hypercapnia, cor pulmonale
Your eighth case study

SUMMARY:
A 34-year-old woman with diabetes presents to the emergency department with complaints of fever, chills, back pain, dizziness, and shortness of breath. She reports a new onset non-productive cough and denies having chest pain. She reports no sick contacts. On examination, she is ill-appearing, febrile, hypotensive, and tachycardic. She has marked right costovertebral (flank) tenderness. Her lung examination demonstrates course rales and rhonchi throughout both lung fields. Her heart rate is tachycardic but with a regular rhythm. Her O2 saturation on room air is very low at 80% (normal is >94%). Urinalysis reveals numerous bacteria and leukocytes, consistent with an urinary tract infection. She has pyelonephritis and septic shock, with evidence of bilateral pulmonary infiltrate, on chest X-ray.

TENTATIVE DIAGNOSIS:

LAB TESTS:

FINAL DIAGNOSIS:

TREATMENT: