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Take a Deep Breath:
Respiratory Emergencies of Dogs and Cats

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Take a Deep Breath: Respiratory Emergencies of Dogs and Cats

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Respiratory Emergencies

- Respiratory disorders are common in small animals and account for a significant number of emergency visits and hospitalizations
- Respiratory distress or dyspnea may be a direct result of
  - Toxin exposure
  - Trauma
  - Acute exacerbation of chronic conditions
  - Secondary to infectious processes
  - Fluid shifts

Just Breath-Control of Breathing

- The medulla is considered the respiratory center, and it is the site responsible for the generation of the respiratory pattern and coordination of voluntary and involuntary input that can alter breathing activity
- Within the medulla is a collection of neurons known as the central pattern generator, which acts as a group pacemaker system that produces the basic, rhythm of breathing
- Central chemoreceptors sense changes in carbon dioxide and pH, which peripheral chemoreceptors also sense changes in oxygenation, and the combined input from these receptors can alter the respiratory pattern to help return blood gases to normal

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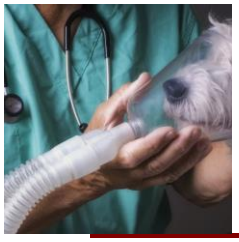
- Carbon dioxide has a major influence on breathing, whereas the partial pressure of oxygen must generally fall to less than 50-60 mm Hg to induce large changes in ventilation
- Receptors in the lungs and airways and other sensory receptors are also involved in reflex mechanisms that can modify the respiratory pattern



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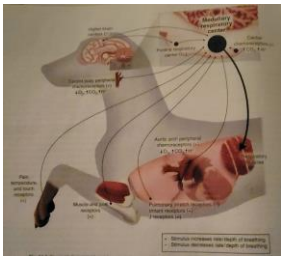

Act of Breathing

- The medulla is considered the center for control of breathing and is the location for the generation of the respiratory rhythm.
- The medullary respiratory center receives input from other centers in the brain, the central and peripheral chemoreceptors, and multiple other types of receptors that can alter the respiratory pattern

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Anatomy of the Respiratory System

The main function of the respiratory system is to provide the body with a continuous source of gas exchange between the inspirited air and the circulatory system

This gas exchange system includes supplying the body with oxygen during inspiration and removing carbon dioxide (CO_2) during expiration

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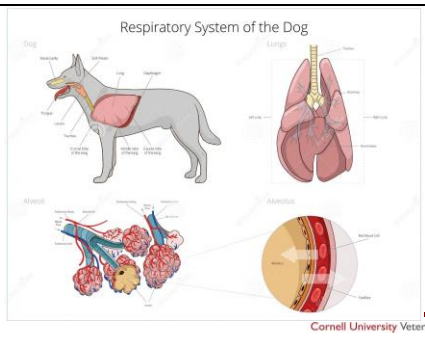
Respiratory System of the Dog



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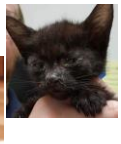
Respiratory Physiology

- Adequate tissue oxygenation is governed by a combination of processes including external respiration, oxygen transport, and internal respiration
- Any impairment of these processes may lead to inadequate oxygenation of the tissues and subsequent cellular damage or death



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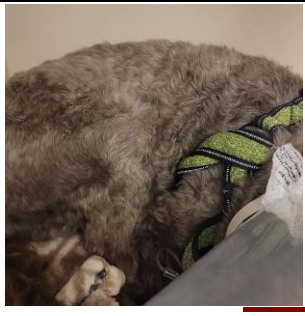
Assessment of Oxygenation and Ventilation

- Observation of either increased or depressed respiratory effort is a common indicator of hypoventilation and possible hypoxemia
- Conditions that lead to decreased lung compliance such as pneumonia, pleural effusion, and pulmonary edema are typified by a pattern of rapid, shallow breathing
- Obstructive conditions such as asthma and laryngeal paralysis are characterized by slow, deep breaths

Observations should be made regarding the phase of ventilation requiring increased effort: ***is the patient working harder during the inspiratory phase or the expiratory phase?***



Auscultation of the Thorax

Crackles are indicative of fluid within the alveoli secondary to pulmonary edema or pneumonia

Wheezes are indicative of narrowed respiratory passages secondary to inflammation, mucous accumulation, or other obstructive processes

Diminished or absent lung or heart sounds may indicate pneumothorax, pleural effusion, diaphragmatic hernia, and other pleural space diseases

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Laryngeal Paralysis

Upper Airway

- Occurs when innervation of the intrinsic laryngeal muscles is disrupted
- Complete or partial failure of the arytenoid cartilages and vocal folds to abduct during inspiration and adduct during expiration
- Acquired idiopathic laryngeal paralysis is the most common form
- Signs are progressive inspiratory stridor, noisy respirations, voice changes, exercise intolerance, heat intolerance, and various levels of dyspnea, cyanosis, and panting
- A definitive diagnosis requires the evaluation of the laryngeal function under a light plane of general anesthesia
- Asymptomatic laryngeal paralysis often requires no treatment. The only definitive therapy for laryngeal paralysis is corrective surgery

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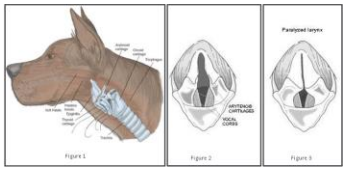

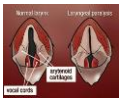

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Emergency Treatment

- Patients with moderate to severe respiratory distress require oxygen supplementation, sedation, corticosteroids to reduce inflammation, and cooling measures if the patient is hyperthermic
- The only definite therapy for laryngeal paralysis is corrective surgery
- A unilateral cricoarytenoid lateralization, or "tieback," can be performed and involves changing the anatomy of the larynx by permanently fixing it in a semi-open position by suture prosthesis

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Collapsing Trachea

Upper Airway

- The trachea spans both the extrathoracic and intrathoraic portions of the respiratory trachea
- "Tracheal collapse" refers to a condition of excessive collapsibility of the tracheal, usually resulting in a flattening of the trachea lumen
- Tracheal collapse is associated with tracheal trauma, compressive extraluminal masses, tracheal hypoplasia, and intraluminal masses
- The tracheal cartilages lose the ability to maintain their rigidity, leading to the upper portion of the tracheal collapsing during inspiration and the thoracic trachea collapsing during expiration
- The resulting collapse reduces the tracheal lumen size, thereby interfering with or obstructing airflow from reaching the lungs

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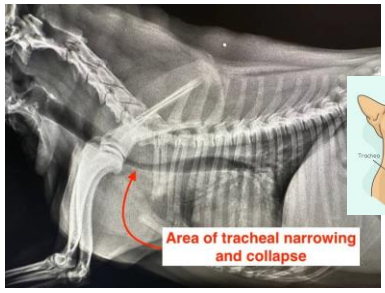

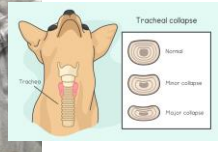

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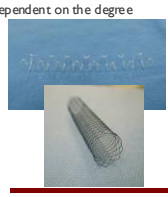
Emergency Treatment

- Patients may present showing clinical signs ranging from mild to severe respiratory distress
- Symptoms may include exercise intolerance, abnormal respiratory noises (wheezing, hacking, coughing), and stridorous breathing, "goose honk" cough, respiratory distress, cyanosis, syncope, open mouthing breathing
- Diagnostic imaging techniques including lateral radiographs of the neck and thorax, tracheal ultrasound, and fluoroscopy usually demonstrate excessive narrowing of the trachea
- Conservative medical management and surgical correction
- Affected dogs should be maintained in an environment free of respiratory irritants, smoke, or allergens
- Medical therapy often provides transient relief and impedes the disease progression

Surgical Intervention

- Tracheal stents and prosthesis are two options potential available for correction
- The feasibility and success of these procedures are dependent on the degree and location of the tracheal collapse



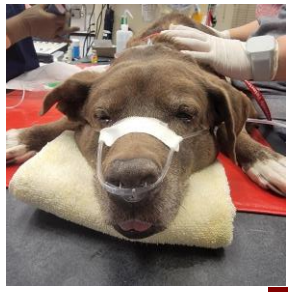
Pulmonary Contusions

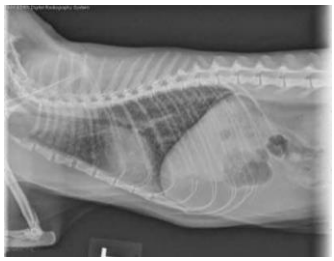
Lower Airway

- Are a frequent finding following thoracic trauma
- Damaged capillaries within the lung tissue hemorrhage into the alveoli and bronchiole
- Blood and fluid accumulate in the alveoli creating a barrier preventing normal gas exchange across the alveolar-capillary membrane and resulting in venous admixture and hypoxemia
- Additional factors which may increase the severity of respiratory compromise include decreased cardiac output from shock or cardiovascular injury and hypoventilation secondary to pain
- Pulmonary contusions vary in severity, coughing, cyanosis, and hemoptysis are typically indicative of severe pulmonary contusions

Emergency Treatment

- Radiographs are helpful to confirm a diagnosis, but changes are not usually apparent for the first 6-12 hours following traumatic incident
- Auscultation often reveals increased bronchovesicular sounds or crackles
- Arterial blood gas monitoring is beneficial to determine the severity of hypoxemia and to monitor therapy
- Supplemental oxygen, analgesics to reduce pain and improve ventilation, intravenous fluids may be required to improve cardiac output and perfusion





Feline Asthma

Feline asthma typically used to describe a hypersensitivity reaction in cats characterized by pulmonary bronchoconstriction, eosinophilic airway inflammation, and airway edema

Patients with severe disease may present with significant dyspnea, crackles, or harsh lung sounds; the classic respiratory pattern is a prolonged expiratory phase, and wheezes are frequently auscultated

Emergency Treatment

- Oxygen therapy
- Administration of an inhaled bronchodilator
- Injectable bronchodilator such as terbutaline or aminophylline

Pneumonia

- Is an inflammation of the pulmonary parenchyma which typically results in exudate infiltration of the alveoli
- Bacterial pathogens are the most common cause; other less common etiologies include viral, fungal, protozoal, and parasitic organisms, aspiration of gastric contents, chemical irritants, and smoke inhalation
- Functional factors that increase the risk of developing pneumonia include brachycephalic anatomy, laryngeal paralysis and megaesophagus
- The gag reflex may be impaired following sedation or in the presence of neuromuscular paralysis, increasing the risk of aspiration pneumonia
- Signs include lethargy, anorexia, moist cough, dyspnea with a rapid and shallow respiratory pattern, audible wheezing, postural adaptations, and cyanosis

Pneumonia

- Diagnosis is based on clinical symptoms, physical exam findings, radiographic images, and laboratory findings
- Fine to coarse crackles are typically notes on auscultation; wheezing
- Consolidation of any portion of the lungs will result in significantly decreased or absent sounds over that area
- Radiographic images are the primary diagnostic tool for determination and evaluation of pneumonia
- Infiltrative patterns in the right cranial or middle and the left cranial lung lobes are characteristically indicative of aspiration pneumonia
- Assessment of PaO2 and SO2 through ABG analysis can be a good indicator of disease severity and response to treatment
- Respiratory cultures should be collected by transtracheal wash (TTW) or bronchoalveolar lavage (BAL)

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Emergency Treatment

Oxygen therapy

Fluid therapy aimed toward restoration and maintenance of tissue perfusion

Antimicrobial therapy

Nebulization

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Pneumothorax

- Occurs when there is an accumulation of air or gas in the pleural space in sufficient quantity to cause collapse of the lung and marked reduction in ventilation
  - Open pneumothorax occurs when there is open communication between the external environment and the pleural space
  - Closed pneumothorax occurs when air accumulates due to leakage from the pulmonary parenchyma, bronchial tree, or esophagus
  - Traumatic pneumothorax can be classified as open or closed and is a result of a traumatic event in which air accumulates in the pleural space
  - Spontaneous pneumothorax occurs in previously healthy animals as a result of air leakage from the lung into the pleural space due to an unknown cause without trauma
  - Tension pneumothorax is a collection of air or gas in the pleural cavity of the chest between the lung and the chest wall-usually as a result of trauma

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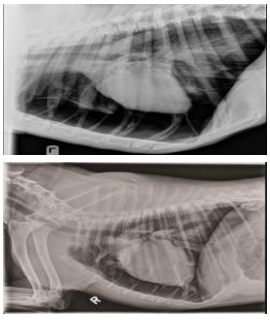

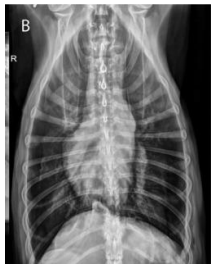

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Clinical Signs

- Symptoms are an acute onset of dyspnea and various degrees of respiratory distress ranging from a mild form to more severe and life-threatening
- Thoracic auscultation may reveal decreased heart and lung sounds
- Traumatic injuries such as rib and limb fractures, pulmonary contusions, and sucking chest wounds often support a diagnosis of traumatic pneumothorax
- Free air in the pleural space through imaging techniques such as thoracic radiographs or ultrasound

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Emergency Treatment

- A significant percentage of pneumothorax patients may be managed medically; surgical intervention is typically required for spontaneous cases and those with extensive wounds to the thoracic wall or internal pulmonary structures
- Medical management involves oxygen supplementation, removal of air from the pleural space, and administration of appropriate analgesics
- Small amounts of air can frequently be managed with periodic needle thoracocentesis until the pneumothorax is resolved
- Large or persistent accumulations typically warrant chest tube placement
  - Intermittent suctioning of the chest tube is appropriate for patients with slow or minimal air buildup
  - Continuous drainage should be considered when dealing with large traumatic defects or persistent pneumothorax as this allows for quicker resolution of dyspnea
  - Surgical intervention is indicated when extensive wounds are present and require closure or repair to facilitate healing
    - Surgical correction is also indicated in spontaneous pneumothorax due to the high incidence of recurrence with medical management

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Hemothorax

- Is the accumulation of blood in the pleural space usually as a result of blunt force or penetrating thoracic trauma or coagulopathy
- Clinical signs range from mild dyspnea to tachycardia, pale mucous membranes, and decreased capillary refill time associated with hypovolemic shock
- Auscultation typically reveals muffled heart and lung sounds
- A diagnosis may be made based on history and physical exam
- Thoracic radiographs and ultrasound will typically reveal the presence of fluid within the pleural space; aspiration of blood from the thoracic cavity

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Emergency Treatment

- Requires identification and resolution of the underlying cause while minimizing dyspnea
- Traumatic hemothorax may resolve with medical management; persistent hemorrhage or arterial bleeds typically require surgical correction
- Coagulopathies require immediate replacement of active clotting factors; this is best achieved through transfusion with fresh frozen plasma, frozen plasma, or fresh whole blood
- It is not advisable to remove large quantities of blood via thoracocentesis unless the patient is experiencing respiratory compromise; blood remaining in the thoracic cavity will be reabsorbed.
- In many cases, blood that is aspirated from the pleural space can be auto transfused back into the patient

Pleural Effusion

- An accumulation of excessive fluid within the pleura, the fluid-filled space that surrounds the lungs
- It occurs when the rate of fluid accumulation exceeds the rate of absorption
- Effusion may result from right heart failure, infection (pyothorax), lymph (chylothorax), neoplasia, or hemorrhage (hemothorax); it is commonly attributed to chronic chylothorax or pyothorax

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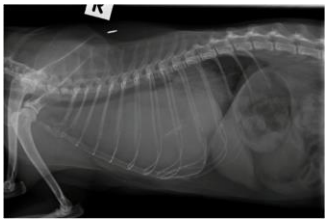

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Clinical Signs

Dyspnea and exercise intolerance are the most common signs

Respiration is marked by forceful inspiration with delayed expiration

This respiratory pattern makes the animal appear as though it is holding its breath and is particularly noticeable in cats

Auscultation of muffled heart and lung sounds in the presence of dyspnea

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Emergency Treatment

Treatment focuses on minimizing patient stress, providing supplemental oxygen, and resolution or reduction of dyspnea as fluid is evacuated by thoracocentesis

Definitive therapy is aimed as identification and treatment of the underlying cause

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Flail Chest

- Occurs secondary to blunt trauma when multiple adjacent ribs are each fractured in more than one place; the resulting flail segment is not attached to either the sternum or spine and moves independently of the nonfractured ribs
- In the absence of a pneumothorax, negative pressure in the thoracic cavity pulls the flail segment inward while the rest of the chest wall moves outward during inspirations

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Clinical Signs and Diagnosis

- The patient will typically present with a rapid, shallow respiratory pattern, tachypnea, tachycardia and anxiety
- Diagnosis is based on patient history, symptoms, observation of paradoxical chest movement, and radiographic evidence of fractures
- The respiratory compromise seen in flail chest is associated with pain and concurrent pathology such as pulmonary contusions, pneumothorax, hemothorax and/or cardiovascular trauma

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Emergency Treatment

- Initial treatment is supportive, typically consisting of oxygen supplementation and analgesic therapy
- Positioning the patient in lateral recumbency with the flail segment down may decrease pain and improve respiratory function
- Chest wraps should be avoided as they tend to compress the chest wall and decrease compliance while providing minimal support of the flail segment
- Patients with significant pulmonary contusions or lung pathology may require ventilatory support
- Once the patient's hemodynamic and respiratory status is stable, the flail segment may be surgically stabilized

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Diaphragmatic hernia

- Thoracic trauma frequently results in tearing of the diaphragm and possible displacement or entrapment of abdominal contents into the thoracic cavity
- Respiratory distress secondary to trauma diaphragmatic hernias varies from subclinical to severe depending upon the extent of abdominal organ displacement

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Clinical Signs and Diagnosis

- Symptoms include tachypnea, a rapid shallow respiratory pattern, and cyanosis; auscultation may reveal decreased heart and lung sounds or bowel sounds within the thoracic cavity
- Myocardial irritation secondary to displaced abdominal contents often results in cardiac arrhythmias
- Diagnosis is based on patient history, clinical symptoms, and diagnostic imaging
- Radiographic evidence of intestinal loops, stomach, or other abdominal organs within the chest is definitive
- Changes in the cardiac silhouette, displacement of lung fields, loss of diaphragmatic outline, and pleural effusion should be considered suspicious, and further imaging may be indicated
- Contrast media may be utilized to enhance radiographic images

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Emergency Treatment

- Treatment involves stabilization of life-threatening conditions and supportive care including fluid therapy for correction of shock and cardiovascular support, oxygen therapy, and pain management
- Surgical repair of the diaphragm is performed once the patient is stable
- Herniation of the stomach into the thorax requires close monitoring; these animals are at significant risk of severe respiratory compromise secondary to gastric distension, and emergency surgery may be required
- Postoperative complications include pneumothorax, organ necrosis secondary to loss of perfusion, and peritonitis or sepsis due to leakage from gastrointestinal perforations
- Re-expansion pulmonary edema can be a serious complication following rapid re-inflations of lung tissue during atelectasis

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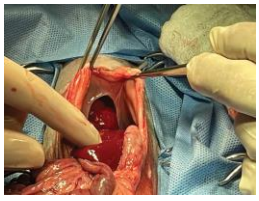

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Acute Respiratory Distress Syndrome (ARDS)

- ARDS and acute lung injury (ALI) describe a generalized inflammatory process characterized by pulmonary edema and infiltration of inflammatory cells
- ALI varies in severity from mild to moderate with a PaO_2 FiO_2 ratio of 300 or less
- ARDS comprises the most severe form and yields a PaO_2 FiO_2 ratio of 200 or less
- Accumulation of neutrophils and macrophages within the lungs, along with interstitial and alveolar edema, are characterized by formation of hyaline membranes within the alveoli, excessive production of type II pneumonocytes, and interstitial fibrosis
- The lungs are highly susceptible to inflammatory insult and ALI/ARDS may be triggered by direct injury to the lungs or by systemic conditions
- Aspiration pneumonia, smoke inhalation, pulmonary contusions, and chemical pneumonitis all result in direct pulmonary injury and inflammation

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Clinical Signs

All patients typically present with mild to moderate respiratory distress and hypoxia

ARDS patients exhibit severe dyspnea, productive thoracic, and open mouth

A moist cough may be present; foamy, pink-tinged fluid may be expectorated

Harsh lung sounds are a frequent finding in ALI; crackles are prevalent in ARDS

Diagnosis is based on clinical symptoms, laboratory findings and radiographs

Arterial blood gas (ABG) sampling typically demonstrates decreased PaO2; in ARDS, the PaO2 may be profoundly decreased and is often accompanied by decreased PaCO2 secondary to hyperventilation

Radiographs are a key tool in the diagnosis of ALI/ARDS

All patients typically exhibit interstitial or alveolar pulmonary patterns

ARDS will appear bilateral with cardiac silhouette, diffuse, bilateral alveolar infiltrates

Emergency Treatment

Oxygen supplementation

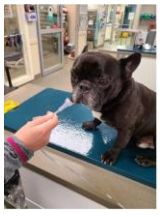
+/- positive-pressure ventilation

ABG monitoring

IV fluid therapy

Treatment of the underlying cause is necessary to minimize the progression

Oxygen Therapy



High-Flow

For patients that do not respond adequately to conventional oxygen therapy, HFOT is an effective alternative method of delivering high volumes and pressures of oxygen


nurse

Use of High-Flow Oxygen Therapy in Critical Canine Patients With Respiratory Distress

Mechanical Ventilation

Mechanical ventilation is a lifesaving intervention that is used to manage a variety of conditions. Broad indications for mechanical ventilation include severe hypoxemia, severe hypercapnia, and increased work of breathing.

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Questions

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