Standing position

* Zone(1) غيرموجود في الـ

فيه Zone(2)+(3)

* Zone(3) موجود في كل الرئة في حاله الاستلقاء على الظهر

8 - Ventilation / perfusion ratio -II

By

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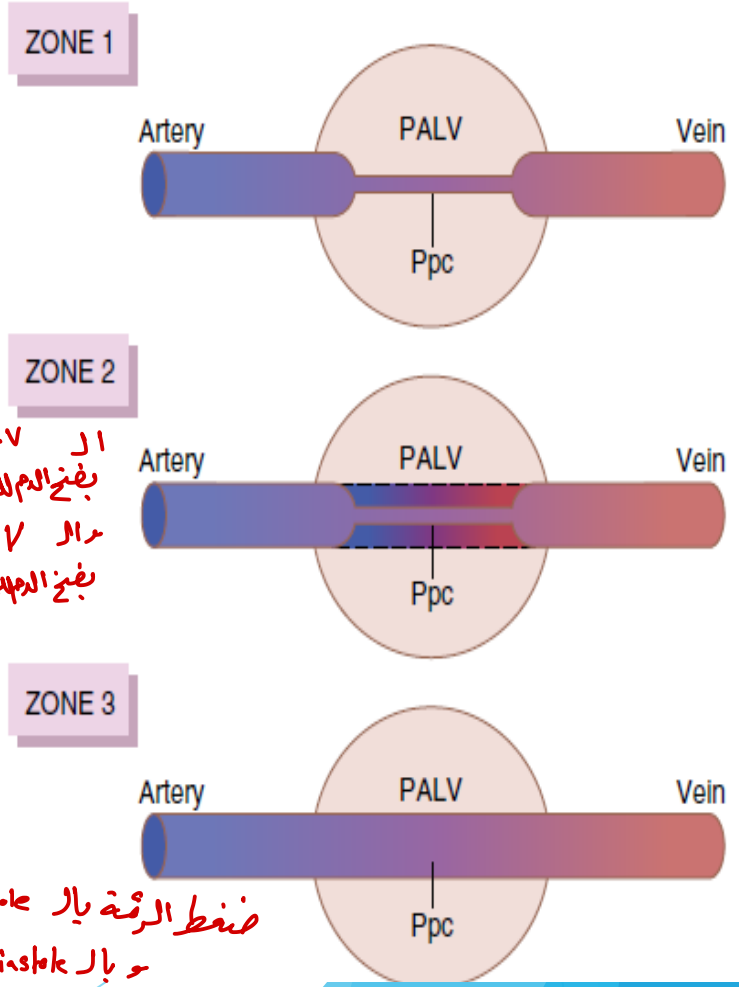
Zones 1, 2, and 3 of Pulmonary Blood Flow

- Zone 1: *No blood flow during all portions of the cardiac cycle* because the local alveolar capillary pressure in that area of the lung never rises higher than the alveolar air pressure during any part of the cardiac cycle
- Zone 2: *Intermittent blood flow* only during the peaks of pulmonary arterial pressure because the systolic pressure is then greater than the alveolar air pressure, but the diastolic pressure is less than the alveolar air pressure

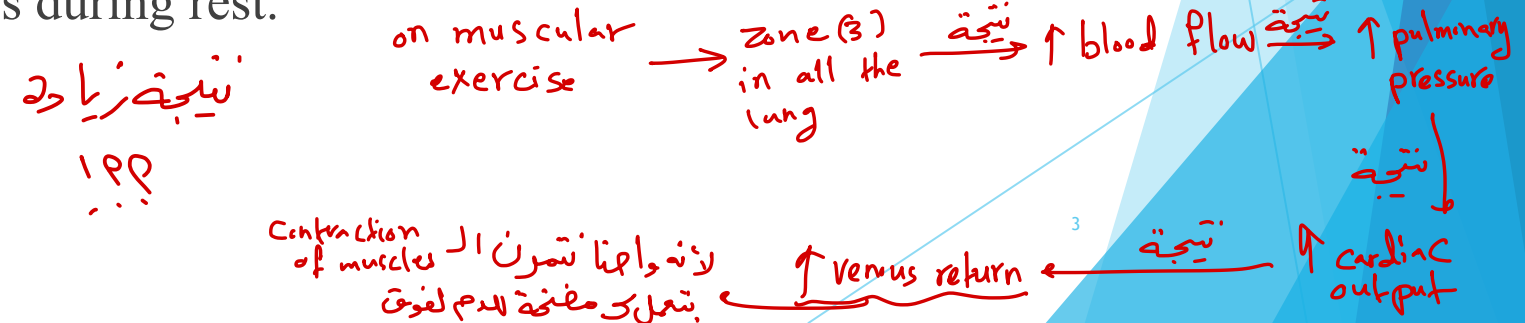
Zone 3: *Continuous blood flow* because the alveolar capillary pressure remains greater than alveolar air pressure during the entire cardiac cycle



-In normal healthy lung during **standing**, there are zone II (Apex) and zone III (at base) and during recumbent position all lung are of zone III.

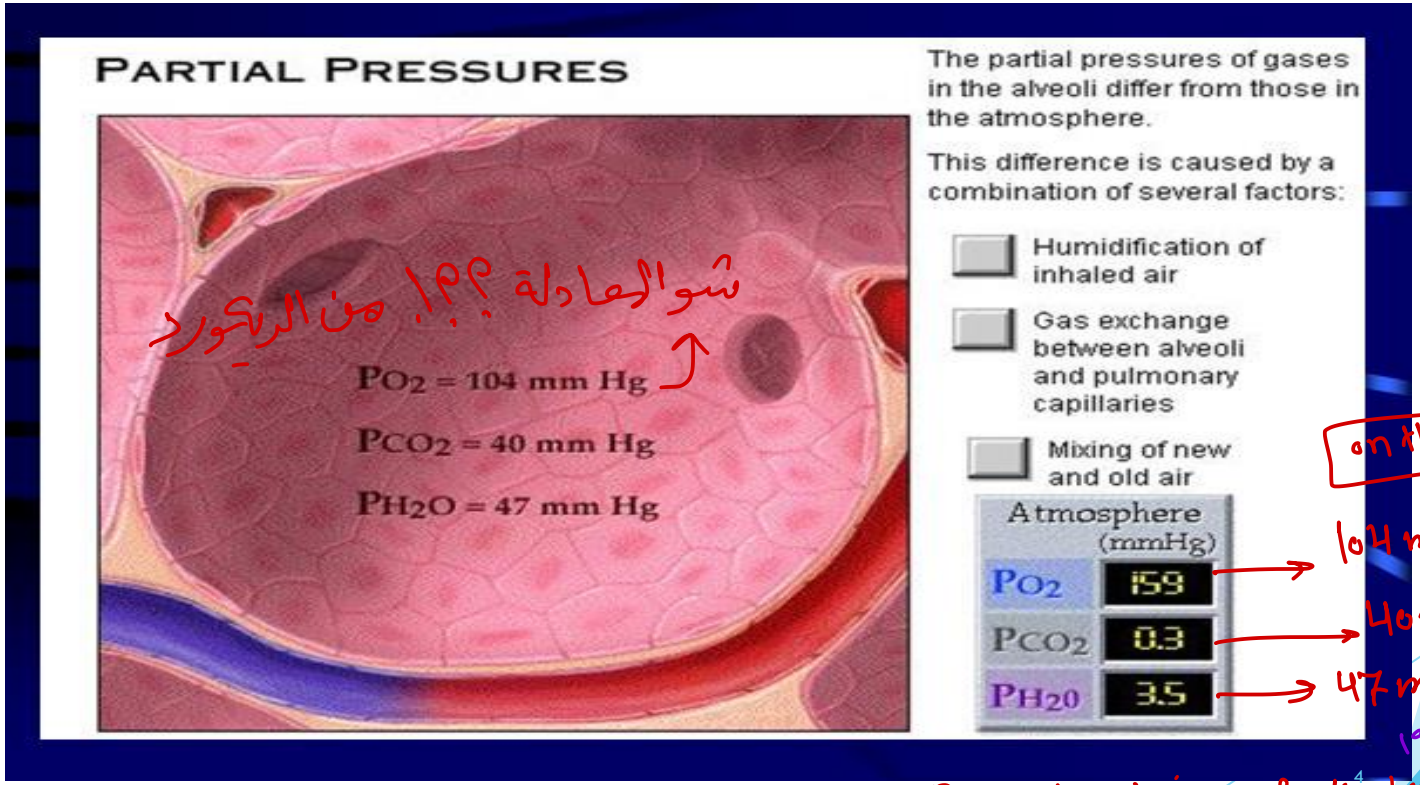
Zone I presents abnormally if the person breaths air under positive pressure in which intra-alveolar pressure reaches 10 mmHg **also** occur in hypovolemic shock.

-During **muscular exercise,** the pulmonary blood flow increases in all parts of the lung via opening of new capillaries especially the apex which has already closed capillaries during rest.



Just to Remember

* ال partial pressure لغاز معين ← الـ pressur exerted by this gas نسبة إلى كل الغازات



شو العادلة ؟؟!! من الريكورد

on the alveoli

104 mm Hg

40 mm Hg

47 mm Hg حسب الـ text book

19% و 20.5% و 21% ← percentage

atmospheric pressure = 760 mm Hg

PO_2 = atmospheric pressure X fraction of O_2 ← في الكلب هنا

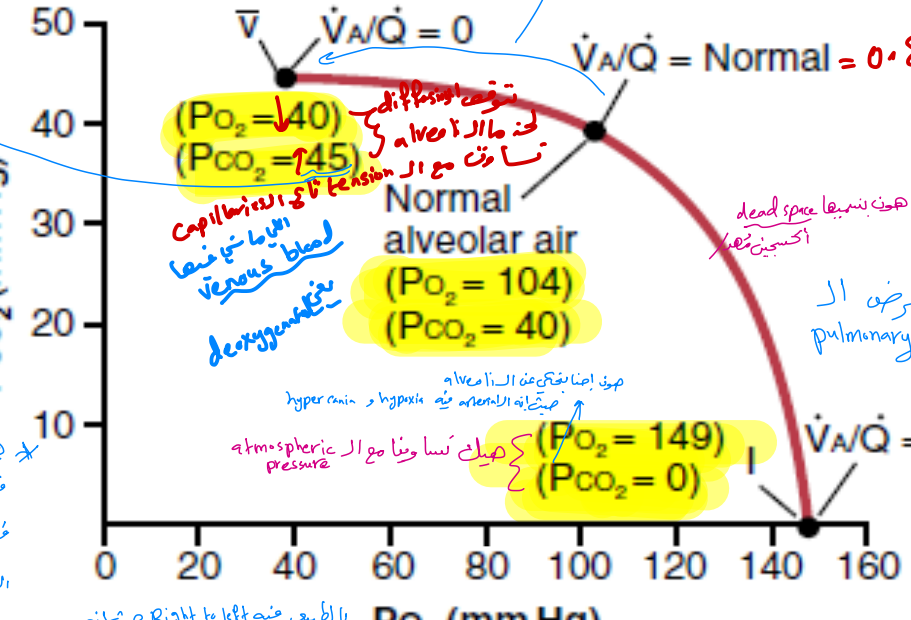


Figure 40-11. Normal partial pressure of oxygen (P_{O_2})–partial pressure of carbon dioxide (P_{CO_2}) ventilation-perfusion ($\dot{V}_A/\dot{Q}$) ratio (P_{O_2}-P_{CO_2}, ($\dot{V}_A/\dot{Q}$) diagram.

Pathophysiology

Extreme alterations of V/Q

-An area with perfusion but no ventilation (and thus a V/Q of **zero**) is termed

(**shunt**)

With airway obstruction, the composition of alveolar air approaches that of mixed venous blood

i.e. PO_2 = 40 mmHg PCO_2 = 45 mmHg

-An area with ventilation but no perfusion (and thus a V/Q **undefined though approaching infinity**) is termed **"dead space".**

With pulmonary embolus, the composition of alveolar air approaches that of inspired air

i.e. PO_2 = 149 mmHg PCO_2 = 0 mmHg

-The term V/Q mismatch is more appropriate for conditions in between these two extremes.

A lower V/Q ratio (with respect to the expected value for a particular lung area in a defined position) impairs pulmonary gas exchange and is a cause of low arterial partial pressure of oxygen (pO2).

Excretion of carbon dioxide is also impaired, but a rise in the arterial partial pressure of carbon dioxide (pCO2) is very uncommon because this leads to respiratory stimulation and the resultant increase in alveolar ventilation returns arterial partial pressure CO2 to within the normal range.

These abnormal phenomena are usually seen in **chronic bronchitis, asthma, and acute pulmonary edema.**

A high V/Q ratio decreases pCO2 and increases pO2 in alveoli.

-Because of the increased dead space ventilation, the pO2 is **reduced (in blood vessels)** and thus also the peripheral oxygen saturation is **lower** than normal, leading to tachypnea .

This finding is typically associated with **pulmonary embolism** (where blood circulation is impaired by an embolus).

Ventilation is wasted, as it fails to oxygenate any blood.

-A **high V/Q** can also be observed in **emphysema** as a mal-adaptive ventilatory overwork of the damaged lung parenchyma. Because of the loss of alveolar surface area, there is proportionally more ventilation per available perfusion area. As a contrast, this loss of surface area leads to decreased arterial pO2 due to impaired gas exchange .

1. V/Q ratio in airway obstruction

If the airways are completely blocked (e.g., by a piece of steak caught in the trachea), then ventilation is zero. If blood flow is normal, then **V/Q is zero,** which is called **a right-to-left shunt.**

There is no gas exchange in a lung that is perfused but not ventilated.

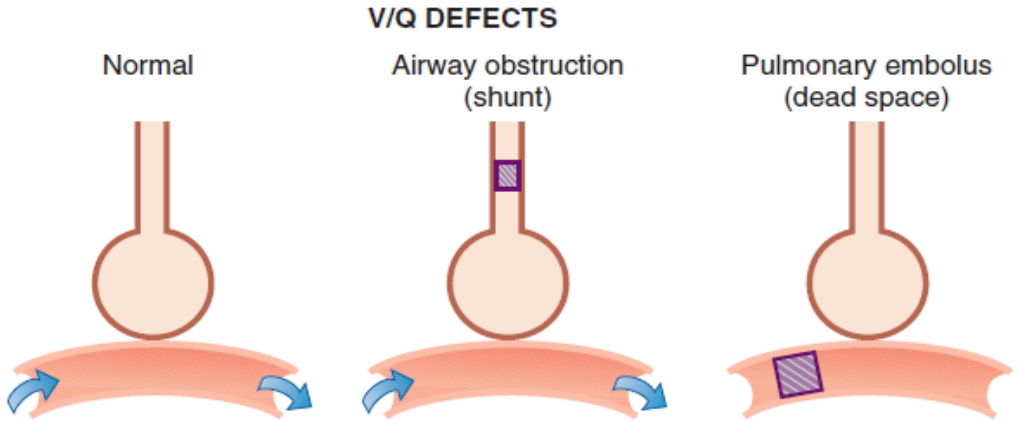
The PO2 and PCO2 of alveolar air will approach their values in mixed venous blood.

2. V/Q ratio in pulmonary embolism

If blood flow to a lung is completely blocked (e.g., by an embolism occluding a pulmonary artery), then blood flow to that lung is zero. If ventilation is normal, then **V/Q is infinite,** which is called **dead space.**

There is ***no gas exchange in a lung that is ventilated but not perfused***.

The PO2 and PCO2 of alveolar gas will approach their values in inspired air.



V/Q	0.8	0	∞
$P_{A_{O_2}}$	100 mm Hg	–	150 mm Hg
$P_{A_{CO_2}}$	40 mm Hg	–	0 mm Hg
Pa_{O_2}	100 mm Hg	40 mm Hg	–
Pa_{CO_2}	40 mm Hg	46 mm Hg	–

FIGURE 4.13 Effect of ventilation/perfusion (V/Q) defects on gas exchange. With airway obstruction, the composition of systemic arterial blood approaches that of mixed venous blood. With pulmonary embolus, the composition of alveolar gas approaches that of inspired air. $P_{A_{O_2}}$ = alveolar P_{O_2}; $P_{A_{CO_2}}$ = alveolar P_{CO_2}; Pa_{O_2} = arterial P_{O_2}, Pa_{CO_2} = arterial P_{CO_2}.

Additional notes:

- **Dead Space**

Dead space is the volume of the airways and lungs that **does not participate in gas exchange.** Dead space is a general term that refers to both the **anatomic dead space of the conducting airways and a functional, or physiologic, dead space.**

- **Physiologic Dead Space**

The physiologic dead space is the **total volume of the lungs that does not participate in gas exchange.** Physiologic dead space includes the **anatomic dead space of the conducting airways plus a functional dead space in the alveoli. T**he functional dead space can be thought of as ventilated alveoli that do not participate in gas exchange. The most important reason that alveoli do not participate in gas exchange is a mismatch of ventilation and perfusion, or so-called ventilation/perfusion defect, in which ventilated alveoli are not perfused by pulmonary capillary blood. **In normal persons**, the physiologic dead space is nearly equal to the anatomic dead space. In other words, alveolar ventilation and perfusion (blood flow) are normally well matched and functional dead space is small.

In certain pathologic situations, however, the physiologic dead space can become larger than the anatomic dead space, suggesting a ventilation/perfusion defect.