VENTILATION & PERFUSION

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VENTILATION

- ventilation is the movement of air between the environment and the lungs and the distribution of air within the lungs to maintain appropriate concentrations of oxygen and carbon dioxide in the blood
- [O2] of air is higher in the lungs than in the blood, O2 diffuses from air to the blood.
- C02 moves from the blood to the air by diffusing down its concentration gradient.
- Gas exchange occurs entirely by diffusion

ALVEOLI

- ~ 300 million air sacs (alveoli).
  - Large surface area (60–80 m^2).
- 2 types of cells:
  - Alveolar type I:
    - Structural cells.90%
    - Adapted for gas exchange
  - Alveolar type II:
    - Secrete surfactant.
    - Allows alveoli to remain inflated at low distending pressures

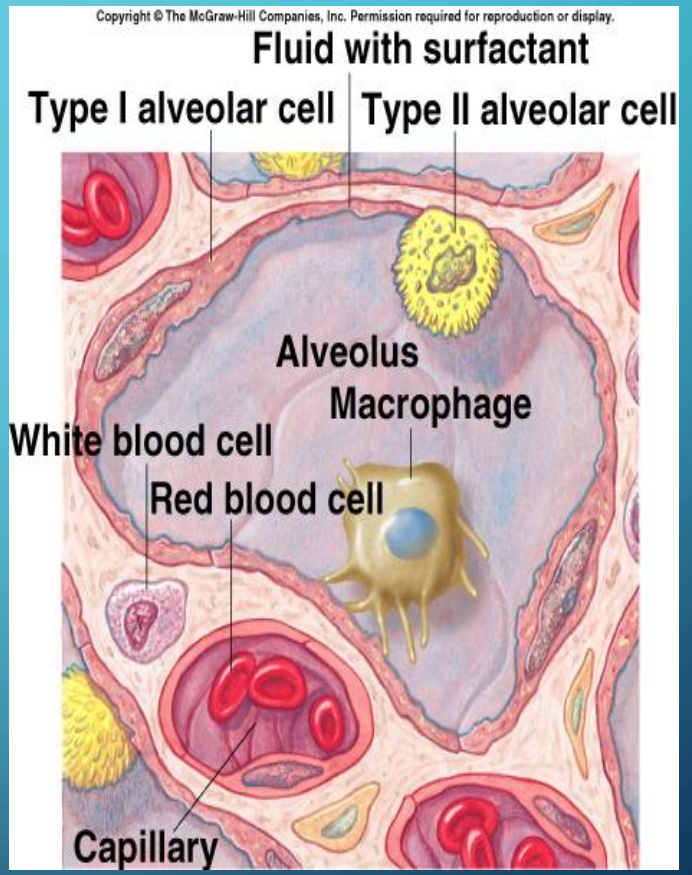


Figure 16.1

AIRWAY BRANCHING SYSTEM

Conducting zone

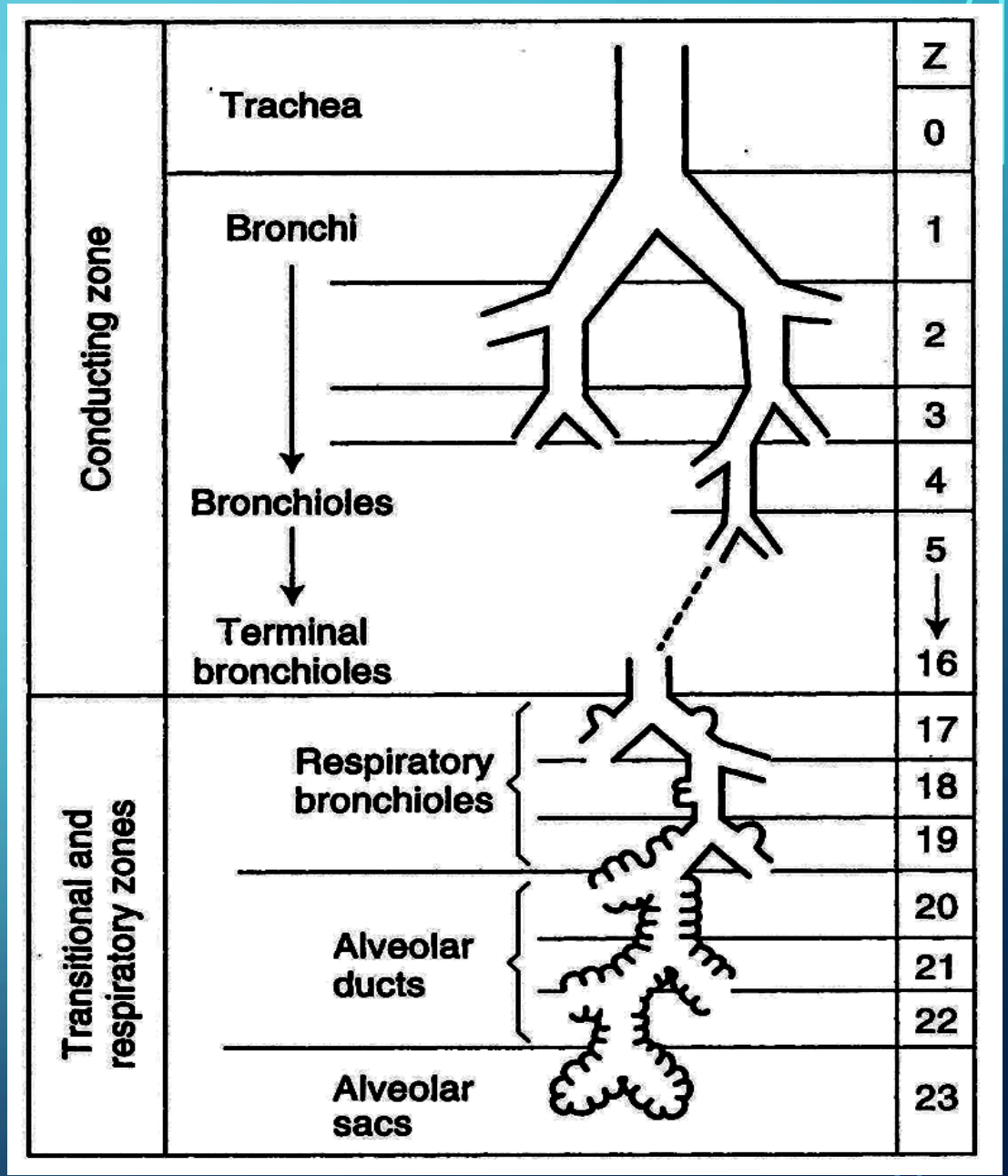
-Warms and humidifies inspired air.

-Filters and cleans:

- ✓ Mucus secreted to trap particles.
- ✓ Mucus moved by cilia to be expectorated.

Respiratory zone:

Region of gas exchange



VENTILATION

Minute ventilation(VE)

- the total volume of gas entering the lungs per minute
- =RR x TV

Alveolar ventilation

- the volume of gas per unit time that reaches the alveoli, the respiratory portions of the lungs where gas exchange occurs:
- VA = TV – anatomical dead space x RR

Dead space ventilation

- the volume of gas per unit time that does not reach these respiratory portions, but instead remains in the airways (trachea, bronchi, etc.).
- =dead space x RR

DEAD SPACE (DS)

- Volume of inspired air which has not participated in gas exchange.

- Physiological DS = Anatomical DS + Alveolar DS
- Anatomical Dead Space

It is the volume of the conducting airways in which no gas exchange takes place

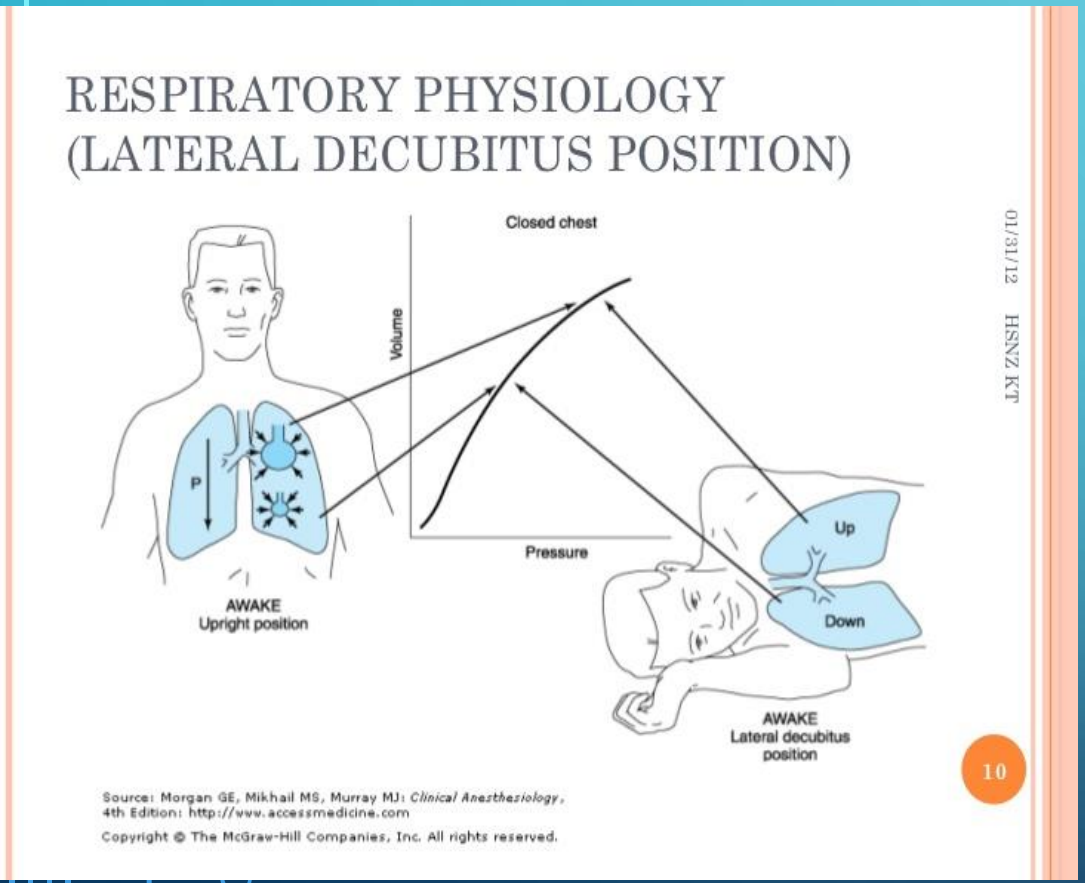
- Alveolar Dead Space VD

that part of the inspired gas which passes through the anatomical dead space and enters alveoli, those alveoli which have little or no blood flowing(ventilated but not perfused)

ALVEOLAR DEAD SPACE VD

- It increase with increasing age
- increases in the upright and lateral positions due to exaggeration of hydrostatic differences
- Increase with increasing in TV

VENTILATION
WHY THE DEPENDENT REGIONS ARE MORE VENTILATED? IN THE VERTICAL POSITION



- The lowest part of the lung in relation to gravity is called the dependent region.
- Gravity and lung's weight act on ventilation by increasing pleural pressure at the base and thus reducing the alveolar volume (transpulmonary pr. is less at the base). Which mean the alveoli are less expand and has greater compliant (more distensible) and so capable of wider oxygen exchanges with the external environment.

Perfusion(Q)

Definition:

The passage of blood through though the pulmonary capillaries" –

Q – the blood that reaches the alveoli

Blood to the lungs

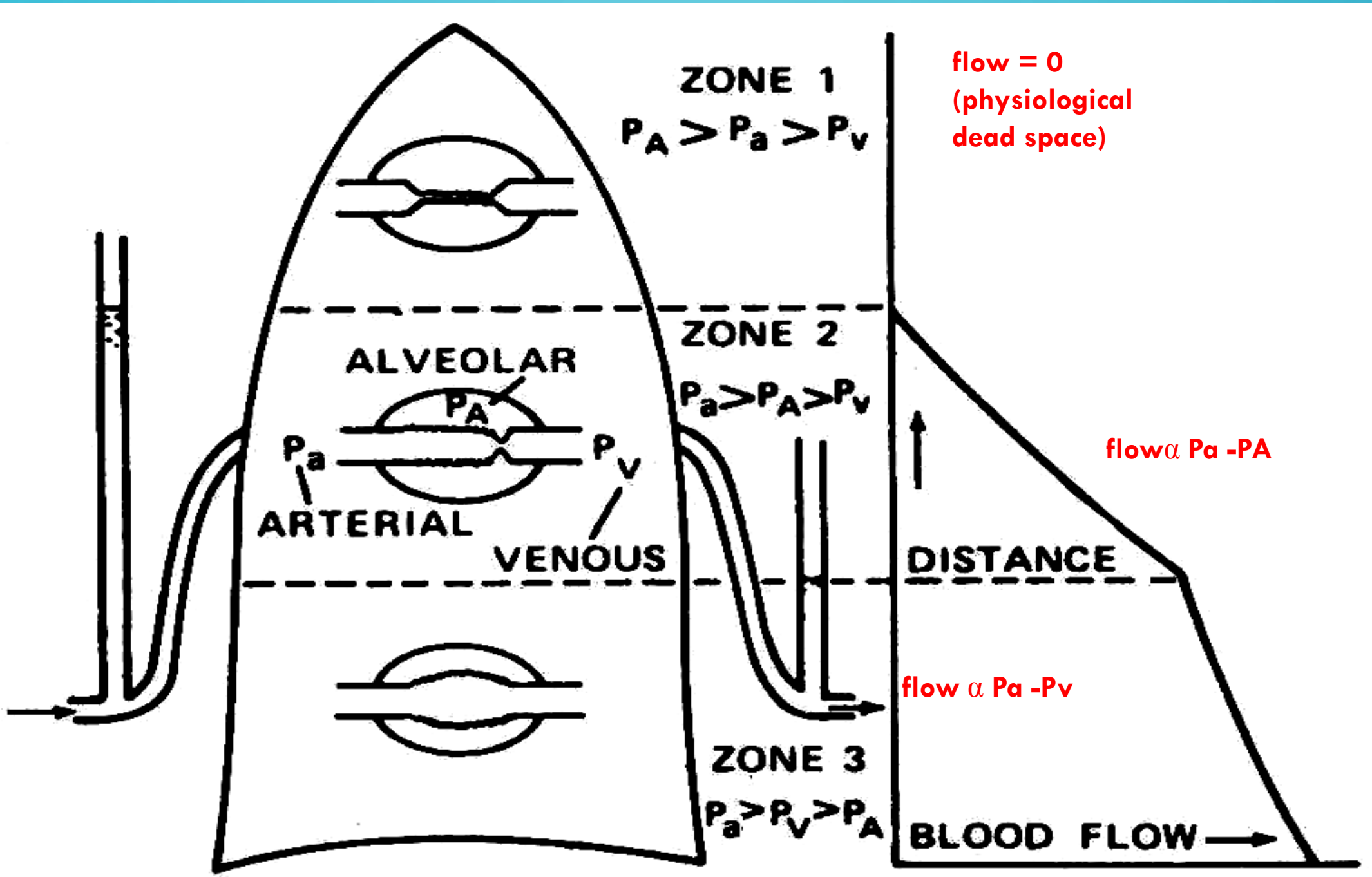
- Pulmonary circulation
- Bronchial circulation

Perfusion(Q) & gravity

The effects of gravity on the distribution of blood flow in the lung are attributed to the hydrostatic pressure difference between the top and bottom of the pulmonary arterial system.

At the uppermost parts of the lung, the pressure within the vessels may be less than the alveolar pressure. Therefore, these vessels collapse and the alveoli that these vessels traverse will receive little blood flow. This accounts for some wasted ventilation' or physiological dead space.

In the gravitational middle zone, pulmonary arterial pressure is greater and pulmonary artery pressure exceeds the alveolar pressure, and, similarly, in the lower zone pulmonary venous pressure also exceeds alveolar pressure.
This well-established 'gravitational model' has shaped our understanding of differences in the matching of ventilation to blood flow in the lung, which affects the efficiency of gas exchange.


ZONE 1
$P_A > P_a > P_v$
flow = 0
(physiological
dead space)
ZONE 2
$P_a > P_A > P_v$
ALVEOLAR
P_A
P_a
P_v
ARTERIAL
VENOUS
flowα Pa -PA
DISTANCE
flow α Pa -Pv
ZONE 3
$P_a > P_v > P_A$
BLOOD FLOW

VENTILATION/PERFUSION RATIO (**V/Q RATIO**)

- **the ratio of the amount of air reaching the alveoli(V) to the amount of blood reaching the alveoli(Q).**
- **a measurement used to assess the efficiency and adequacy of the matching of two variables**
- **VA/Q various within the normal lung.**

VENTILATION / PERFUSION RATIO

- Ventilation (V)
- • Alveolar minute ventilation = 4 to6L
- Perfusion (Q)
- Normal cardiac output= 5 L

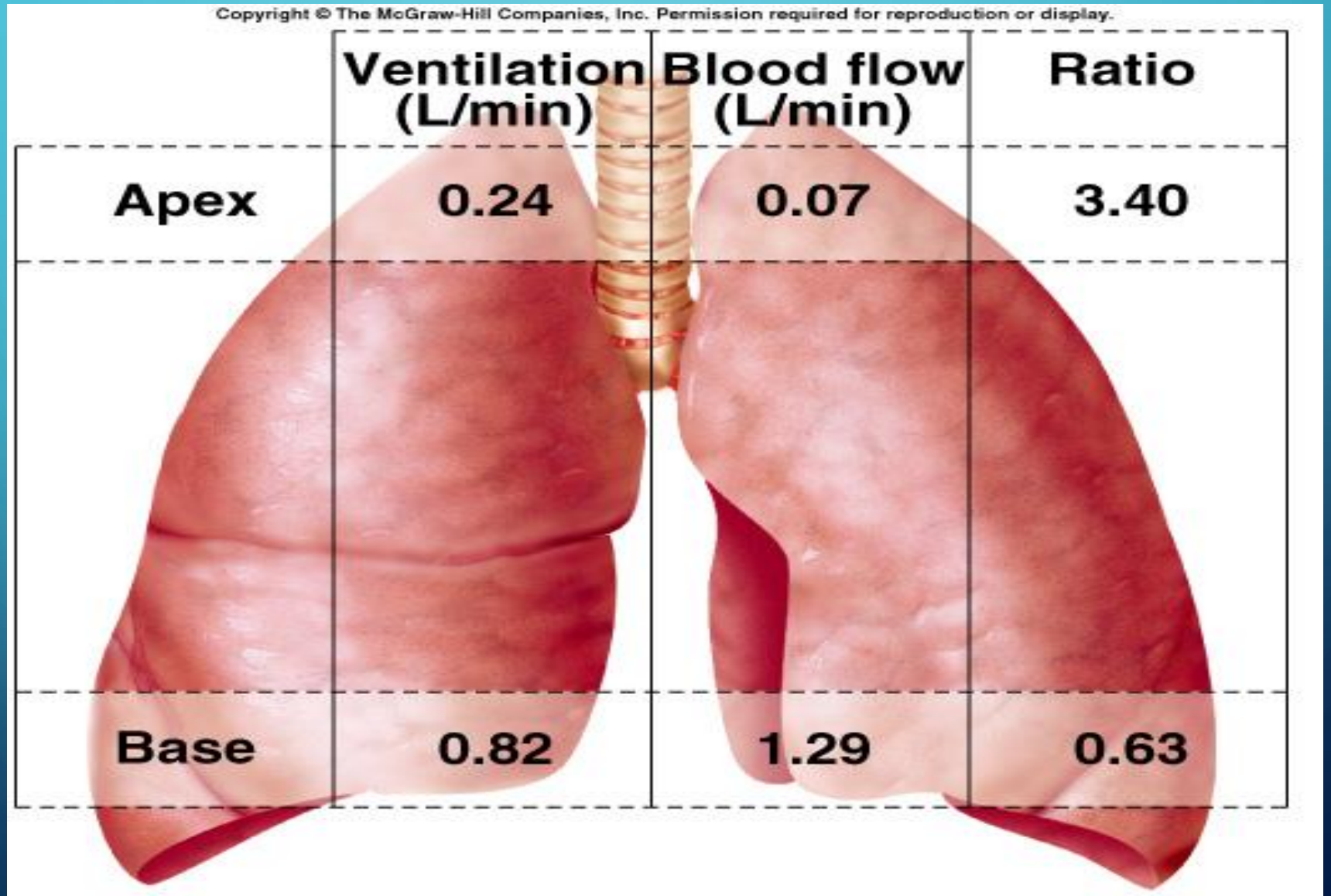
Normal ventilation / perfusion ratio (V/Q ratio) = 0.8 to 1.2

Ventilation and perfusion must be matched at the alveolar capillary level to reach adequate gas exchange

VENTILATION/PERFUSION RATIO (**V/Q RATIO**)

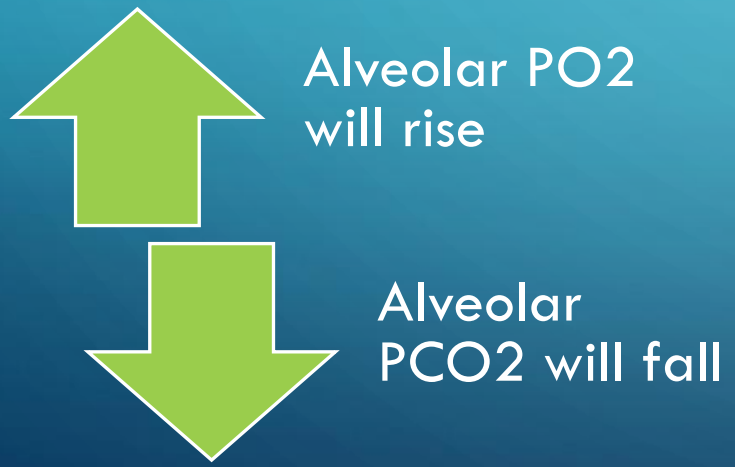
- **In a subject standing (upright) ,the apex of the lung shows higher V/Q ratio, while at the base of the lung the ratio is lower but nearer to the optimal value for reaching adequate blood oxygen concentrations. WHY?**
- **The main reason for lower V/Q ratios at the base is that both ventilation and perfusion increase when going from the apex to the base, but Q does it more strongly thus lowering the V/Q ratio.**

LUNG VENTILATION/PERFUSION RATIOS

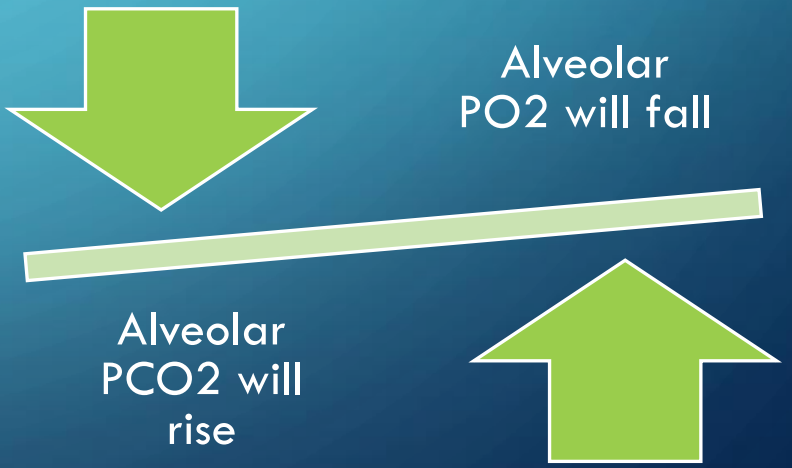


VENTILATION / PERFUSION RATIO

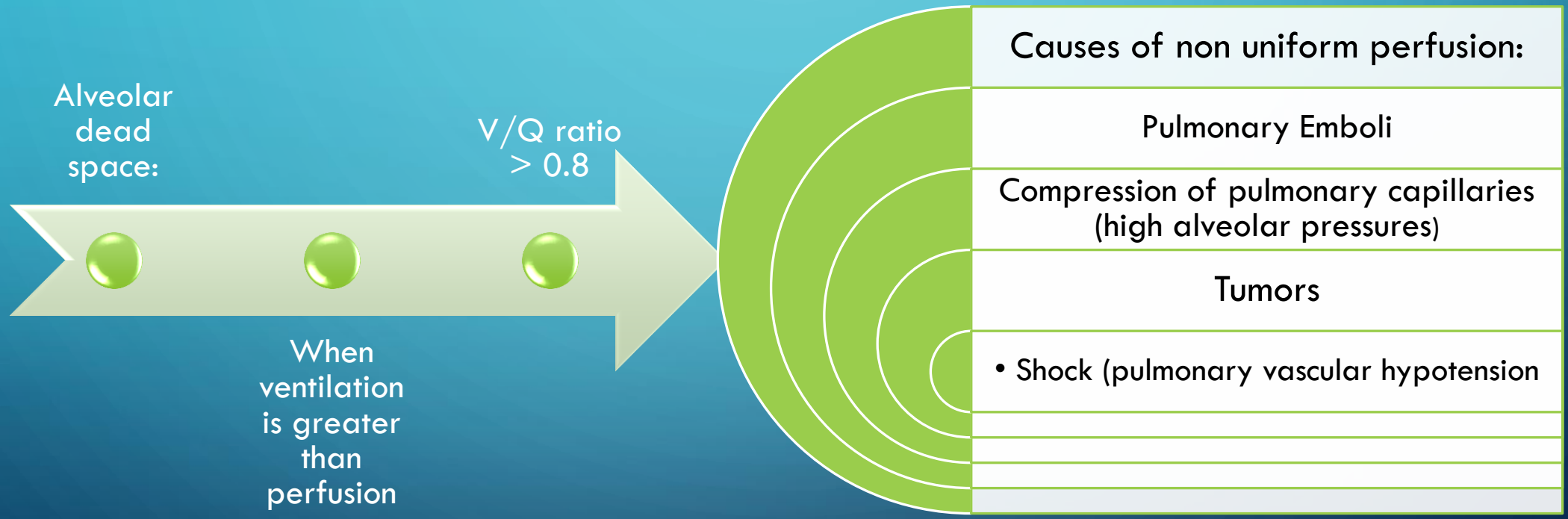
- Increase in ventilation perfusion ratio



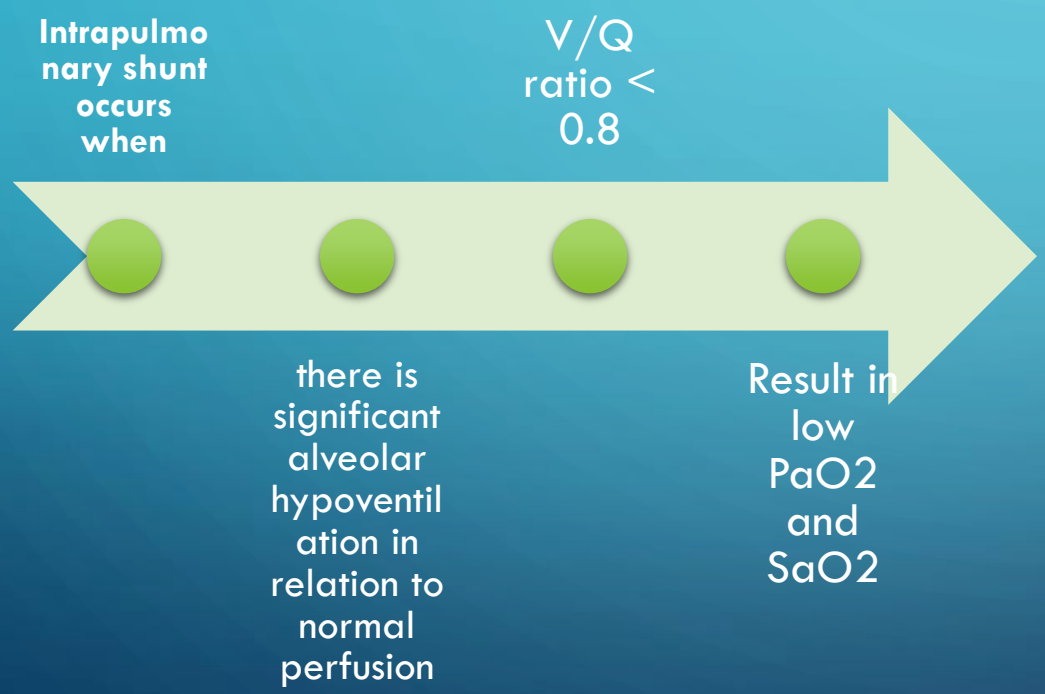
- Decrease in ventilation perfusion ratio



INCREASED V/Q RATIO: ALVEOLAR DEAD SPACE



DECREASED V/Q RATIO: INTRAPULMONARY SHUNTING



Causes
atelectasis,
pneumonia, Asthma, chronic bronchitis
pulmonary edema,
adult respiratory distress syndrome.

THANK YOU