RESPIRATORY SYSTEM

RESPIRATORY FUNCTIONS
MECHANICS OF RESPIRATORY SYSTEM
GAS TRANSPORT

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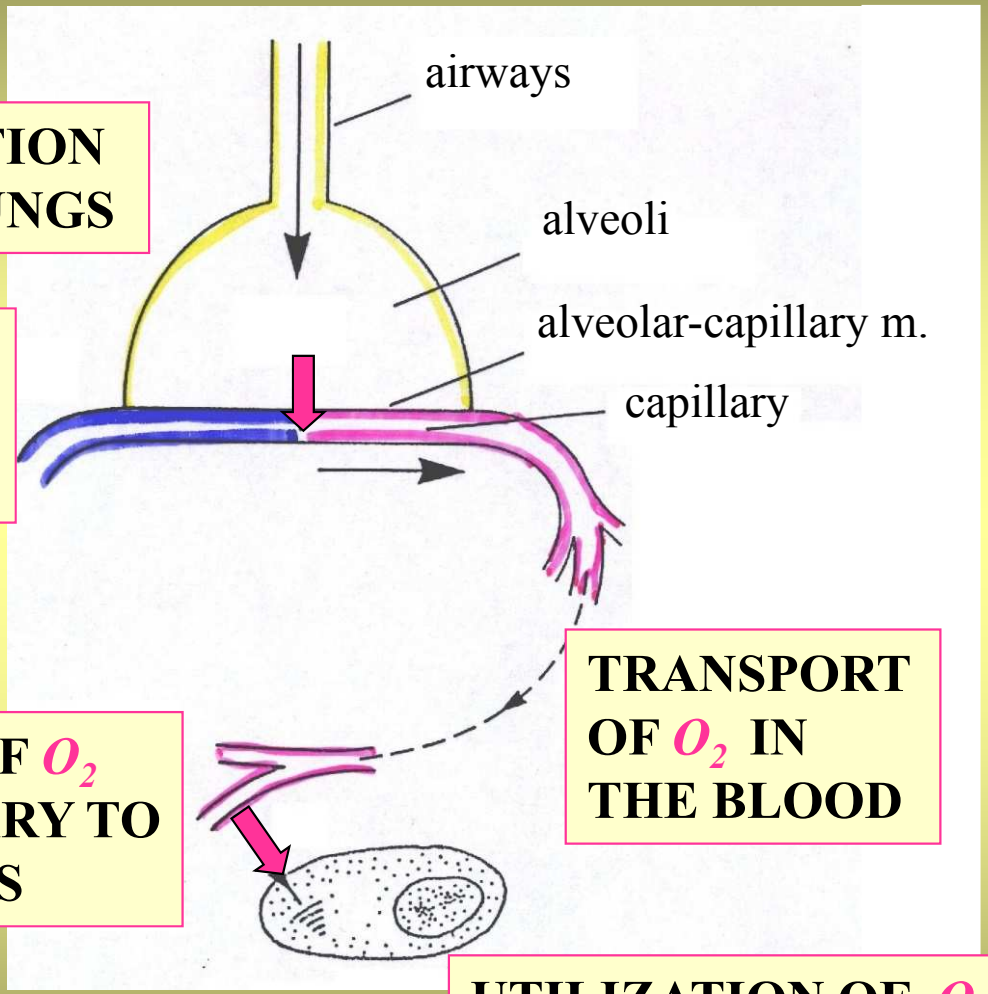
STEPS IN THE DELIVERY OF O_2 TO THE CELLS

VENTILATION OF THE LUNGS

DIFFUSION OF O_2 ACROSS ALVEOLAR-CAPILLARY MEMBRANE



TRANSPORT OF O_2 IN THE BLOOD

DIFFUSION OF O_2 FROM CAPILLARY TO THE CELLS

UTILIZATION OF O_2 BY MITOCHONDRIA

AT REST

O_2 UPTAKE ~300 ml / min

CO_2 OUTPUT ~250 ml / min

INTERNAL RESPIRATION

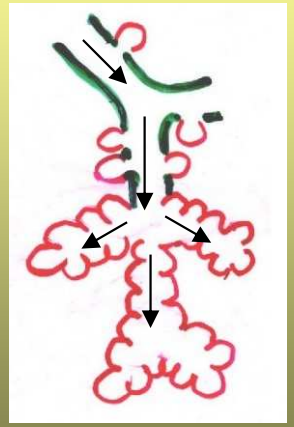
AIR PASSAGES

ANATOMICAL DEAD SPACE –CONDUCTING ZONE

- NASAL PASSAGES
- PHARYNX
- LARYNX
- TRACHEA
- BRONCHI
- BRONCHIOLES
- TERMINAL BRONCHIOLES

Other physiological functions:

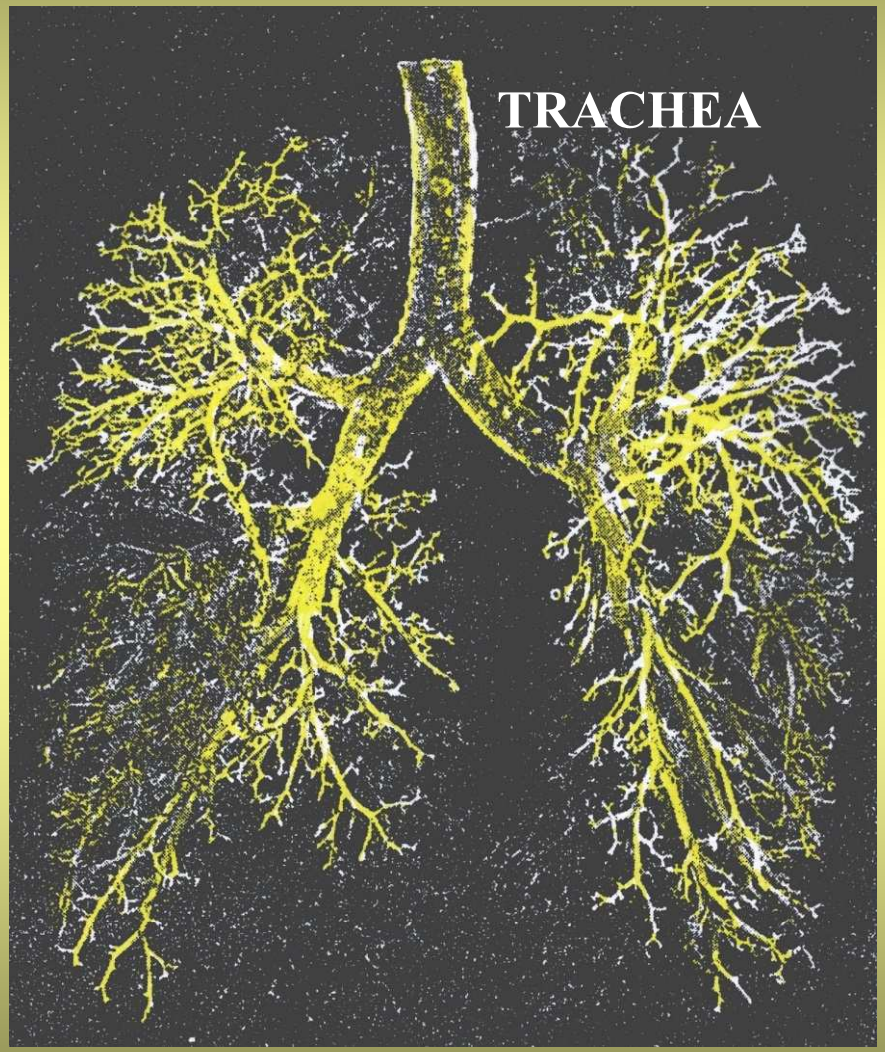
- air is warmed, cleaned and takes up water vapour
- respiratory reflex responses to the irritants
- speech and singing (function of larynx)



RESPIRATORY ZONE
(GAS EXCHANGE)

Total alveolar area ~100 m^2

CAST OF HUMAN AIR PASSAGES

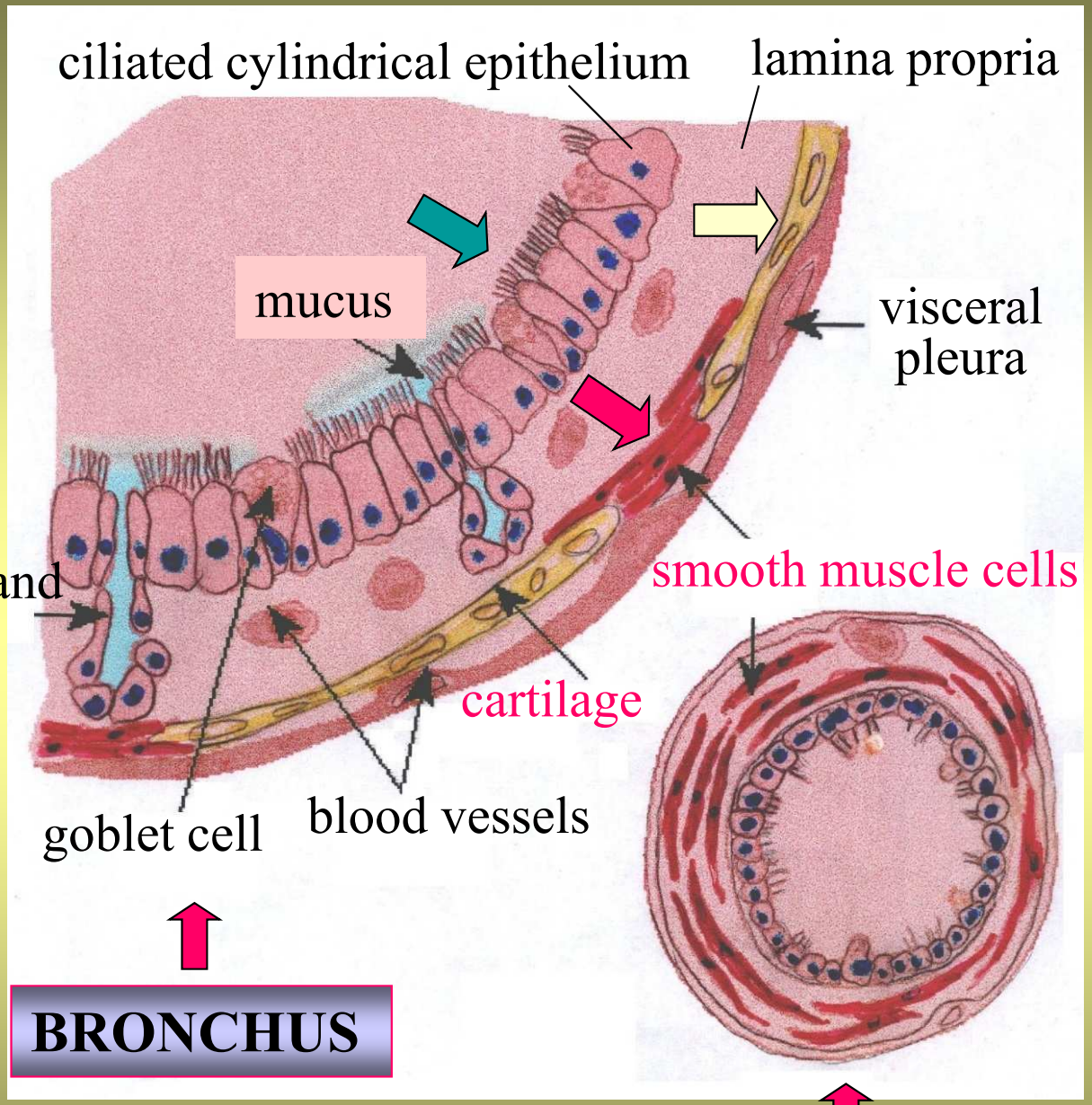


BRONCHI

BRONCHIOLES

TERMINAL BRONCHIOLES

AERODYNAMIC RESISTENCE



BRONCHUS

TERMINAL BRONCHIOLE

∅ < 1 mm

AUTONOMIC INNERVATION of smooth muscle cells

Muscarinic receptors:
Acetylcholine activates
bronchoconstriction

β-adrenergic receptors:
Noradrenaline activates
bronchodilatation

V_T tidal volume ~ 500 ml

$V_T = V_A + V_D$

V_A part of tidal volume entering alveoli ~ 350 ml

V_D part of tidal volume remaining in the dead space ~ 150 ml

f = 12/min

$\dot{V} = V_T \times f$

PULMONARY MINUTE VENTILATION

6 l/min

$\dot{V}_A = V_A \times f$

ALVEOLAR VENTILATION

4.2 l/min

$\dot{V}_D = V_D \times f$

DEAD SPACE VENTILATION

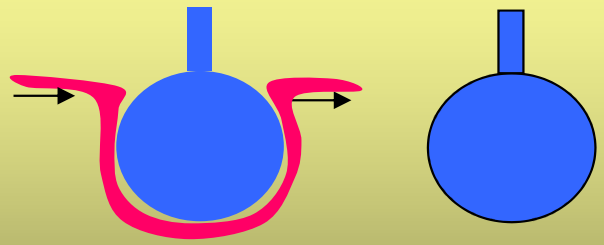
1.8 l/min

DEAD SPACE

TOTAL GAS VOLUME NOT EQUILIBRATED WITH BLOOD
(without exchange of gasses)

- **ANATOMICAL dead space - volume of air passages**
- **FUNCTIONAL (total) dead space**

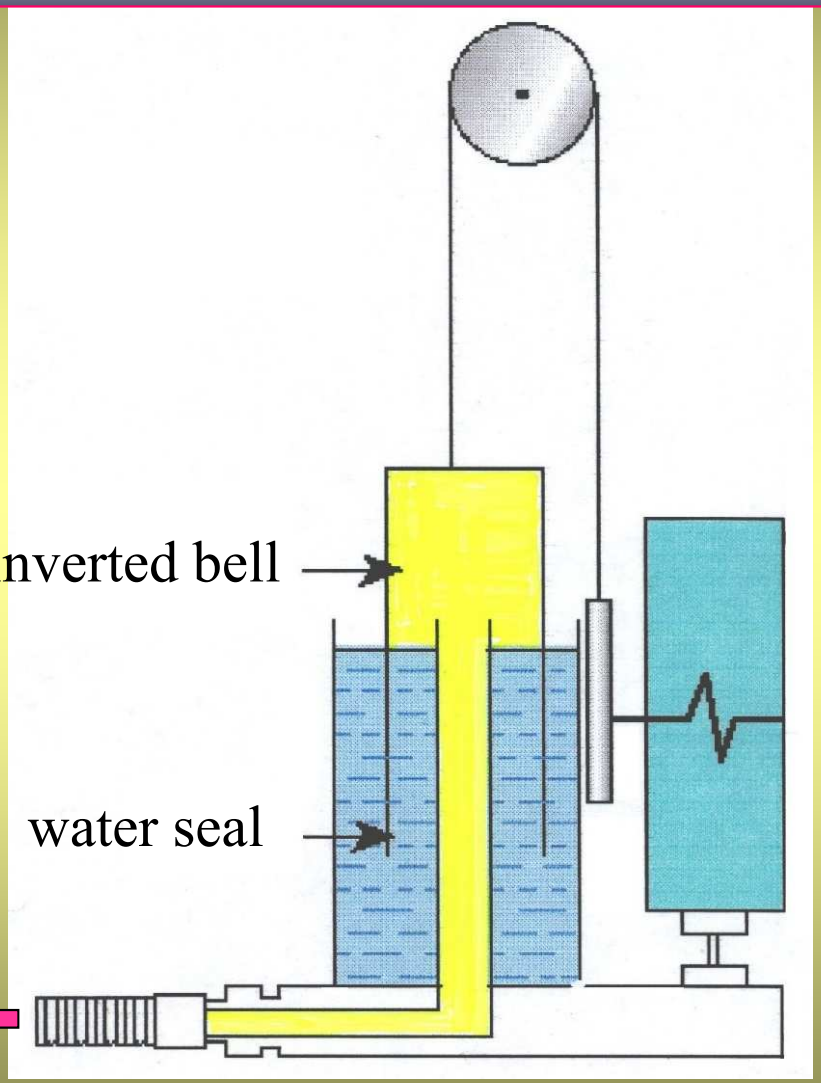
ANATOMICAL dead space + total VOLUME of ALVEOLI without functional capillary bed



IN HEALTHY INDIVIDUALS
both spaces are practically identical

SPIROMETRY

(measurements of lung volumes, capacities, functional investigations, …)



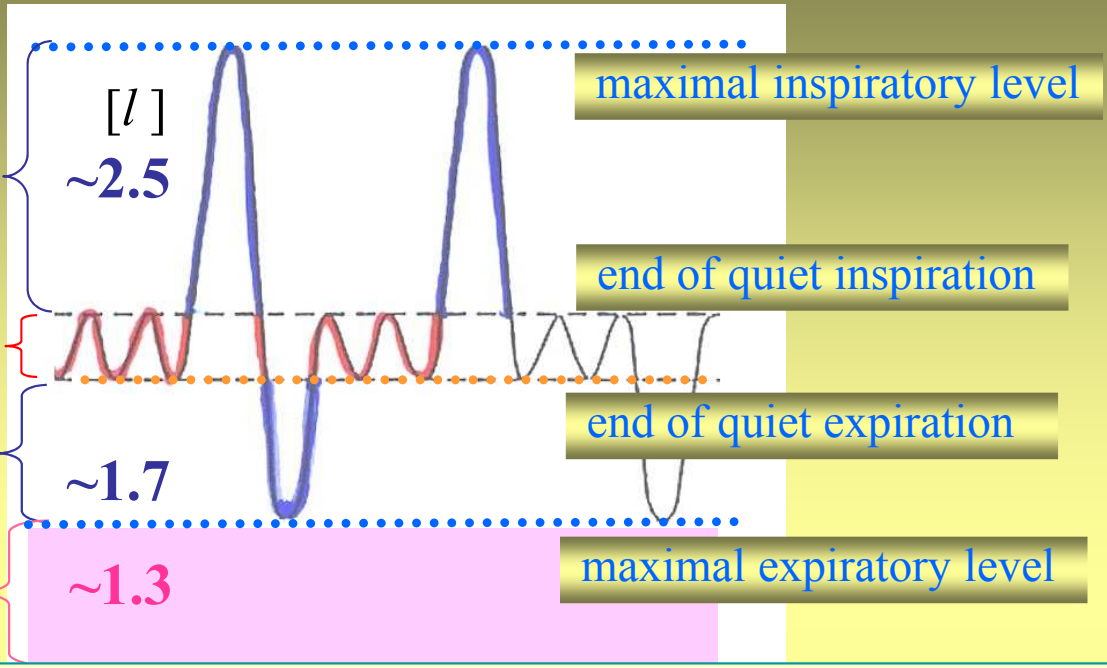
LUNG VOLUMES

INSPIRATORY RESERVE VOLUME *IRV*

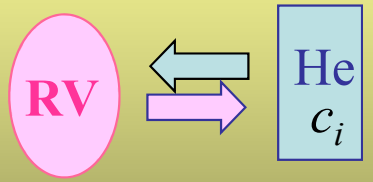
TIDAL VOLUME V_T

EXPIRATORY RESERVE VOLUME *ERV*

RESIDUAL VOLUME *RV*



DILUTION METHOD *He*

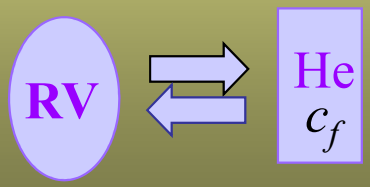


reservoir (V_r)

Principle of method: **1** Maximal expiration, **2** Repeated inspiration from and expiration into a reservoir (known **volume** V_r) with inert gas ***He*** (known concentration c_i)

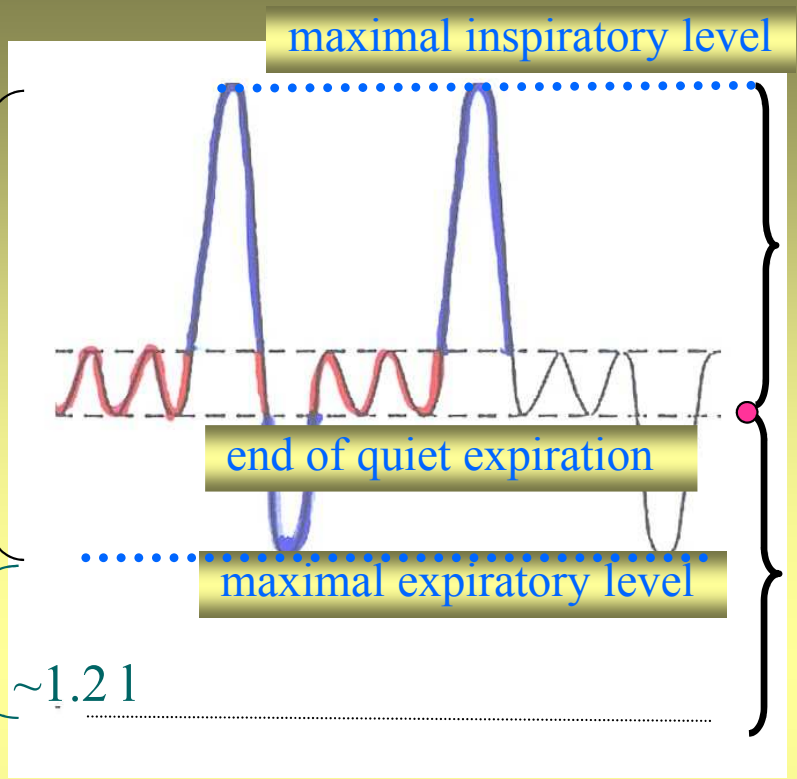
⇒ Equilibration of the air in the residual volume and reservoir

3 Calculation of **residual volume *RV*** from the initial and final *He* concentrations in reservoir (c_i , c_f).



reservoir (V)

$$RV = V_r \frac{c_{i\,He} - c_{f\,He}}{c_{f\,He}}$$



TLC

VC

RV

INSPIRATORY CAPACITY

>3.0 l

FUNCTIONAL RESIDUAL CAPACITY

<3.0 l

VC **VITAL CAPACITY = V_T + IRV + ERV** ~ 4.7 l

VC - the largest amount of air that can be expired after maximal inspiration

TLC **TOTAL LUNG CAPACITY = VC + RV** ~ 6.0 l