# BMSN1601 – Anatomy – Part II – Part B (L16~L17)

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| Introduction to the Respiration Process |

* Respiration involves **4 distinct** processes

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| Pulmonary ventilation | External respiration | Transport | Internal respiration |
| movement of air  into & out of lungs | Gas exchange between lungs & blood | transport of O2 & CO2 between lungs & tissues | gas exchange between systemic arterial blood & body tissues across capillary membrane |

* Recap: Basic Information About Different Pressure during the discussion
  + Atmospheric pressure: 760mmHg
  + Intrapulmonary Pressure [Palv]: Pressure in the alveolar
  + – Intrapleural Pressure [Pip] = Collapsing Pressure of Lung  
    → The Intrapleural Pressure is always smaller than Intrapulmonary Pressure
* Recap: Basic Information About Inspiration
  + Lungs are stretched & intrapulmonary volume increases  
    → Intrapulmonary pressure drops (-1 mmHg / Minimum Value)  
    → Air flows into lungs down pressure gradient  
    → Intrapulmonary Pressure gradually increase → Intrapulmonary Pressure = Atmospheric Pressure (760mmHg)

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| 💬 | **Lungs can slide but not separated from pleura**   * Lungs adhere to thoracic wall * Expand/recoil as thoracic cavity changes in volume during breathing |

* Recap: Basic Information About Expiration
  + Quiet expiration depends on natural elasticity of lungs  
    → No Muscle Contraction
  + **Inspiratory muscles relax** & **resume resting length**  
    → Rib cage descends due to gravity  
    → Volume of thoracic cavity decreases  
    → Lungs **recoil**
  + Intrapulmonary volumes decreases  
    → Intrapulmonary pressure rises (to +1 mm Hg / Maximum Value)
* Pressure & Volume Changes during Pulmonary ventilation

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|  | Intrapulmonary pressure  (Relative) | Intrapleural pressure  (Relative) |
| Inspiration | -1mmHg | -6mmHg |
| Expiration | +1mmHg | -3mmHg  Still **(< intrapulmonary pressure**) to **keep alveoli inflated** |

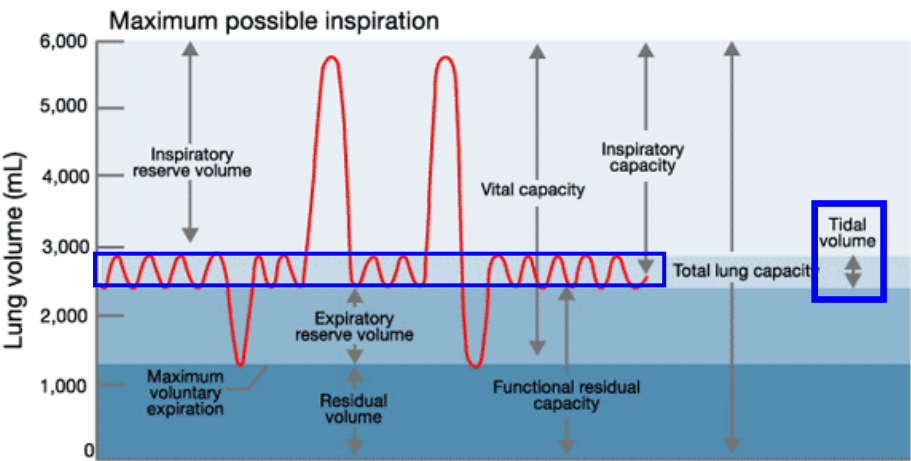
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| Introduction to the Clinical Physiology Regarding the Pulmonary Ventilation |

* Dead Space: Volume of inhaled air which **does not take part in gas exchange**

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| Dead Space | |
| Anatomical Dead Space | Volume of conducting respiratory passageways (~150mL) |
| Alveolar dead spaces | Volume occupied by alveoli that stop to act in gas exchange (**due to collapse, obstruction or lack of adjacent pulmonary capillaries**)   * Emphysema * Pneumonia * Chronic obstructive pulmonary disease |

* Non-respiratory Air Movements
  + Coughing, Sneezing, Crying, Laughing, Yawning

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| Introduction to the Lung Volume & Lung Capacities |



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| Tidal volume (TV) | * volume of air that moves into or out of lungs with **each normal, quiet breath**   (~ 500 mL) |
| Inspiratory reserve volume (IRV) | * extra volume of air that can be inspired forcibly **after a tidal inspiration**   (2,100 – 3,200 mL) |
| Expiratory reserve volume (ERV) | * extra volume of air that can be evacuated from lungs **after a tidal expiration**   (1,000 – 1,200 mL) |
| Residual volume (RV) | * volume of air left in lungs **after strenuous expiration**   (1,200 mL) |

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| Inspiratory capacity (IC) [**total amount of air that can be inspired after a tidal expiration**] | Tidal volume (TV) |
| Inspiratory reserve volume (IRV) |

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| Functional residual capacity (FRC)  [~~total~~ **amount of air remaining in lungs after a tidal expiration**] | Expiratory reserve volume (ERV) |
| Residual volume (RV) |

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| Vital capacity (VC)  [**total amount of exchangeable air (TV + IRV + ERV)**] | Tidal volume (TV) |
| Inspiratory reserve volume (IRV) |
| Expiratory reserve volume (ERV) |

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| Total lung capacity (TLC) | Tidal volume (TV) |
| Inspiratory reserve volume (IRV) |
| Expiratory reserve volume (ERV) |
| Residual volume (RV) |

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| External Respiration – Gas Exchange between Lungs & Blood |

* The Characteristic of Alveoli:

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| Account for most of Volume of Lung | Large Surface Area to facilitate the gas exchange | Surrounded by  **fine elastic fibers** | **Densely** covered with of **pulmonary capillaries** |

* Structure of Alveoli:

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| Type I Alveoli Cells | * Single Layer of Squamous epithelial cells that form Alveolar Wall → For Gas Exchange |
| Type II Alveoli Cells | * Secrete Surfactant → Coat the outer, Alveolar surfaces |
| Marcophages: | * Keep The Alveolar Surfaces **sterile** |
| Alveolar Pores: | * Connect adjacent alveoli * Equalize the air pressure throughout the lung |

* Respiratory Membrane:

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| Barrier across which gases are exchanged between alveolar air & blood (~1-thick) | | |
| Alveolar Epithelium | Capillary Endothelium | Basement Membrane  between Alveolar Epithelium  and Capillary Endothelium |

* Pulmonary Gas Exchange:

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| At alveoli with **maximal ventilation** | * pulmonary arterioles dilate → increasing blood flow into associated capillary |
| At alveoli with **inadequate ventilation** | * pulmonary arterioles constrict → redirecting blood to other respiratory areas |

* Pressure Gradient @ External Respiration

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|  | PO2 | PCO2 |
| Alveoli | 100 mmHg | 40 mmHg |
| Pulmonary Artery | 40 mmHg | 46 mmHg |

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| Transportation – Transport of O2 & CO2 between Lungs & Tissue |

* Transportation of O2

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| Direct Dissolve in Plasma | * By Direct Diffusion |
| Bound to Hemoglobin with RBCs | * Each hemoglobin molecule binds 4 oxygen molecules   + Oxyhemoglobin (HbO2)   + Deoxyhemoglobin (After Releasing O2) |

* Equilibrium of Oxyhemoglobin
  + The Factors: PO2, PCO2, [H+], [BPG]/[2,3-bisphosphoglycerate]

图示

描述已自动生成

*Note: Haemoglobin-Oxygen dissociation graph shift to the right, affinity is reduce;  
Haemoglobin-Oxygen dissociation graph shift to the left, affinity is increase.*

(RR: Right → Reduce Affinity).

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| 💬 | The Chemical Equations:  Thus, we have: |

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| Increase PCO2 → Acidity of Blood is Higher  → Equilibrium Shift to the Right → Affinity Decrease |
| Increase PO2  → Equilibrium of Equation I shift to the Left → Affinity Increase |
| Increase in Temperature→ Forward Reaction is Endothermic  → Equilibrium shift to the Right → Affinity Decrease |
| Increase [H+]  → Equilibrium shift to Right → Affinity Decrease |
| Increase [BPG]→ BPG selectively binding to deoxyhemoglobin → [HHb+] Decrease  → Equilibrium shift to the Right →Affinity Decrease |

* Transportation of CO2
  + Dissolved in plasma
  + Bound to hemoglobin (carbaminohemoglobin)
  + Bicarbonate ions in plasma (70%)