

Role of Mechanical Stresses in Optimising Breathing Therapy Humidification

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Common Breathing Therapy Issues



Augmented Pressure

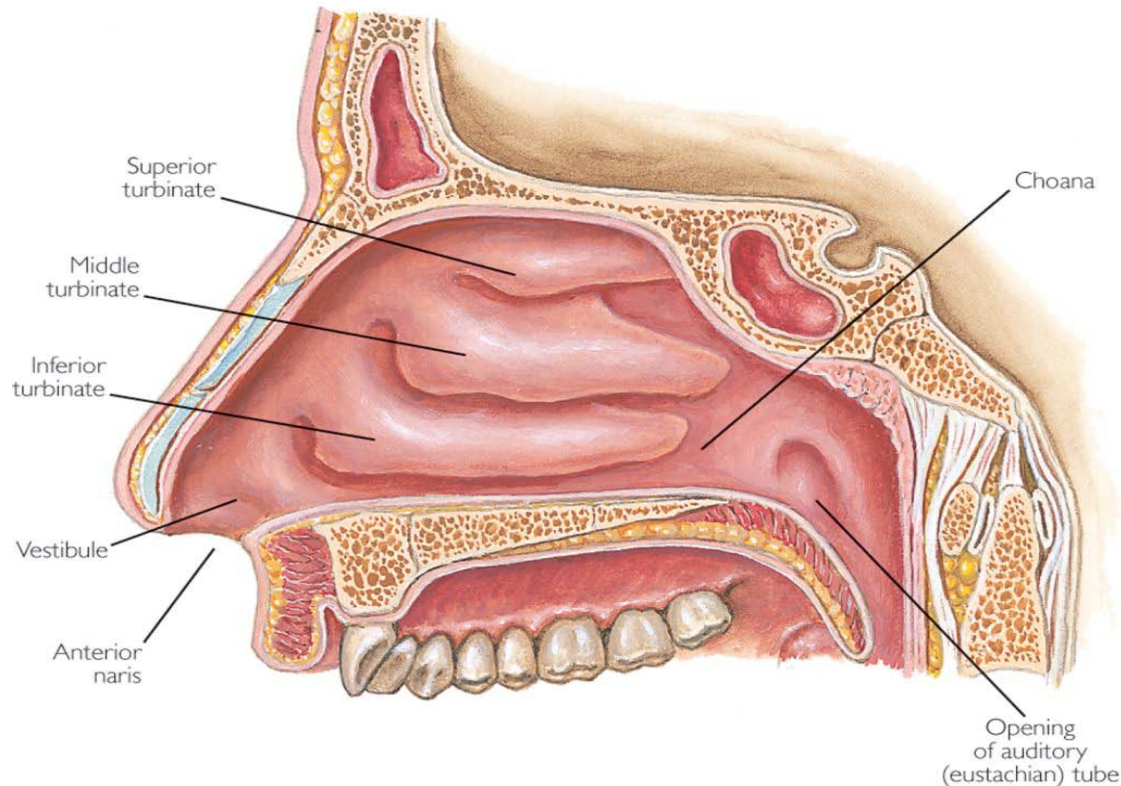


Most Common are Nasopharyngeal Complaints:

- Nasal Stuffiness / Rhinorrhea / Nasal Obstruction etc...
- Dry nose & mouth/ Crusted nose.

Why Does Breathing Therapy Require Humidification?

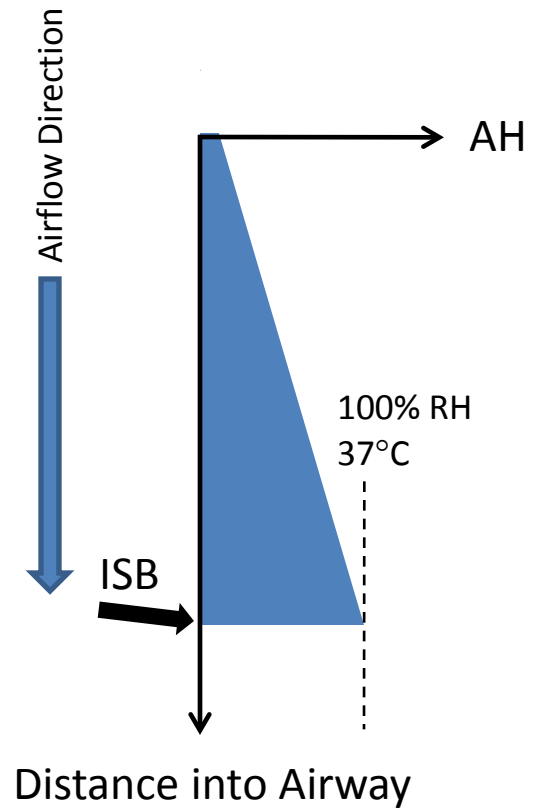
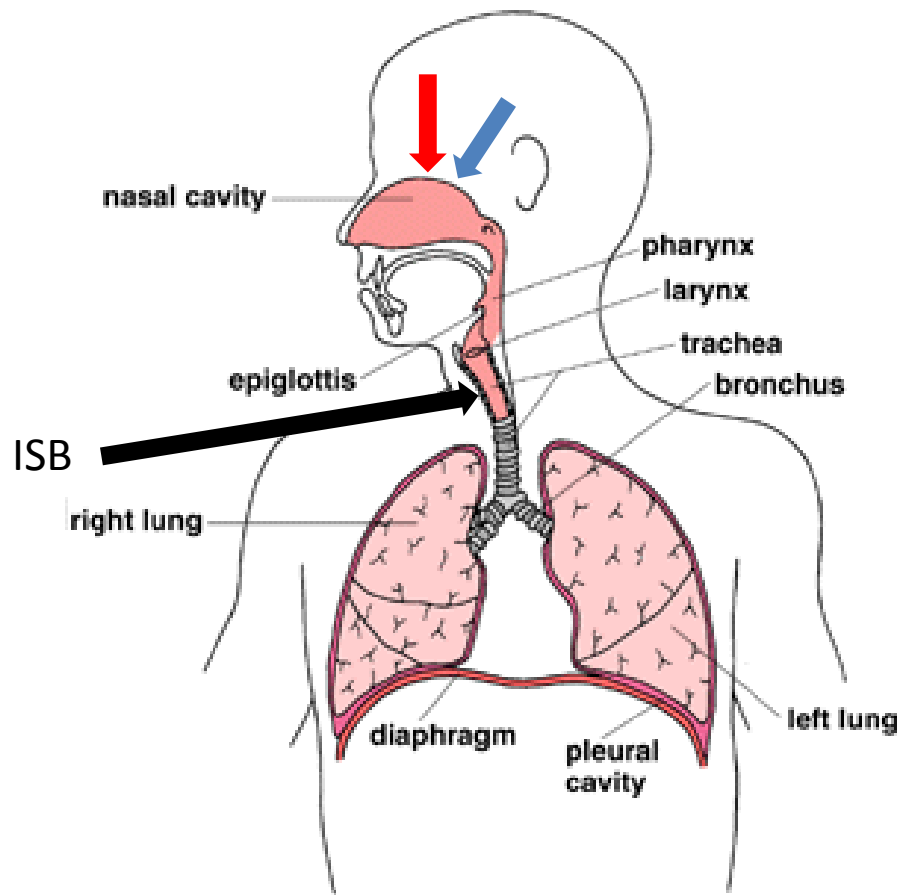
24 hour rest period breathing ambient air
at 25°C temperature and 50% RH



- 10,000 litres of air
- 400 ml of water
- 1470 J of heat energy

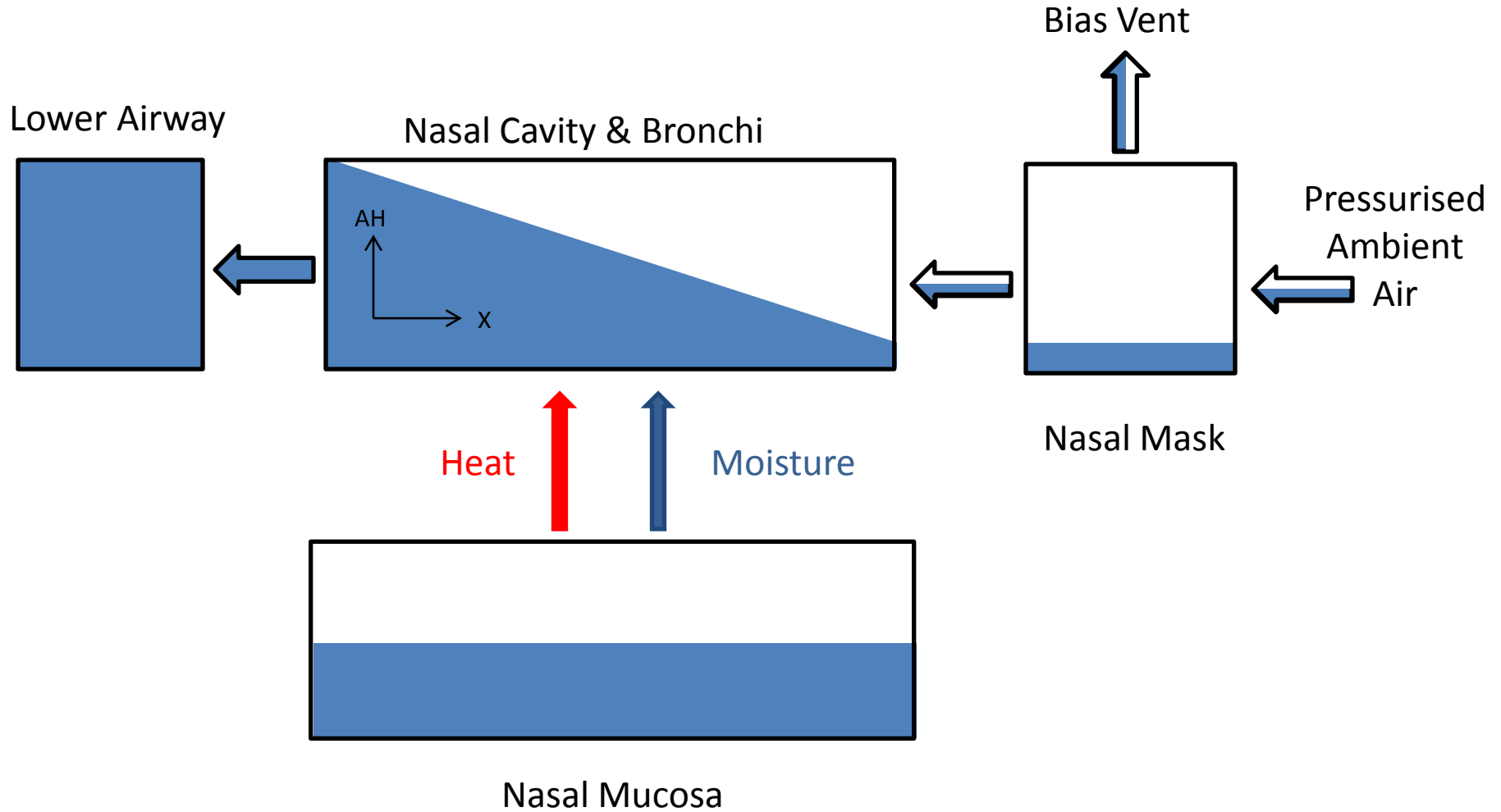
nose provides about 90% of
respiratory system air-conditioning
requirements and recovers 25% of
exhaled heat & moisture.

Nasal Air-Conditioning

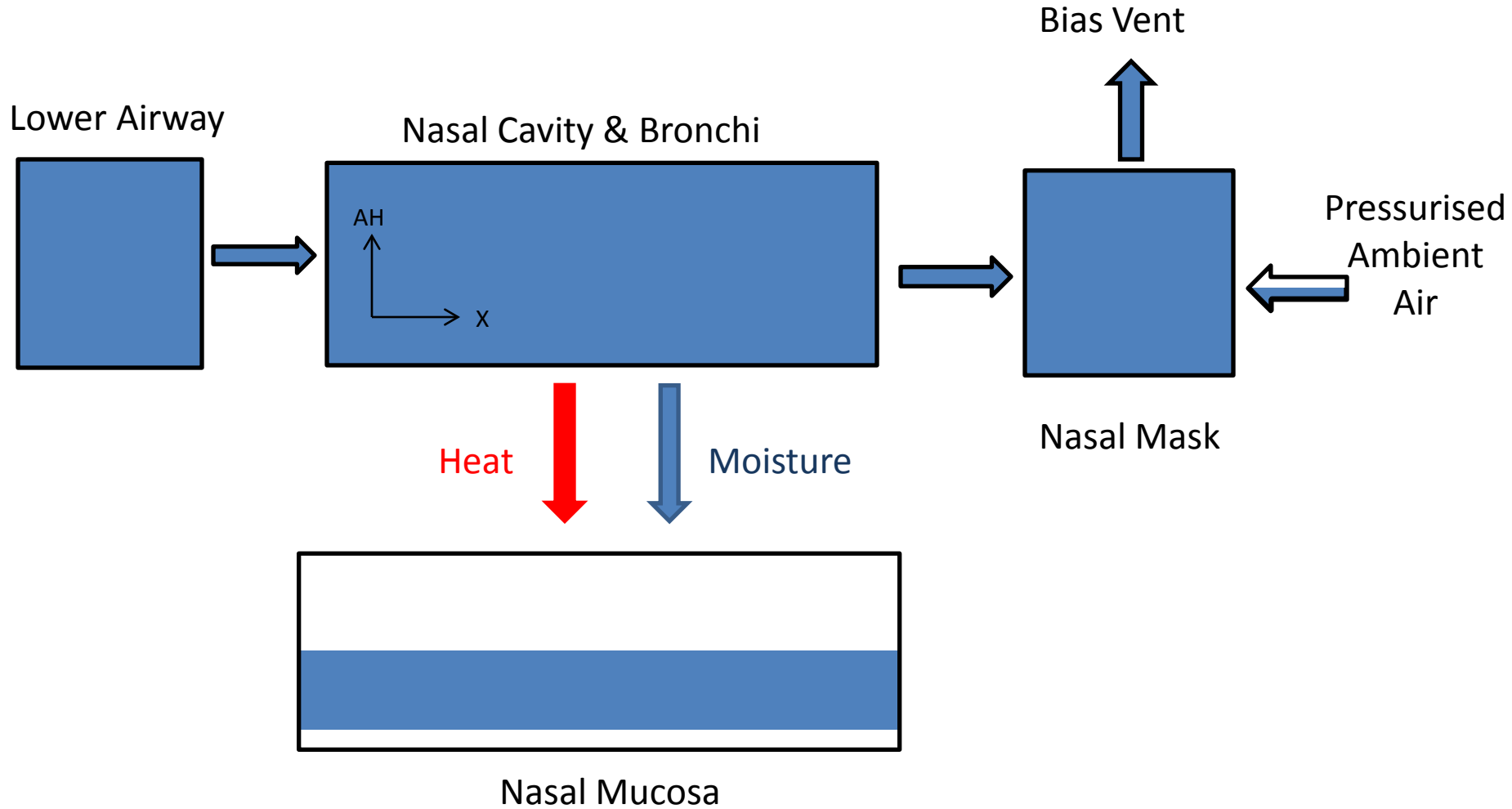


Isothermic Saturation Boundary (ISB)

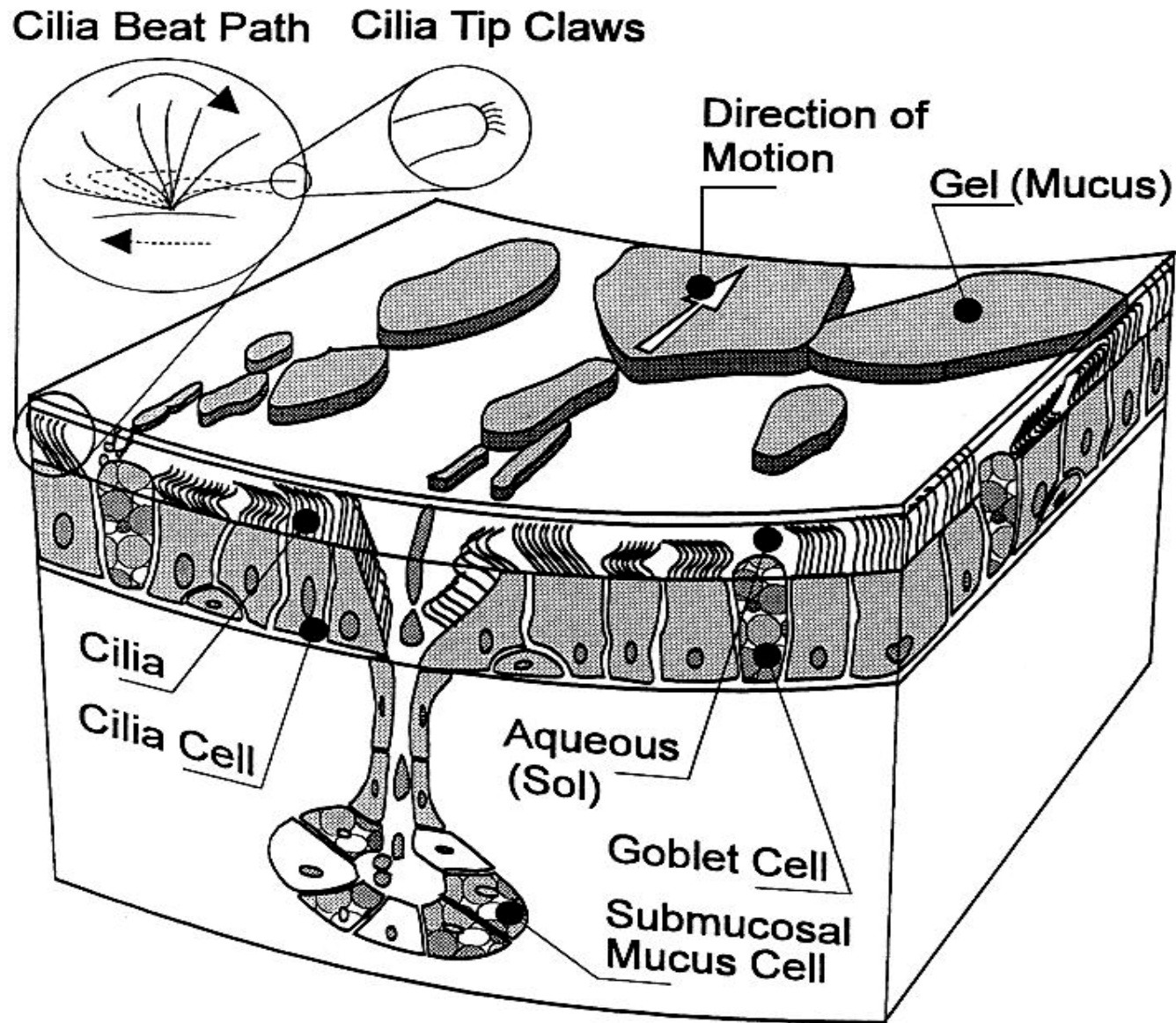
Inhalation



Exhalation



Upper Airway Cellular Structure and Liquid Lining



Autonomic Regulation

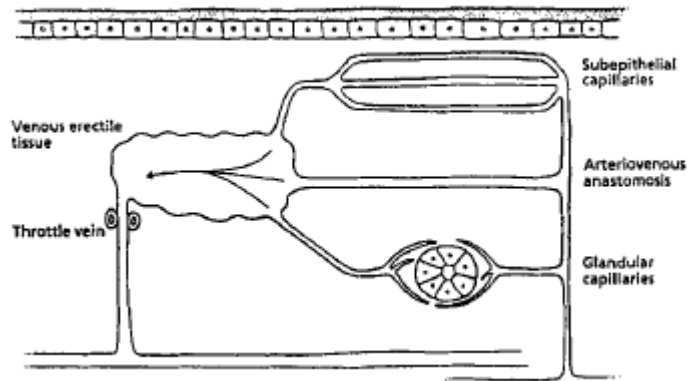
Sympathetic/Parasympathetic Nervous System

Airflow Regime Regulation

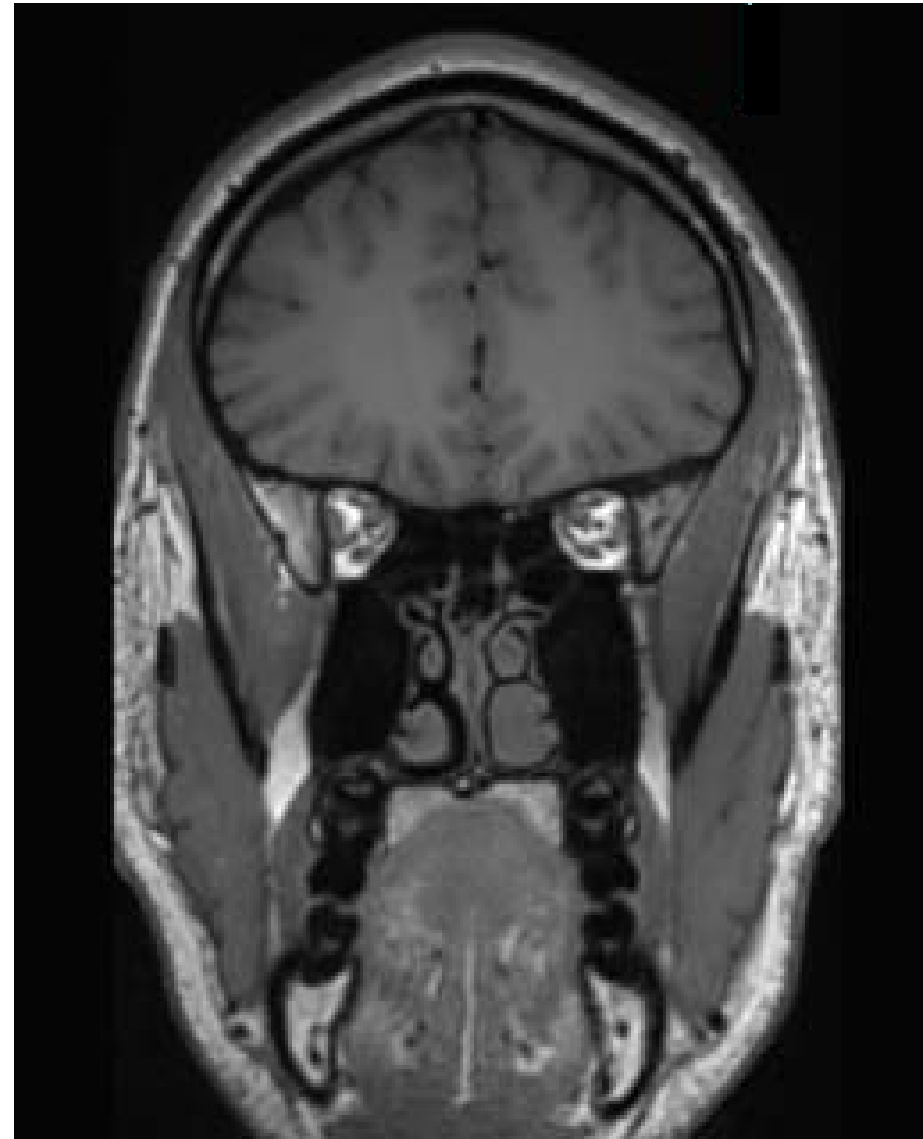
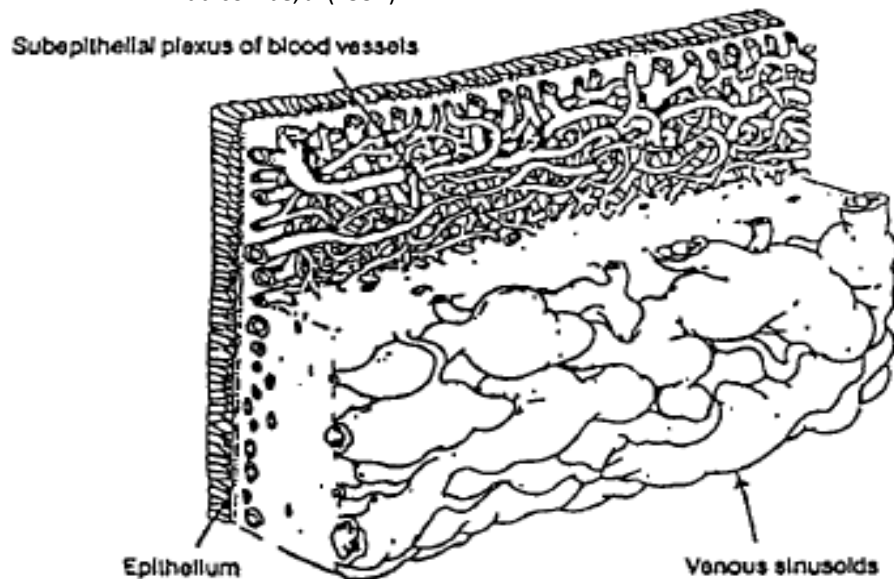
Air Heating Source

Nasal Cycle

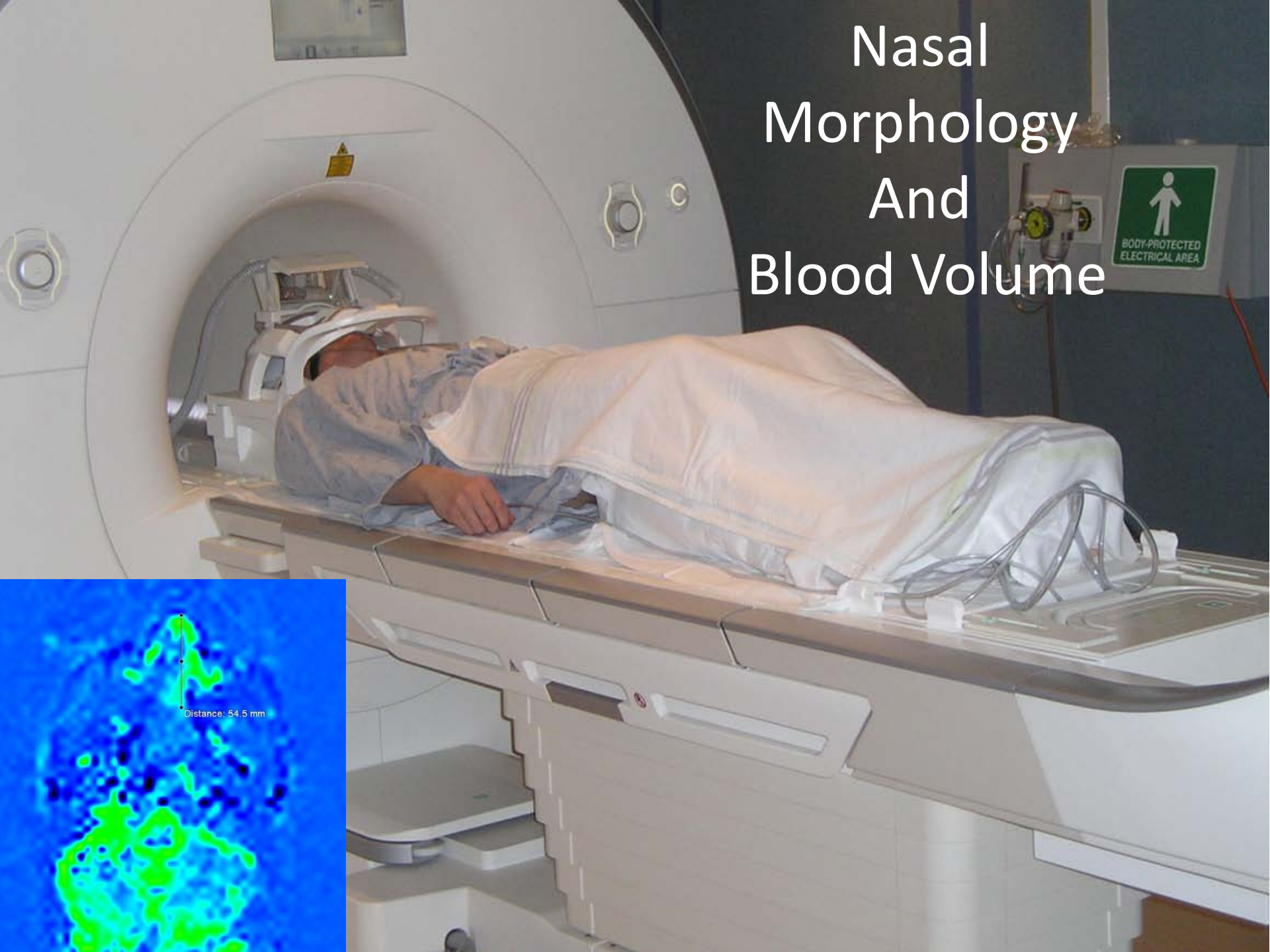
~ 40 % of population



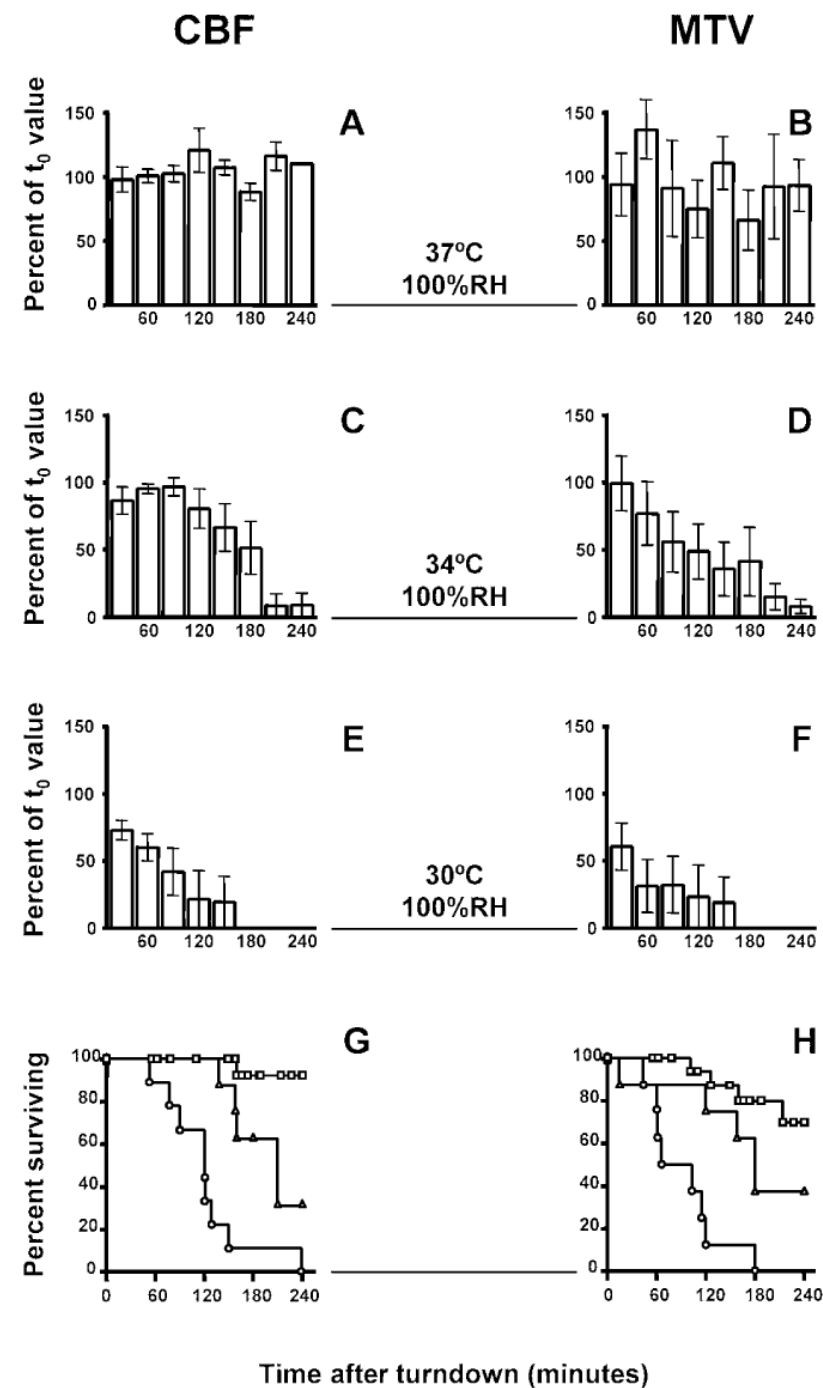
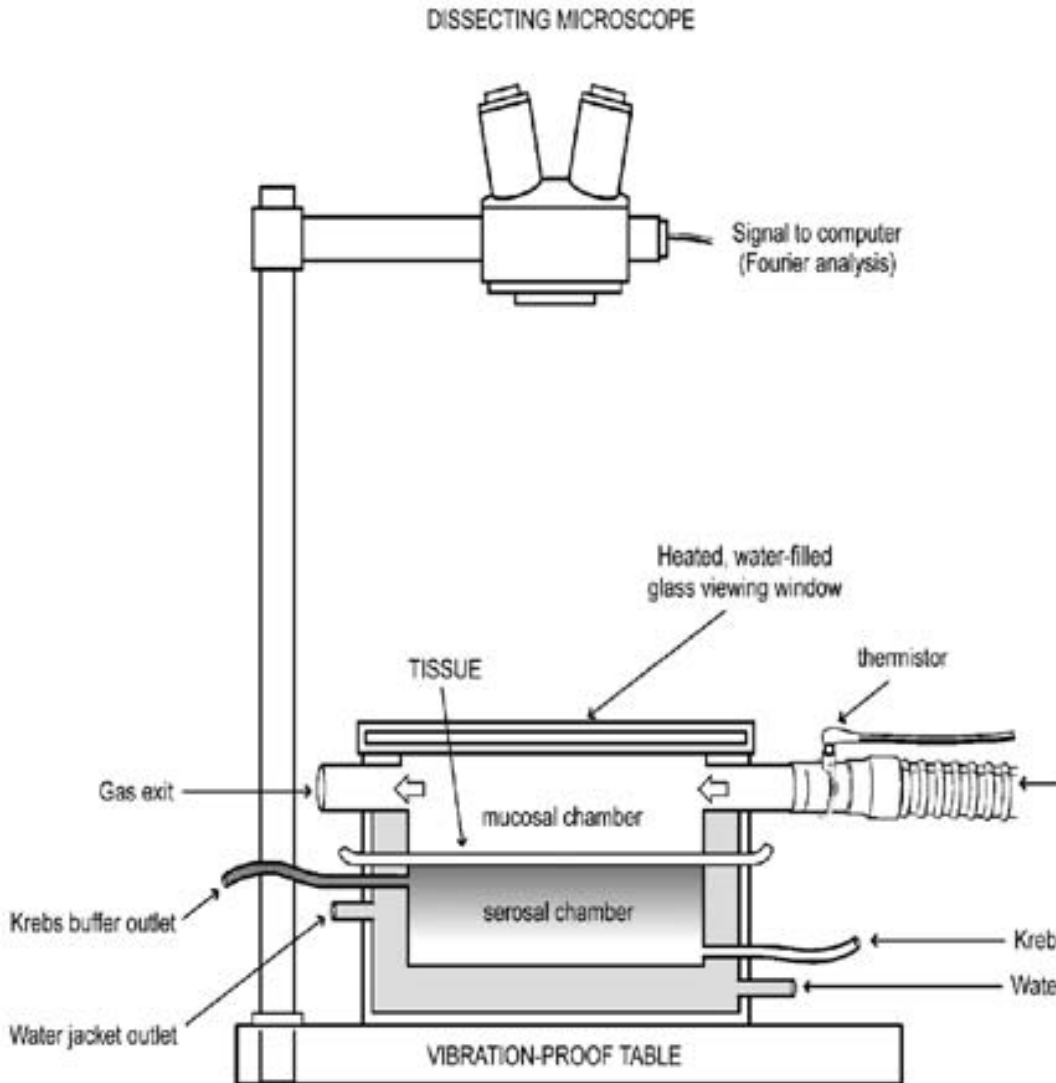
Widdicombe, J. (1997)



Nasal Morphology And Blood Volume



Epithelial Purinergic Regulation

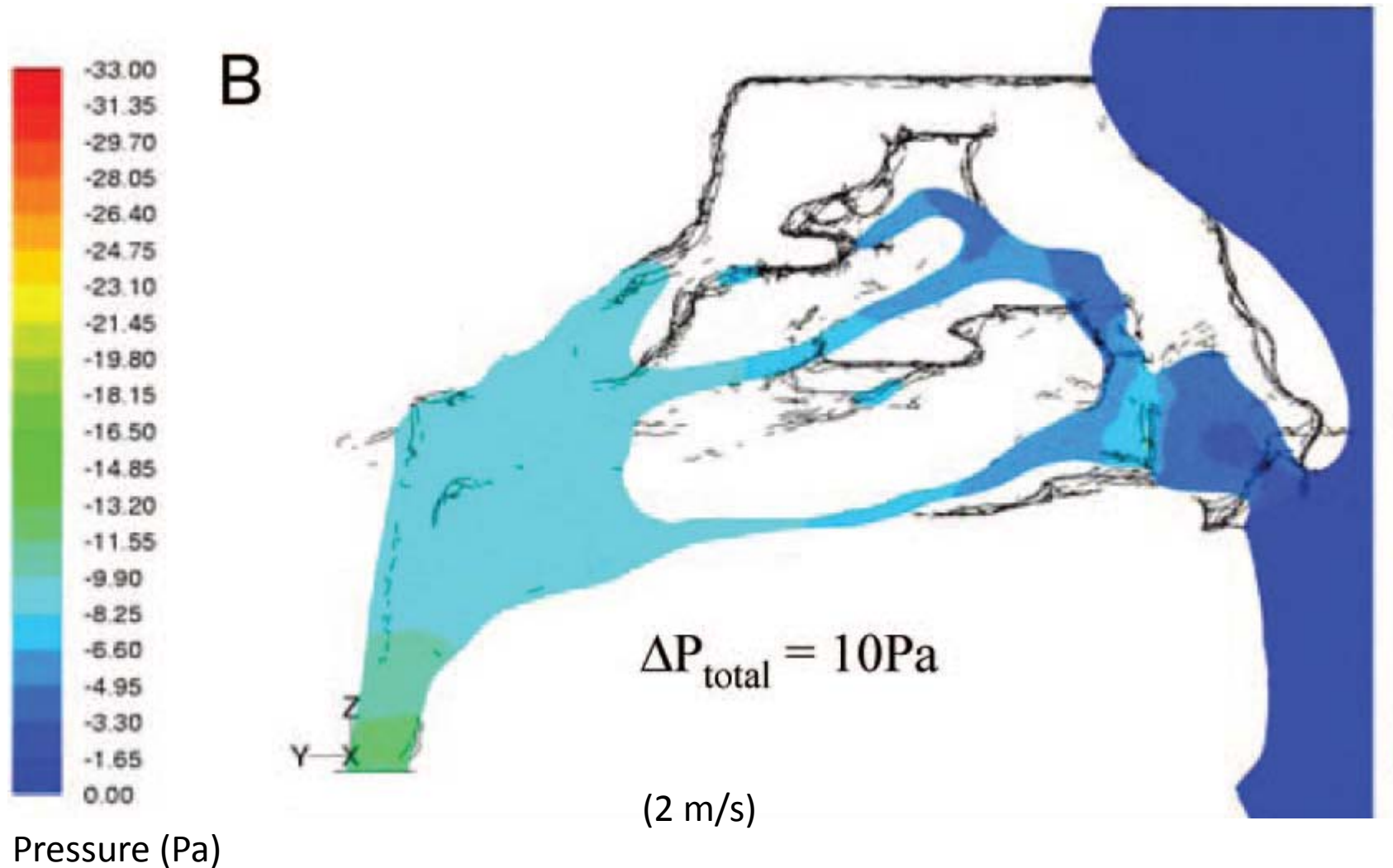


Current Paradox



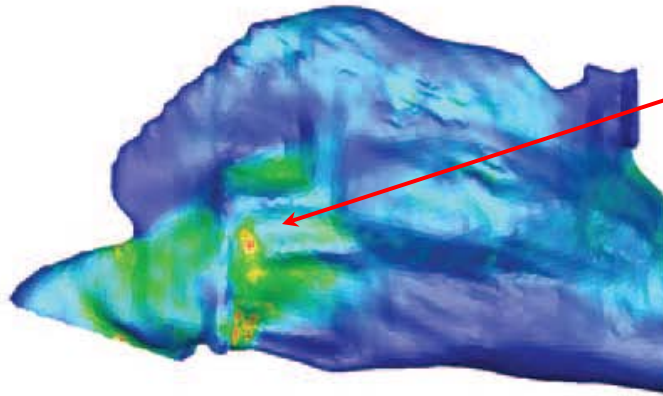
Ambient Air
 $T = 25^{\circ}\text{C}$
50% RH

Airway Tissue Mechanical Stress





Right

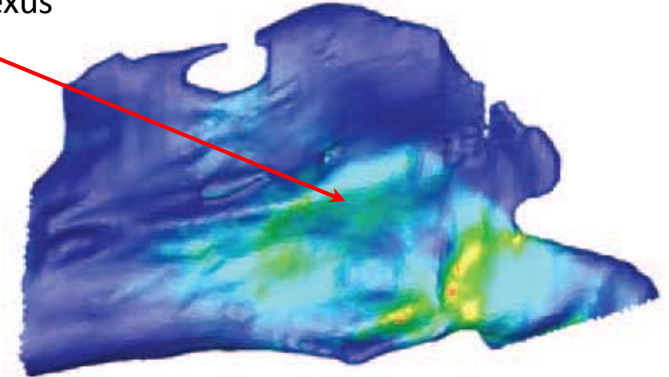


222 ml/s

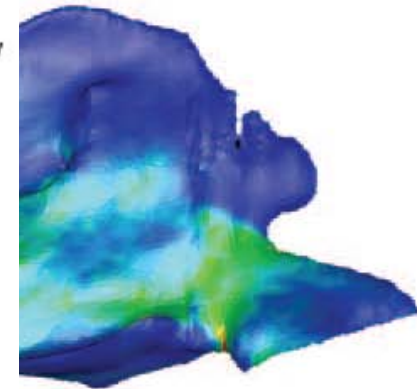
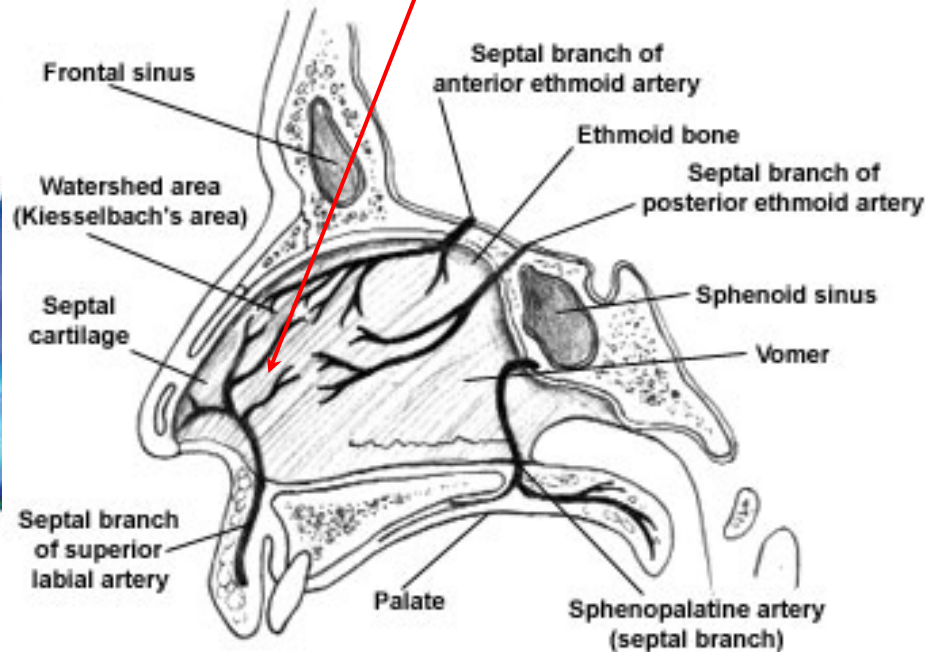
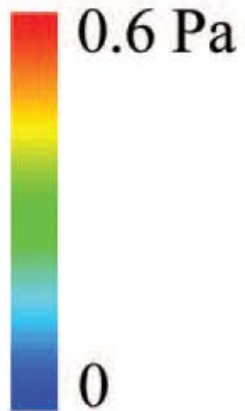
Kiesselbach's Triangle

Several arteries
anastomose to form
vascular plexus

Left

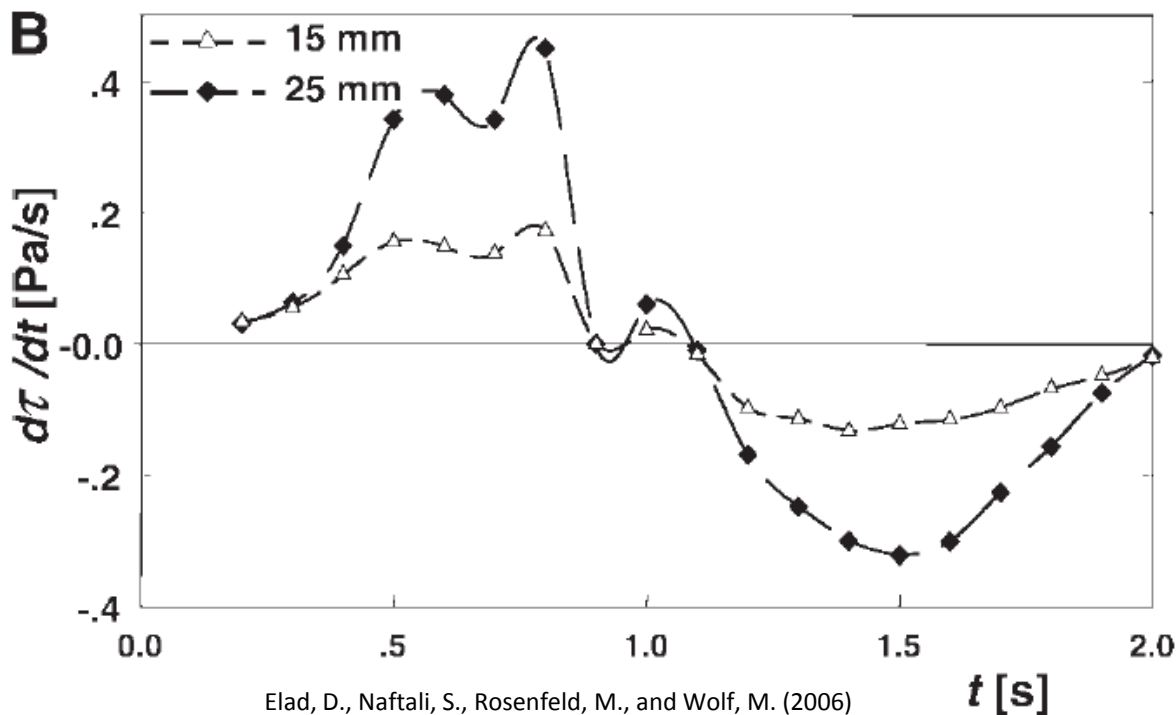
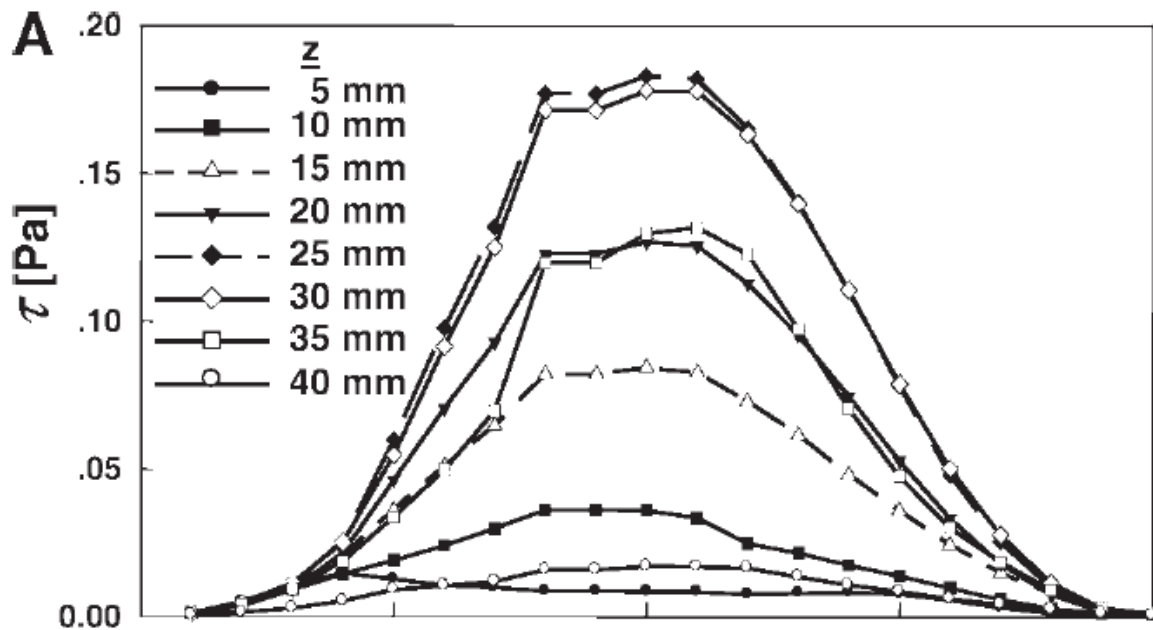


130 ml/s



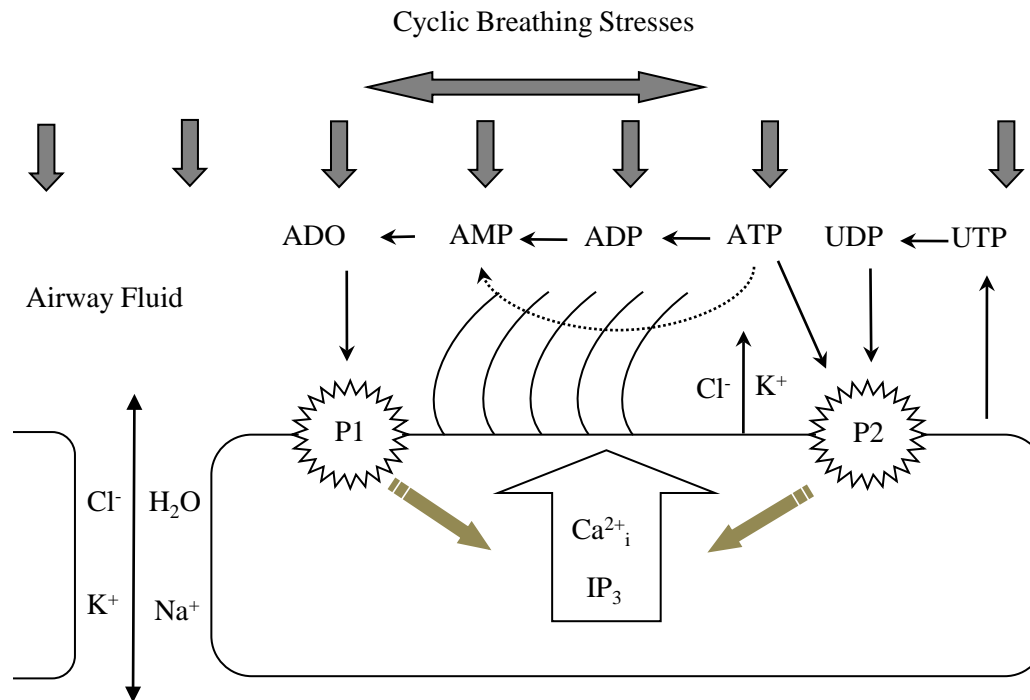
0 ml/s

Lateral Wall Shear Stress Distribution



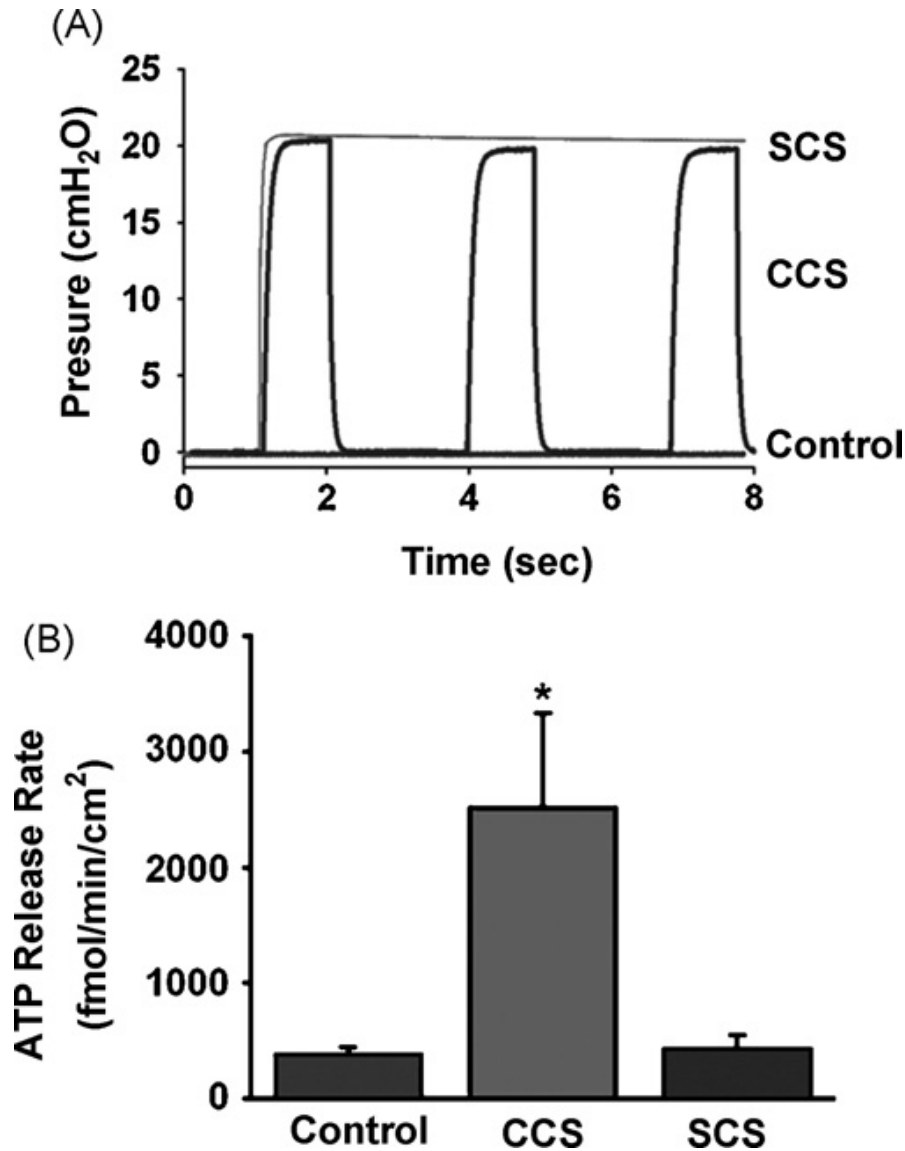
Epithelial Cell Purinergic Regulation

Airway Surface Liquid Volume and MTV Control – P1 & P2 Channels

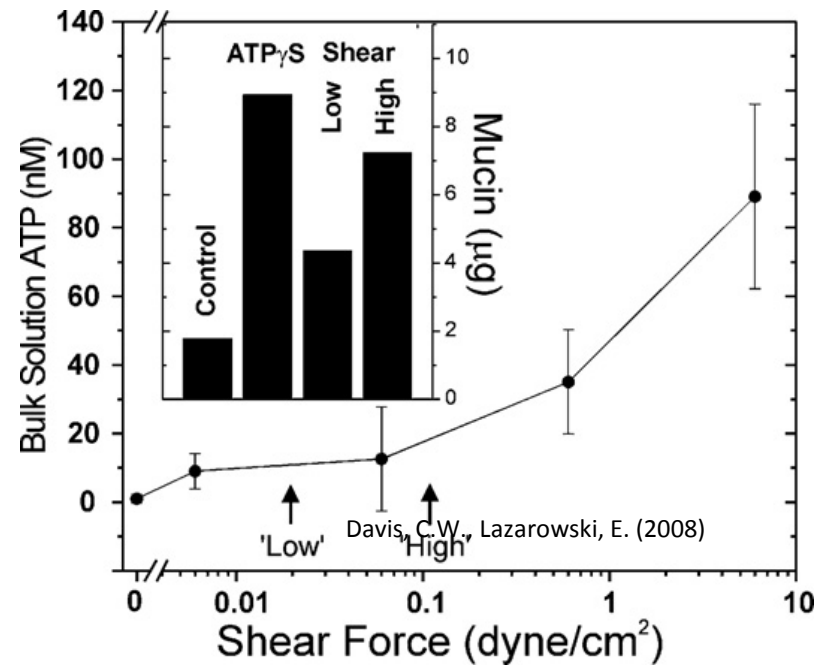


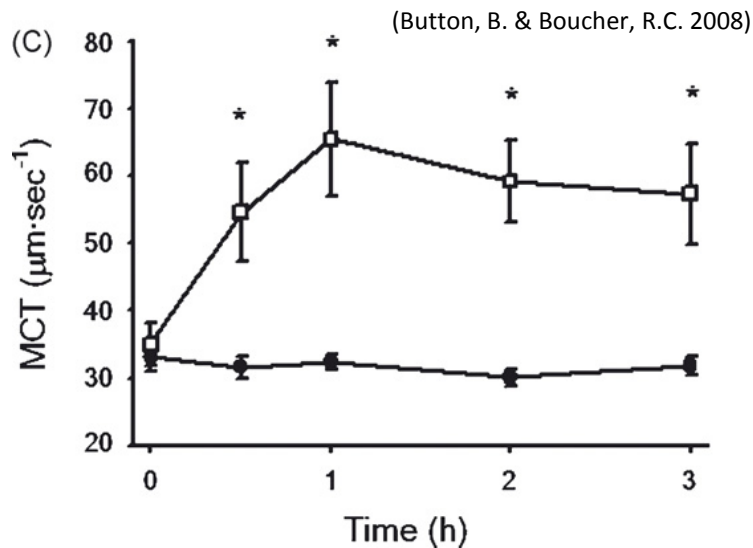
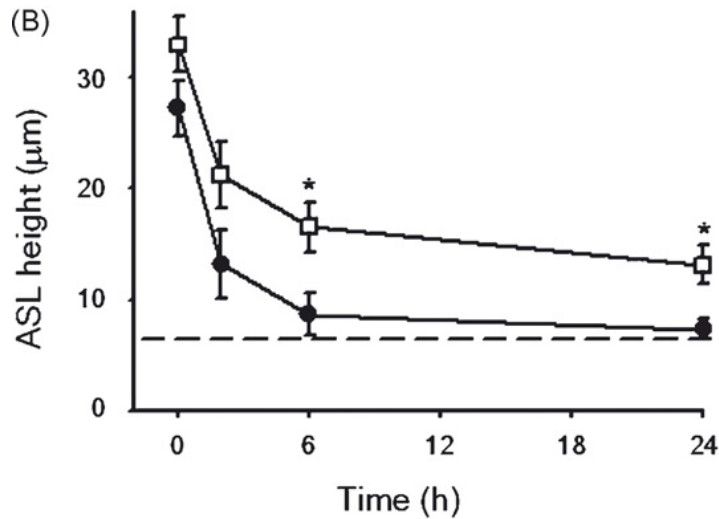
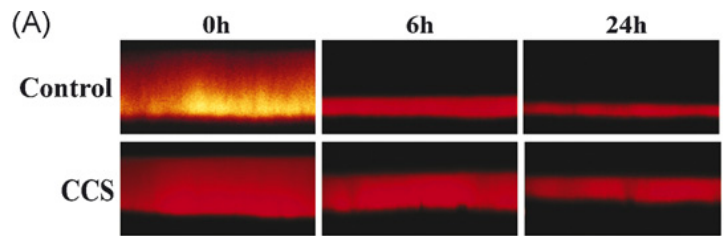
White, D., Al-Jumaily, A.M. and Bartley, J. (2010)

Role of Mechanical Stress Stimuli



(Button, B. & Boucher, R.C. 2008)



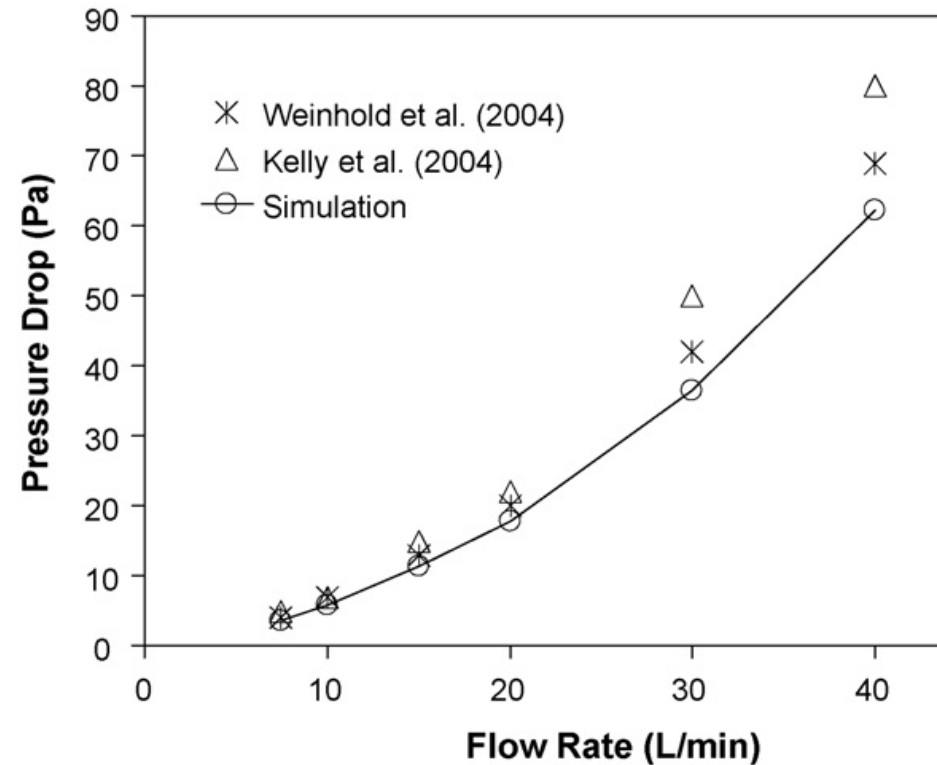
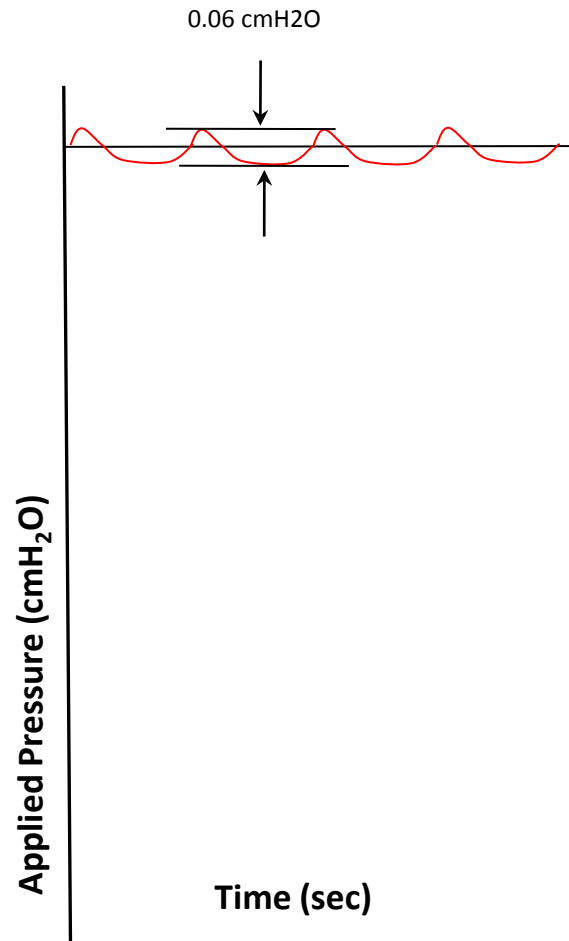


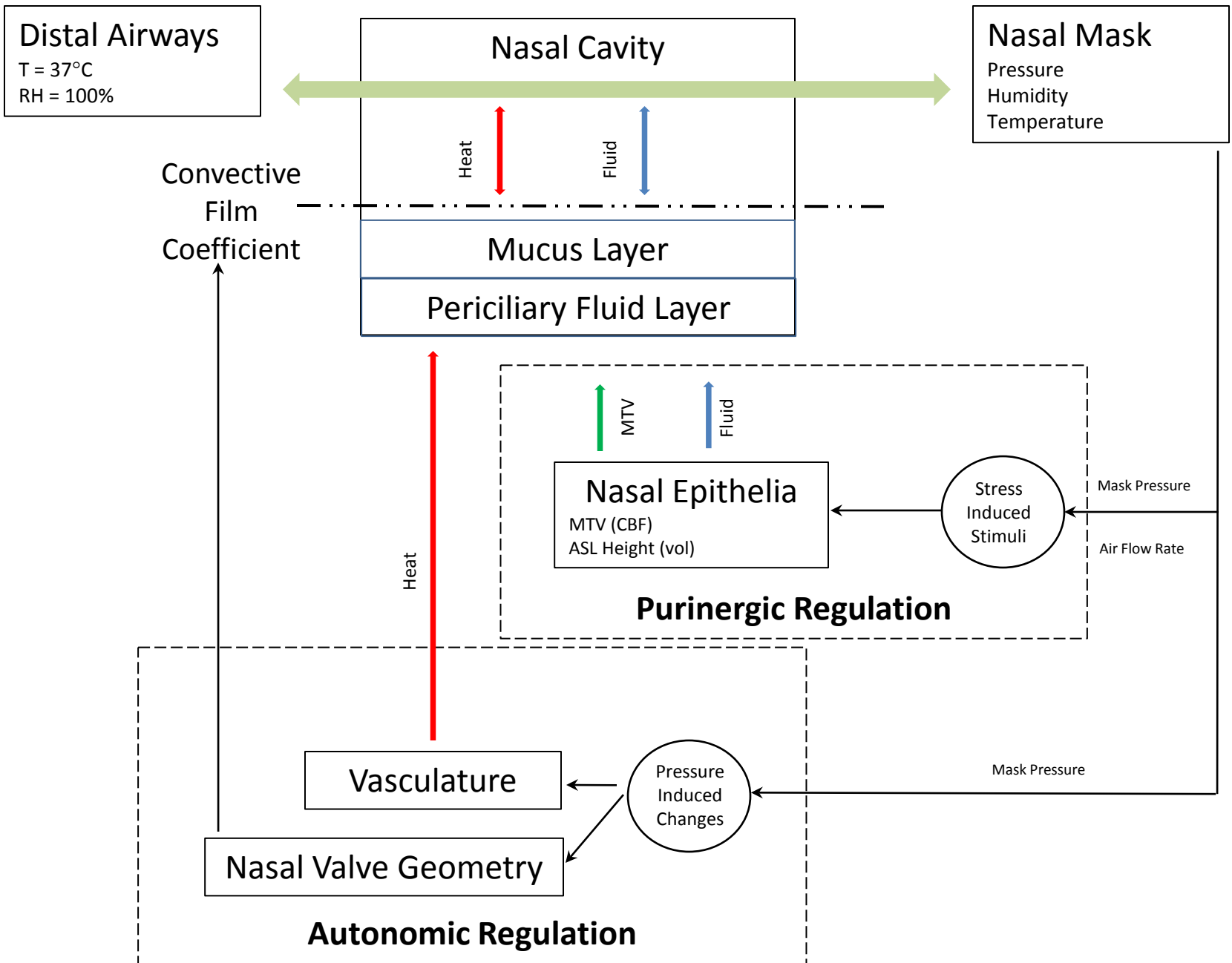
Role of Compressive Mechanical Stimuli

□ = 20cmH₂O CCS

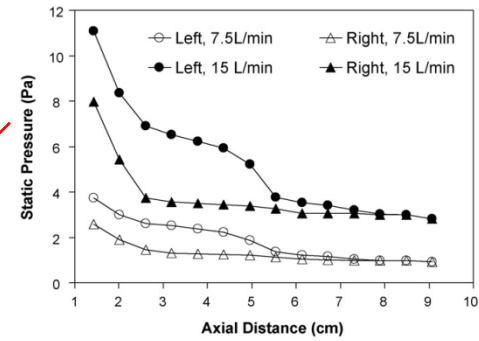
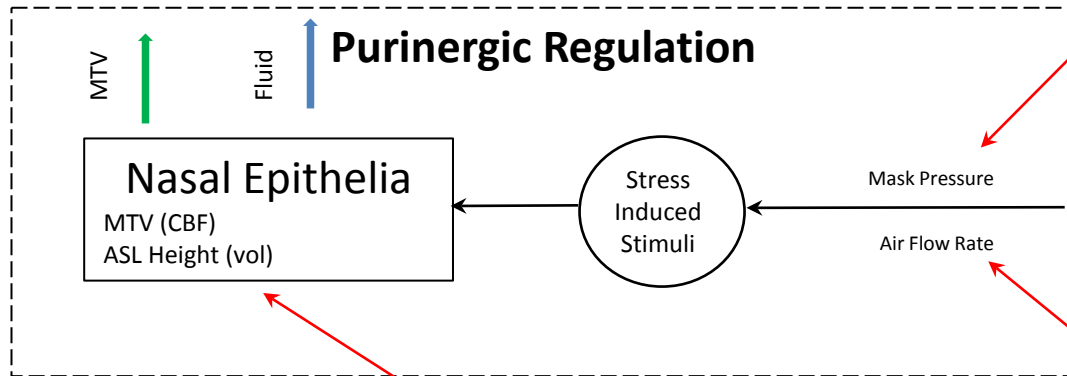
● = Control

Epithelial Stresses During Applied Breathing Therapy

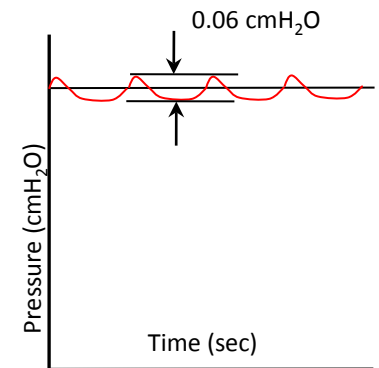
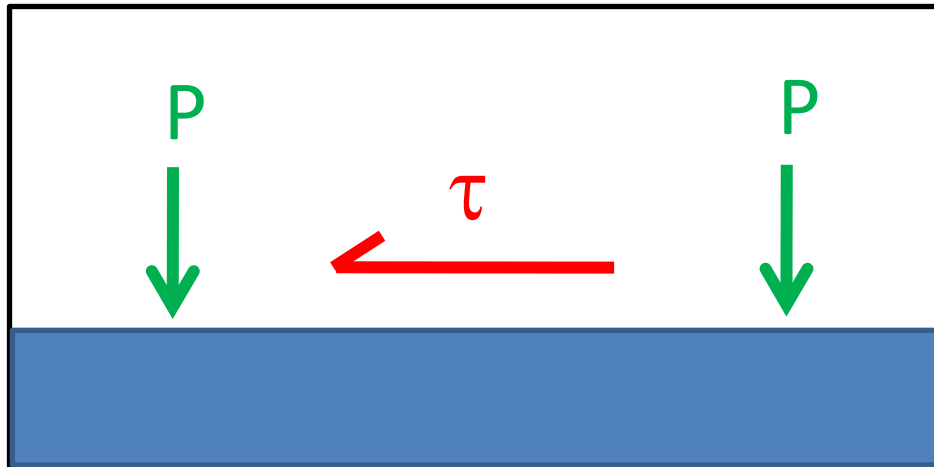
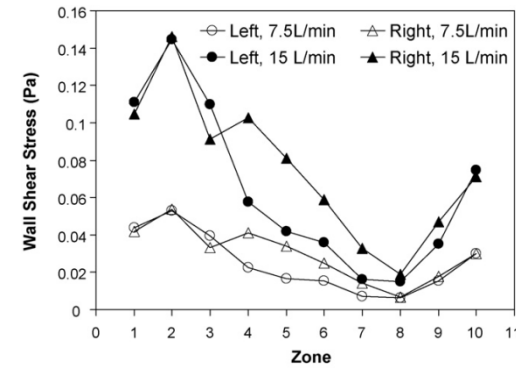




Tissue Testing



(Wen, J., Tu, I.J. & Wang, S., 2008)



Acknowledgement



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