

# Teaching Model for Ventilation and Perfusion Mismatching

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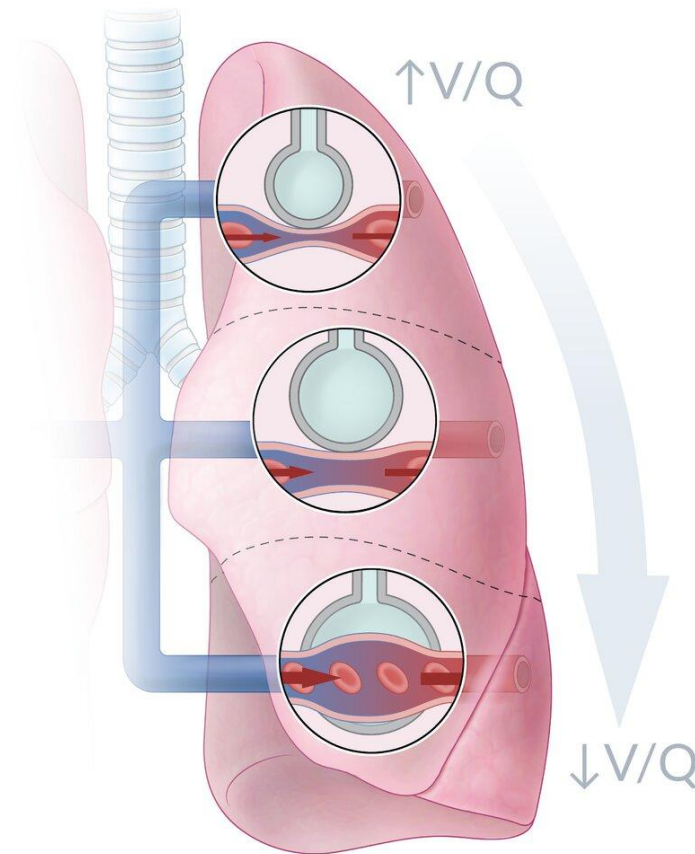
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Client: Dr. Green

# Overview of Presentation

- Client: Dr. Chris Green - Pediatric Pulmonologist at UW-Health
- Project Description:
  - Teaching model to explain Ventilation/Perfusion Mismatching
  - Need:
    - Leading cause of Hypoxemia - Ventilation/Perfusion Mismatching
    - No relevant representation of this concept other than a textbook diagram by John West
    - Medical Students have a hard time understanding the concept

## Problem Statement

- Lack of adequate teaching models
- Expand on previous work
- Create intuitive model

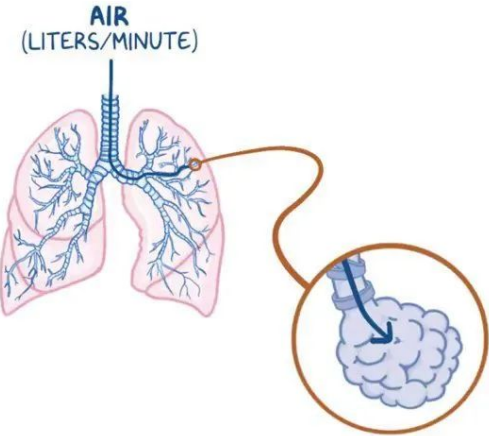


**Figure 1.** Passage through capillaries at different V/Q ratios<sup>1</sup>

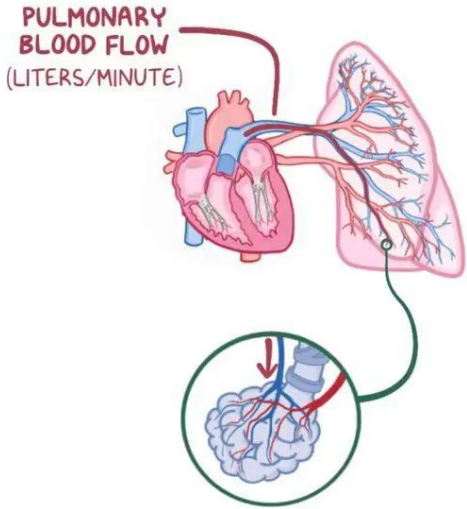
# Background Material

- V/Q Ratio
- Mismatch
- 0.8 is normal

## ALVEOLAR VENTILATION (V)



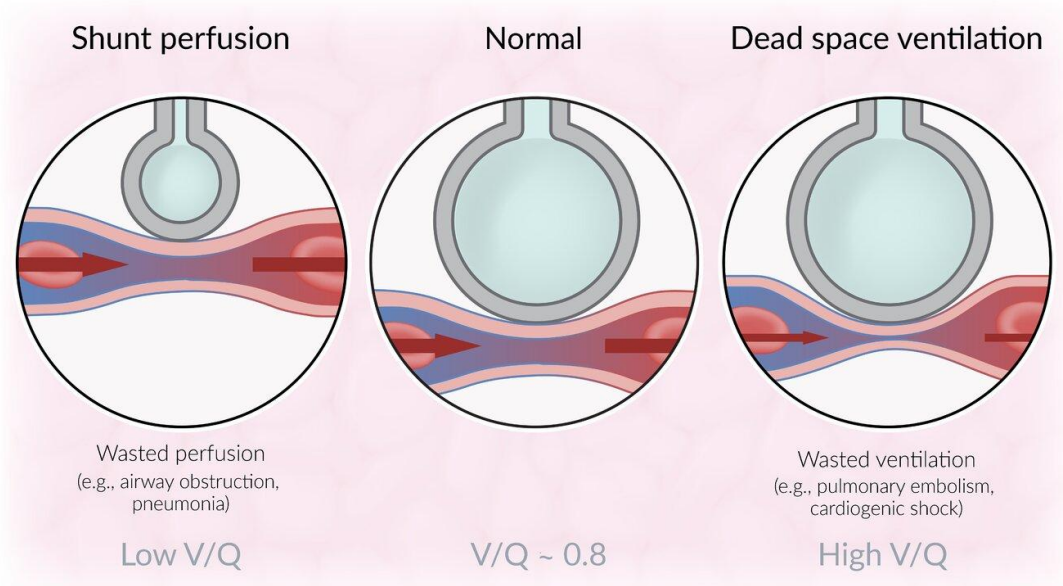
## PERFUSION (Q)



**Figure 2.** Depiction of alveolar ventilation versus perfusion<sup>2</sup>

# Summary of PDS

- Accurate representation
- Adjustable V/Q ratios
- Digital display
  - Partial pressure oxygen
  - Partial pressure carbon dioxide
- Interactive for students
- Durable
- Convenient size for teaching and storage

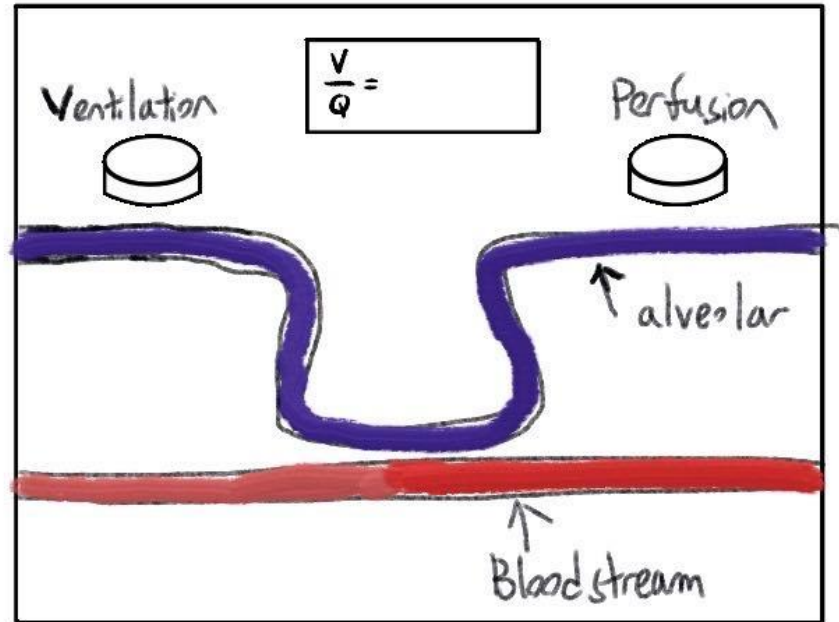


**Figure 3.** Depictions and defining factors of different V/Q ratios<sup>3</sup>

# Design Alternatives (Winning design)

- Two sliders adjust V/Q ratio
- LEDs represent concentration
- Advantages
  - High adjustability
  - Great learning outcomes
- Disadvantages
  - Require programming and circuits building skills

## Slider with LEDs and Screen



**Figure 4.** Visualization of the slider with LEDs and screen design

# Design Alternatives

- Animation of the ventilation and perfusion process
- Advantage
  - Able to change V/Q ratio precisely
  - Ease of use
- Disadvantage
  - Require high programming skills
  - No physical teaching model

## Computer Animation

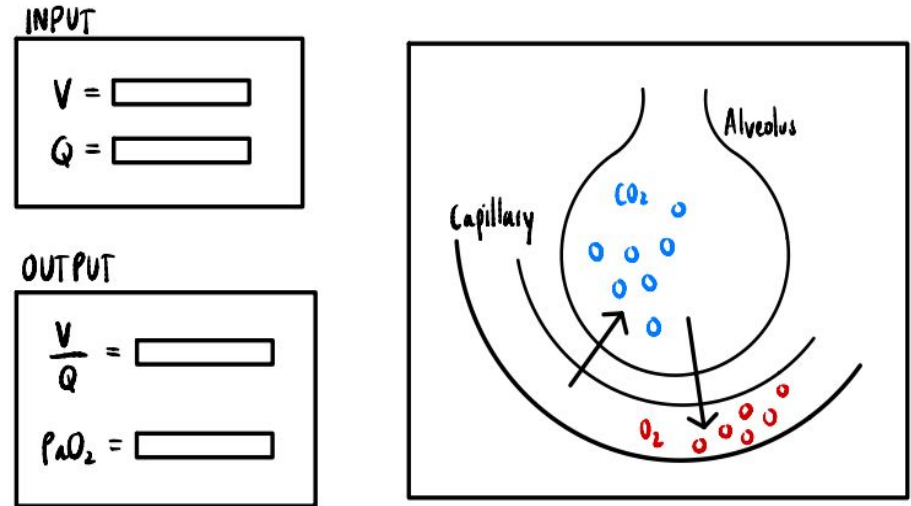
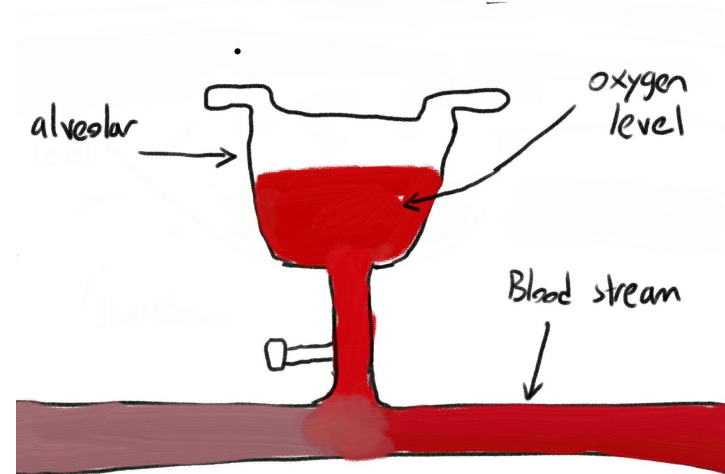


Figure 5. Visualization of the computation animation design

# Design Alternatives

- Dye concentration represent oxygen level
- Utilize valve to change dye concentration
- Advantage
  - Great learning outcome
- Disadvantage
  - Difficult to utilize
  - Disable to change perfusion ratio

## Water/Dye Concentrations



**Figure 6.** Visualization of the water/dye concentrations design



# Design Matrix

Criteria (Weight)	Slider with LEDs and Screen*		Computer Animation*		Water/Dye Concentrations	
Intuitive use (30%)	5/5	30%	4/5	24%	2/5	12%
Learning Outcomes (30%)	4/5	24%	2/5	12%	4/5	24%
Adjustability (20%)	4/5	16%	5/5	20%	4/5	16%
Ease of fabrication (10%)	3/5	6%	2/5	4%	1/5	2%
Cost (5%)	2/5	2%	5/5	5%	2/5	2%
Safety (5%)	4/5	4%	5/5	5%	5/5	5%
<b>Total</b>	<b>82%</b>		<b>70%</b>		<b>61%</b>	

Figure 7. Design Matrix

# Future Work

- Fabrication Plans
  - Redesign the position of the LEDs
    - Better representation of an alveolus
    - Clearer flow rate
  - 3D print housing for LEDs/electrical components
  - Order sliders, digital display
- Testing Plans
  - Check if:
    - Sliders adjust accurately
    - LEDs move accurately based on V/Q ratio
    - The model is interactive and hands on
    - Client Feedback/Classroom Review

# References and Acknowledgments

Thank you to Professor Brace and Dr. Green for all of their help and guidance!

[1] Respiratory physiology - Knowledge @ AMBOSS. Amboss.com. Published 2021. Accessed October 15, 2021.

[https://www.amboss.com/us/knowledge/Respiratory\\_physiology/](https://www.amboss.com/us/knowledge/Respiratory_physiology/)

[2] Osmosis - A Better Way To Learn - Ventilation-perfusion ratios and V/Q mismatch: Video | Osmosis. Osmosis. Published 2021. Accessed October 15, 2021. [https://www.osmosis.org/learn/Ventilation-perfusion\\_ratios\\_and\\_VQ\\_mismatch](https://www.osmosis.org/learn/Ventilation-perfusion_ratios_and_VQ_mismatch)

[3] Respiratory physiology - Knowledge @ AMBOSS. Amboss.com. Published 2021. Accessed October 15, 2021.

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