Human Performance Limitations In Aviation Exam Notes

Topics covered (In order)

Human Performance Limitations in Aviation Part 1

Physics of the Atmosphere

3 Functions of the Atmosphere

- Radiation Protection (UV & sub-atomic particles)
- Thermal Protection (cloud reflects IR radiation (greenhouse))
- Gaseous Support of life (O_2, CO_2, H_2O)

Atmospheric Devisions

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere
- Exosphere

The Physiological zones

- MSL - 10,000 ft (physiological zone)
- 10,000 ft - 50,000 ft (Physiologically deficient zone)
- 50,000 ft + (Space equivalent zone)

Composition of the Atmosphere

- Nitrogen = 78%
- Oxygen = 21%
- Other gases (methane, ozone, CO_2 etc.) = 1%

Note: Percentage relationship remains constant at altitude

ICAO Standard Atmosphere

- Pressure (MSL) = 760mmHg
- Density (MSL) = 1.2225 kg/m3
- +15 C at MSL
- Lapse rate = 1.98 C per 1000ft increase until 36000 ft

The Gas Laws
Boyle's Law

- At constant temperature, the volume of a gas is inversely proportional to the pressure to which it is subjected.

Dalton's Law

- Total pressure is the sum of partial pressures of constituent gases
- Example: Air at sea level

O_2 = 21%	pO_2 = 160mmHg
N_2 = 78%	pN_2 = 593mmHg
Other = 1%	Other = 7mmHg
Total = 100%	Total = 760mmHg

Charle's Law

- Pressure remaining constant, volume of a gas will vary with temperature
- If volume remains constant, pressure of a gas will vary with temperature

Henry's Law

- The amount of gas held in solution is proportional to the pressure of gas above the solution
- E.g. Ocean

Law of gaseous diffusion

- Gas will move from an area of higher pressure to an area of lower pressure

Cardiovascular & Respiratory Physiology

Oxygen & Cellular Metabolism

- Oxygen is energy for cells
- Oxygen + glucose produces energy

- Aerobic = lots of energy
- Anaerobic = no energy
- More oxygen = more energy

Kreb's cycle

- Production of energy - rich adenosine triphosphate (ATP)
- 1 molecule of glucose = 38 ATP (Aerobic) or 2 ATP (Anaerobic)

Critical mitochondrial O_2 range 0.5-3 mmHg

Metabolism

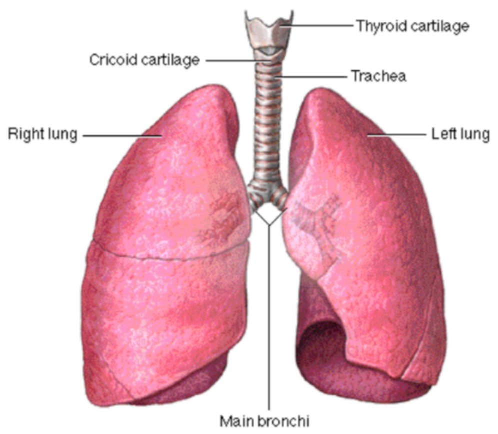
- Process where cells use oxygen and produce carbon dioxide (waste product)
- Occurs in all cells
- Requires constant source of fuel (Carbohydrate from food) and oxygen

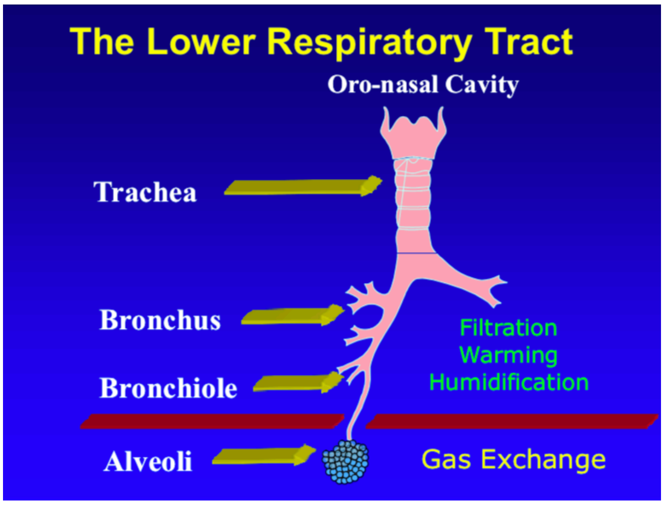
3 phases of Metabolism

- Exchange of gases (respiration)
- Distribution of gases (circulation)
- Oxidation process in cells

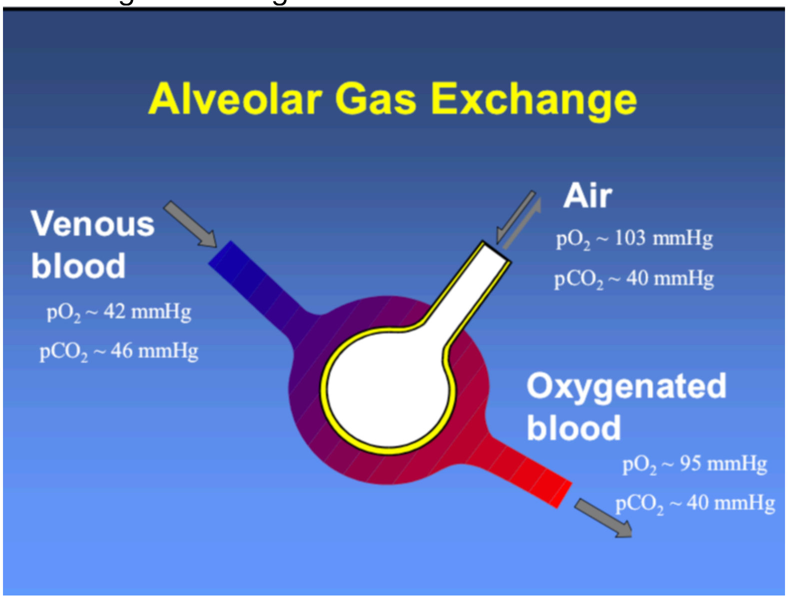
Respiration

- Oro-nasal cavity - (filters air, warms and humidification)





Alveolar gas exchange



Oxygen Pathway

1. Atmosphere
2. Trachea & Bronchi
3. Alveoli
4. Blood
5. Tissues

Hemoglobin

- A conjugated protein
- Consists of a haem (an iron-porphyrin compound) and a globin (A 4 polypeptide complex)

Carbon Dioxide Pathway

1. Tissues
2. Blood (CO_2 carried in solution as H+ & HCO3 (Carbonic acid)
3. Alveoli
4. Trachea & Bronchi
5. Atmosphere

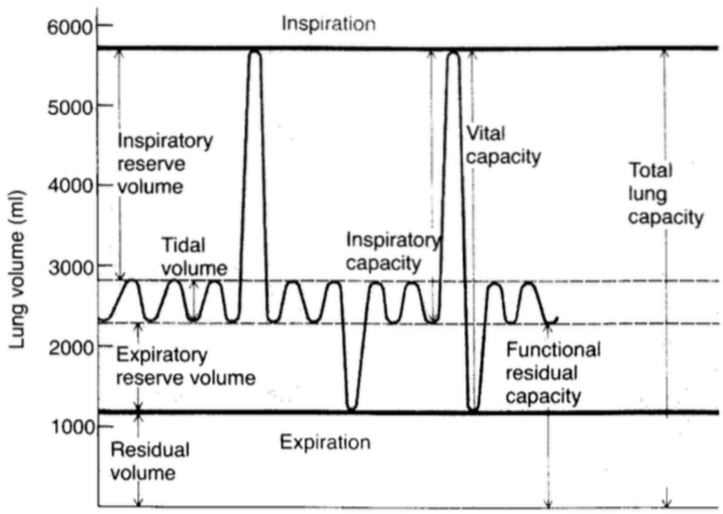
CO_2 dissolved in blood = 2.6 ml/100 ml

Control of Breathing

- Voluntary
- Automatic (Chemoreceptors, Stretch receptors)

Chemoreceptors

- Central chemoreceptors located in Medulla (Sensitive to CO_2, will detect rise in pCO_2/fall in pH (more acidic))
- Peripheral chemoreceptors located in aorta & carotid arteries (Sensitive to O_2, will detect a fall in pO_2 (esp. below 55 mmHg))
- A rise in pCO_2 or fall in pO_2 will lead to an increase in rate and depth of breathing



Circulation

The Heart

- 4 chambered pumps
- 2 atria, 2 ventricles
- Valves ensure one way blood flow