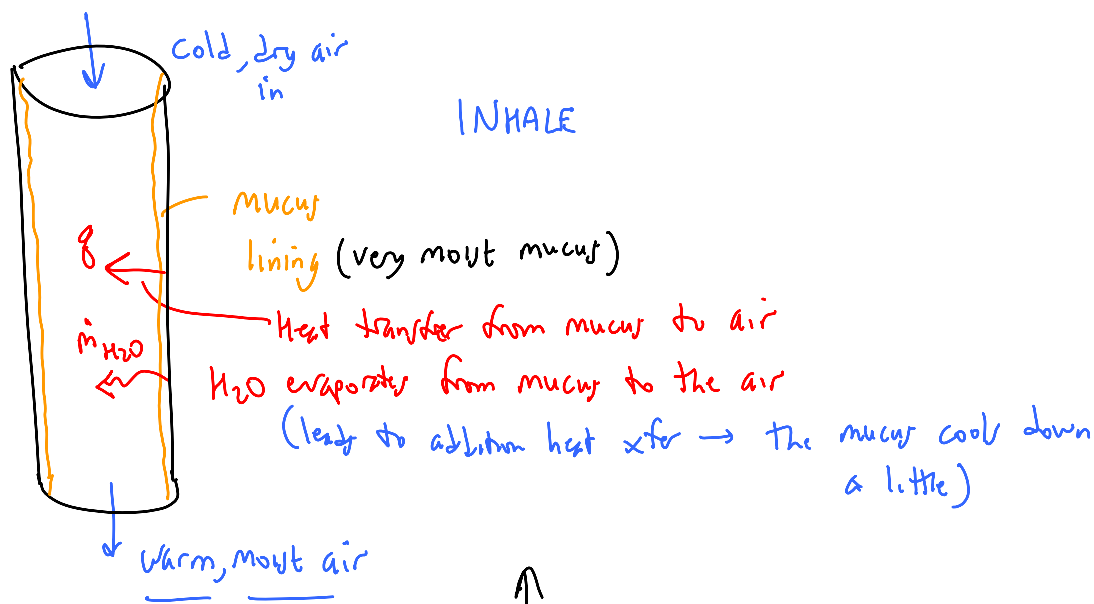
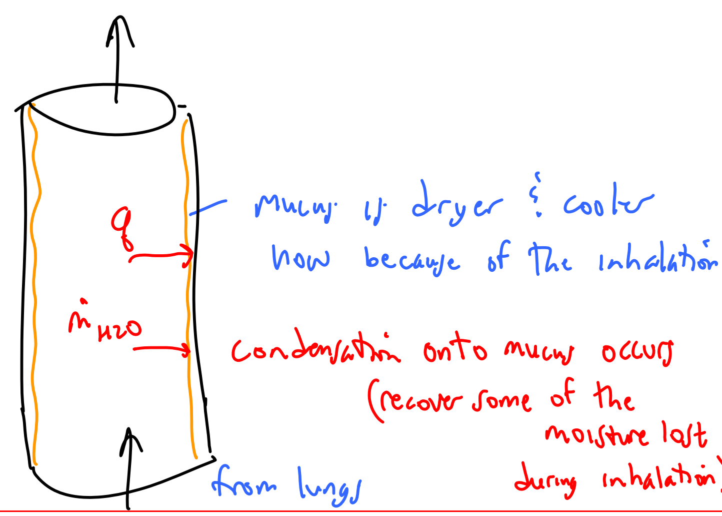
Today, we will:

- Wrap up our discussion about carbon monoxide poisoning
- Discuss **the conditioning of inhaled air** in **Section 2.3.2**
- Do some example problems
- Discuss **toxicology** in **Section 2.4**
- Discuss **sick buildings** and **bioaerosols** in **Sections 2.5-2.6**
- Discuss **dose-response characteristics** in **Section 2.7**

- The importance of humidity & temperature in breathing:
  - The alveoli require 100% humid air @ the body's core Temp. ($37.0°C \approx 98.6°F$)
  - By about 1/3 of the way down the bronchial tree, $T = 37.0°C$, $\Phi = 100\%$ (saturated with water vapor)



When you EXHALE:



Overall, (in exhalation) we recover about 25% of the water that was evaporated during inhalation.

Overall, the body loses both heat <u>and</u> water by breathing

Up to 15% of your body's total heat loss is due to breathing.

Example

Given: A man is walking on a hot day in Arizona.

- The outside air conditions are $T = 35^oC$, $P = 99.8$ kPa, and $\Phi = 10\%$.
- After breathing, the exhaled air conditions are $T = 30^oC$, $P = 99.8$ kPa, and $\Phi = 85\%$.

To do: Estimate the man's volume of *liquid* water loss per hour due to breathing.

Solution:

- Table A-17 → P_v or P_{sat} of H_2O @ $T = 30^\circ C \to 4.246$ kPa (exhale)
  @ $T = 35^\circ C \to 5.628$ kPa (inhale)
- Eq. 1-29 → $c_j = y_j \frac{P}{T} \frac{M_j}{R_u}$ $[j = H_2O]$
- Def'n of Φ ⇒ $y_j = \frac{P_j}{P}$, $\Phi = \frac{P_v}{P_{v,j}}$; $y_j = \Phi \frac{P_{v,j}}{P}$
  & y_j

$$c_j = \Phi \frac{P_{v,j} M_j}{R_u T}$$

Recall, $\dot{m}_j = c_j Q = c_j \dot{V}$

What Q to use? Q_t or Q_a ?

Since the air is conditioned in the bronchial tubes, Q_t is the better choice.

Table 2.4 → Light exercise (LE) $Q_t = 32.2$ L/min (of air)

So, inhalation → $\dot{m}_{j\,in} = c_j Q_t = \Phi_{in} \frac{P_{v,j\,in} M_{H_2O}}{R_u T_{in}} Q_t$

Similarly exhalation $\dot{m}_{j\,ex} = c_j Q_t = \Phi_{ex} \frac{P_{v,j,ex} M_{H_2O}}{R_u T_{ex}} Q_t$

Combine $\quad \dot{m}_{j\,\text{net loss}} = \dot{m}_{j\,ex} - \dot{m}_{j\,in}$

& $\quad Q_j = \frac{\dot{m}_j}{\rho_j} \quad$ where ρ_j here is in terms of liquid water

$\rho_j = 1000\ kg/m^3$

Final eq.:

$$Q_j\ [\text{or } \dot{V}_j] = \frac{Q_t}{\rho_j}\frac{M_j}{R_u}\left[\left(\frac{\Phi P_{v,j}}{T}\right)_{ex} - \left(\frac{\Phi P_{v,j}}{T}\right)_{in}\right]$$ ☆

Ans. in variables

Plug in the #s & do some unit conversions:

$$Q_j = 0.042\ \frac{L}{hr} \text{ of liquid water}$$

For HE (Heavy exercise) → get $0.116\ L/hr$

Toxicology Sec 2.4 (Read)

Ex. 2.3 → make sure you understand this problem

- Particles $\quad D_p$ = particle diameter (in microns typically)
  $[1\ \mu m = 10^{-6}\ m]$

- General "rules of thumb" $\quad$ · If $D_p \lesssim 10\ \mu m$, it is inhalable
  [gets into the bronchial tubes, but mucus catches it, & cilia remove these particles]

If $D_p \lesssim 2.5\ \mu m$ The particle is **respirable**.

[get all the way down to the alveolar region]

↙

"Fine particles" → These are of greater concern

CH. 8 → Particles

Sec. 2.5 – 2.6 Sick Buildings & Bioaerosols

SBS Sick Building Syndrome → People get sick due to poor air quality in a building

↙

Caused by molds, yeasts, bacteria, spores, etc.

BIOAEROSOLS [also called biogenic aerosols]

↘ aerosol = particle suspended in air

biological (life) →
- pollen
- bacteria
- viruses
- molds & spores

read

Sec. 2.7 Dose-Response

When setting PELs, 3 things to consider:

- ① Body exposure → How much the body is exposed to
- ② Body absorption → " " ... actually absorbs
- ③ Body response → How does the body reacts to the chemical