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INTRODUCTION TO PHYSIOLOGY

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I RESPIRATORY + CIRCULATORY SYSTEM (JD)RESPIRATORY SYSTEM:

- $O_2$  FROM ATMOSPHERE  $\rightarrow$  MITOCHONDRIA
- $CO_2$  EXCRETION

CIRCULATORY SYSTEM:

- DISTRIBUTION OF GASES & NUTRIENTS

$\dot{V}_{O_2} \approx 250 \text{ mL/min} \Rightarrow$  CONSUMPTION OF  $O_2$  AT REST } STEADY STATE  
 $\dot{V}_{CO_2} \approx 200 \text{ mL/min} \Rightarrow$  PRODUCTION OF  $CO_2$  AT REST }

IN ATMOSPHERE:

$$F_{O_2} \approx 0.21$$

$$F_{N_2} \approx 0.79$$

$$F_{CO_2} \approx \phi$$

WHAT CONSUMES ALL THE  $CO_2$ ? PLANTS  $\rightarrow$  PRODUCE  $O_2$  FROM  $CO_2$   
 \* LATELY WE HAVE BEEN PRODUCING MORE  $CO_2$  THAN IT  
 CAN BE CONSUMED

0.0003 INCREASED TO 0.00045  $\Rightarrow$  BIG <sup>RELATIVE</sup> CHANGE BUT SMALL

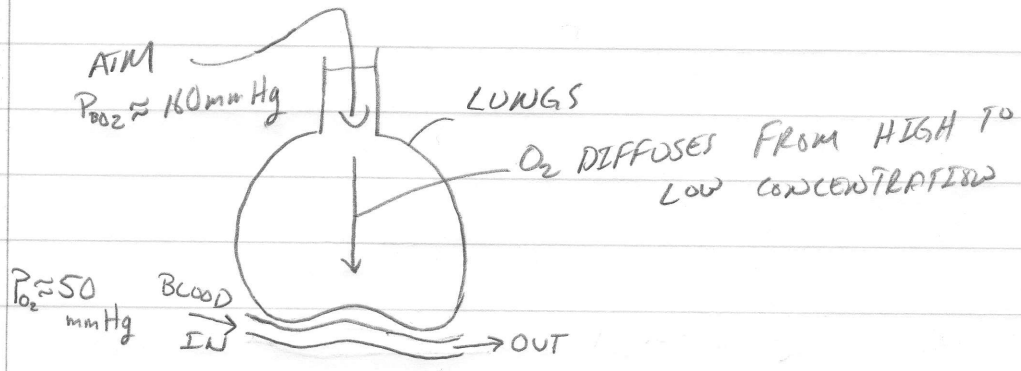
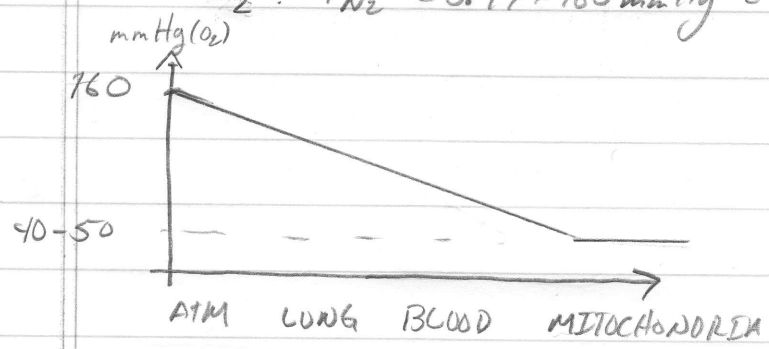
ABSOLUTE %

BAROMETRIC PRESSURE:  $P_B \approx 760 \text{ mmHg} \pm 20 \text{ mmHg}$

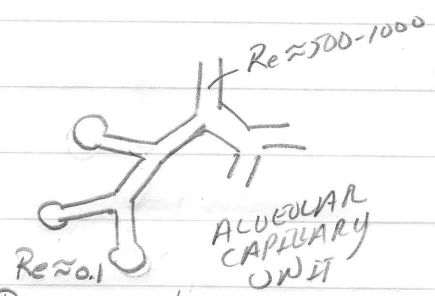
$$P_x = F_x \cdot P_B$$

FOR O<sub>2</sub>:  $P_{BO_2} = 0.21 \cdot 760 \text{ mmHg} = 160 \text{ mmHg}$

N<sub>2</sub>:  $P_{N_2} = 0.79 \times 760 \text{ mmHg} = 600 \text{ mmHg}$



FOR AIR TO DIFFUSE TO A  $\Delta P_{O_2} \approx 100 \text{ mmHg}$  IT WILL REQUIRE AN AREA OF ABOUT A TENNIS COURT!!



\* BY BRANCHING HUNDREDS OF TIMES, THE LUNG ACHIEVES A VERY LARGE SURFACE AREA.

$P_a =$  ARTERIAL PARTIAL PRESSURE

		NO VENT	VENTILATION LIKE MAD!!	NORM AX
$P_{aO_2}$	45	45	160	100
$P_{aCO_2}$	45	45	$\phi$	40

IN  $P_{O_2} \approx 160 \text{ mmHg}$ ,  $P_{N_2} \approx 600 \text{ mmHg}$

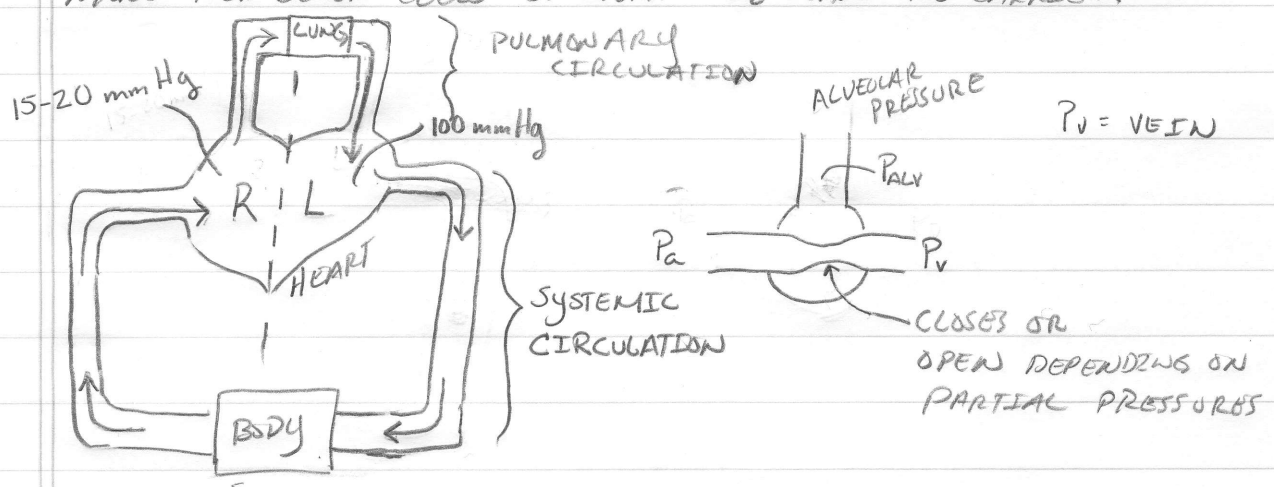
OUT  $P_{aO_2} \approx 100 \text{ mmHg}$

BLOOD FLOW

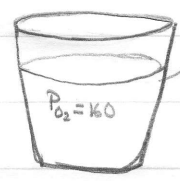
% completion of Diffusive Transport

Time 750sec

DURING REST, WE ONLY USE ABOUT 1/3 OF LUNG CAPACITY  
 AT HIGH ALTITUDE  $P_{O_2}$  IS LOWER BUT THE BODY MAKES  
 MORE RED BLOOD CELLS SO MORE  $O_2$  CAN BE CARRIED.



CAPACITY TO CARRY  $O_2$



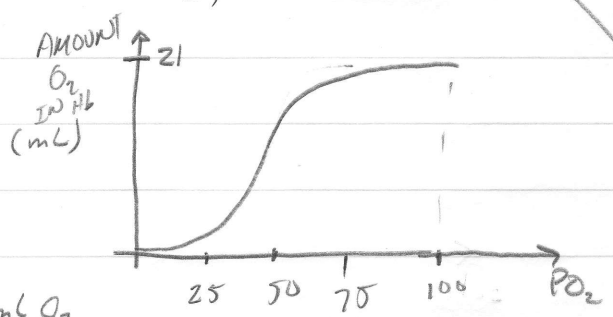
100 mL OF  $H_2O$

AMOUNT = SOL. OF  $O_2$  X  $P_{O_2}$

$= 0.003 \frac{mL}{mmHg} \times 160 mmHg = 0.48 mL O_2$

IN BLOOD  $\Rightarrow$  HEMOGLOBIN TRAPS  $O_2$ , DEPENDS ON:

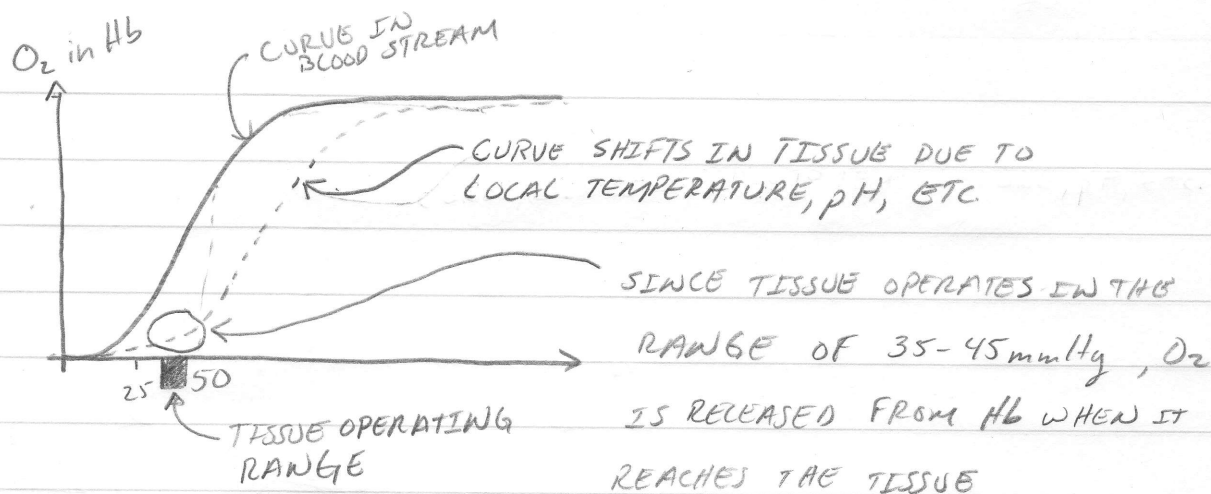
- ① AMOUNT OF Hb
- ②  $P_{O_2}$



100 mL OF BLOOD  $\approx$  15g Hb  $\rightarrow$  21 mL  $O_2$

COMPARE WITH 0.48 mL  $O_2$  IN 100 mL OF  $H_2O$  !!!

BLOOD IS MUCH MORE EFFICIENT ON CARRYING  $O_2$



CONGESTIVE HEART FAILURE  $\Rightarrow$  ACCUMULATION OF FLUID (EDEMA) DUE TO REDUCED FUNCTION OF EITHER SIDE OF HEART

ASTHMA  $\Rightarrow$  MUSCLE CONTRACTS LUMEN, ADDING RESISTANCE TO AIR FLOW

EMPHYSEMA  $\Rightarrow$  DESTRUCTION OF ELASTIC COMPONENTS OF LUNG, DIFFICULT TO EXHALE.

## II PHYSICAL PRINCIPLES IN ABDOMINAL PHYSIOLOGY (MZ)

- HOMEOSTASIS  $\Rightarrow$  INTERACTION WITH ENVIRONMENT, BALANCE

EPITHELIAL CELLS  $\Rightarrow$  LINED UP ALONG SURFACE OF MANY ORGANS

ANATOMY:

STOMACH,	GITRACT,	LIVER,	KIDNEY, ETC
pH=2	ABSORB	FOOD IS	REMOVE
DEGRADATION	NUTRIENTS	PROCESSED	POISON
OF FOOD			TO BE
			EXCRETED (W <sub>2</sub> )

EPITHELIAL CELLS  $\Rightarrow$  APICAL SURFACE  $\Rightarrow$  EXPOSED TO CAVITY, LUMEN

POLARIZED BASOLATERAL SURFACE  $\Rightarrow$  ATTACHED TO SURFACE BLOOD SIDE

ANATOMY OF STOMACH, LIVER, KIDNEY

THE EPITHELIAL TISSUE KEEPS THE BODY IN BALANCE BY CHECKING ION CONCENTRATION, pH, OSMOLALITY, ETC.

URINE: pH ~ 5, ALSO EXCRETES ACIDS

### PHYSIO-CHEMICAL PROCESSES

Ⓐ PASSIVE DIFFUSION: ALLOW REGULATION

$H_2O$ , UREA,  $NH_3$ ,  $H^+$ ,  $CO_2$

AQUOPORINS  $\Rightarrow$  ALLOW  $H_2O$  TRANSPORT ACROSS MEMBRANES

ION CHANNELS  $\Rightarrow$  " ION " " "

Ⓑ ACTIVE TRANSPORT  $\Rightarrow$  USE ATP TO MOVE AGAINST GRADIENT

$Na^+$ ,  $K^+$  ATPase

PROTON ATPase

Ⓒ SECONDARY ACTIVE TRANSPORT (USE GRADIENTS FORMED IN ACTIVE TRANS)

$Na^+$ , GLUCOSE

SEE SLIDES FOR PROXIMAL TUBE: TRANSPORT FUNCTIONS

### TRANSPORTERS:

NA/K-ATPase  $\Rightarrow$  BASOLATERAL SIDE OF EPITHELIUM

MTAL  $\Rightarrow$  BUMETANIDE-SENSITIVE CO-TRANSPORTER, ABSORB SALT

SEE SLIDES FOR OTHER EXAMPLES

HORMONES CAN REGULATE  $H_2O$  ABSORPTION (ANTI-DIURETIC HORMONE)

THERE ARE REDUNDANT SYSTEMS TO KEEP THE BODY IN BALANCE