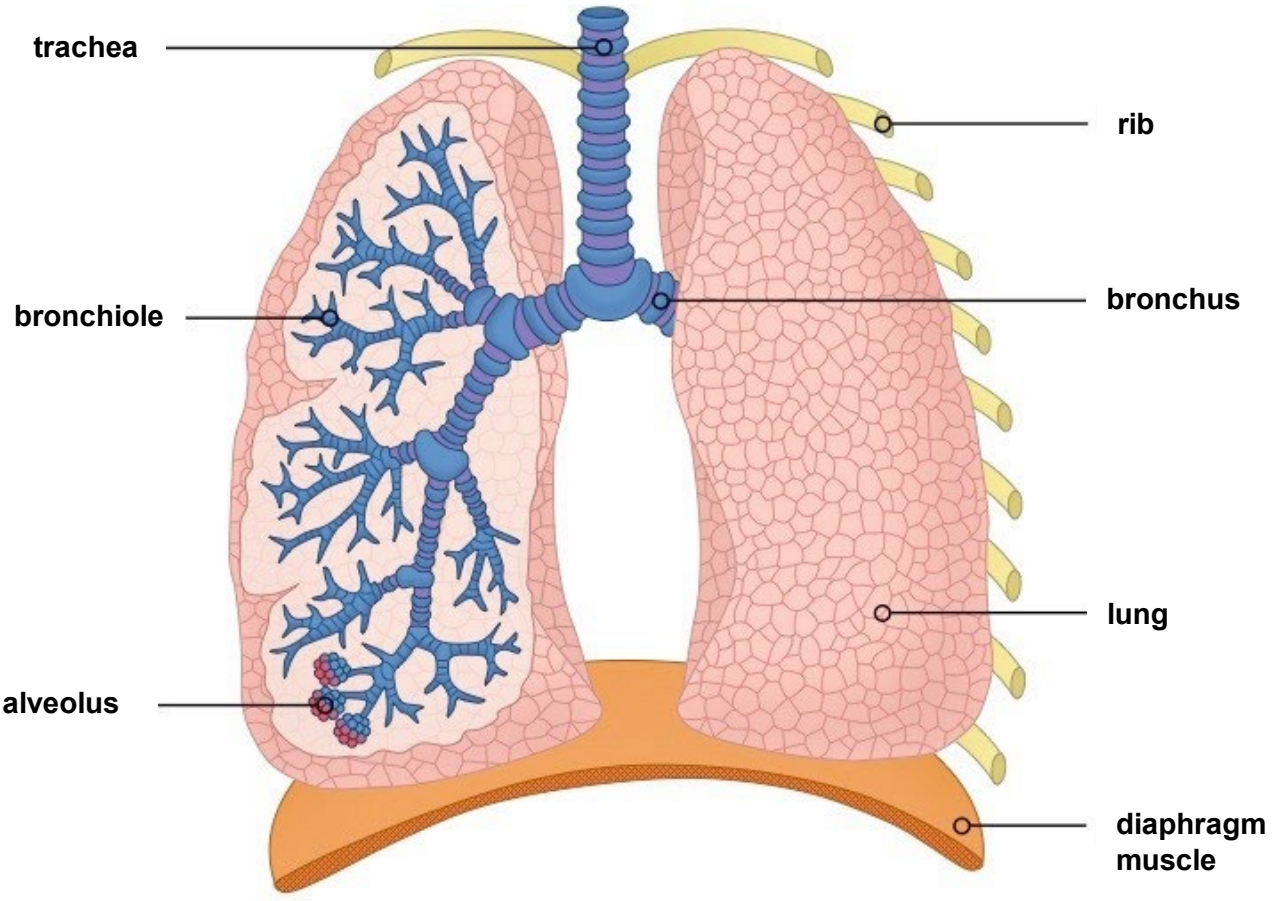
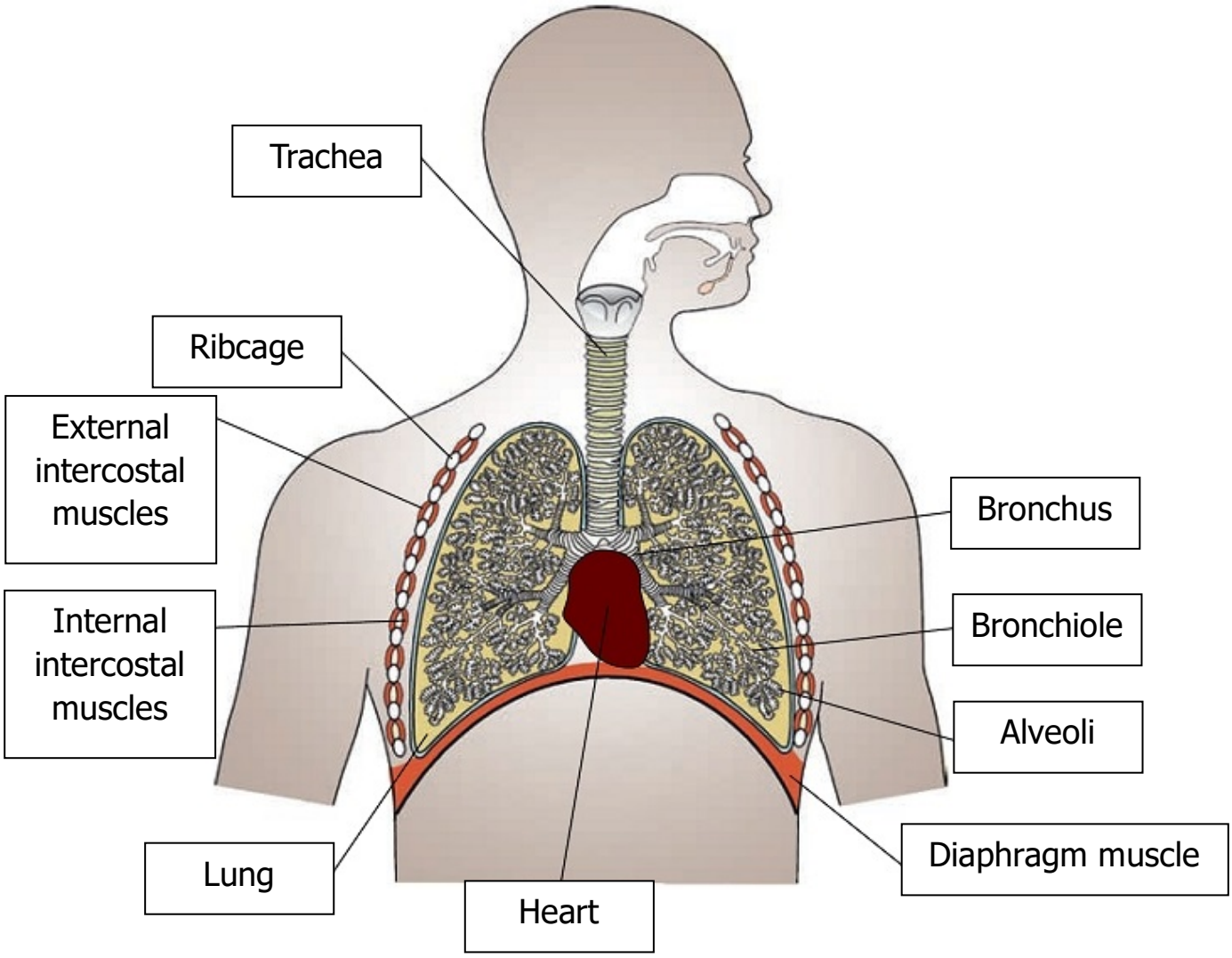
A. THE RESPIRATORY SYSTEM

- Air enters through the **nose** or **mouth** and enters the **trachea** (windpipe).
- The trachea **splits** into two **bronchi** which connect to each lung.
- The **bronchi divide** into **many smaller** tubes called **bronchioles**, which increases the **surface area**.
- The **bronchioles** lead to **tiny air sacs** called **alveoli**, where **gas exchange** with the **blood** occurs.

Structure



- There are two sets of **intercostal muscles** between the **ribs** that **move** the **ribcage up** or **down**.
- They are called the **internal intercostal muscles** and the **external intercostal muscles**.



B. SOME KEY TERMS

VENTILATION

The physical movements in the chest (thorax)
that brings fresh air (O_2) to the alveoli and removes stale air (CO_2)

GAS EXCHANGE

Swapping gases (O_2 and CO_2) between the alveoli and blood

RESPIRATION

The release of energy from glucose,
usually in the presence of oxygen

C. VENTILATION

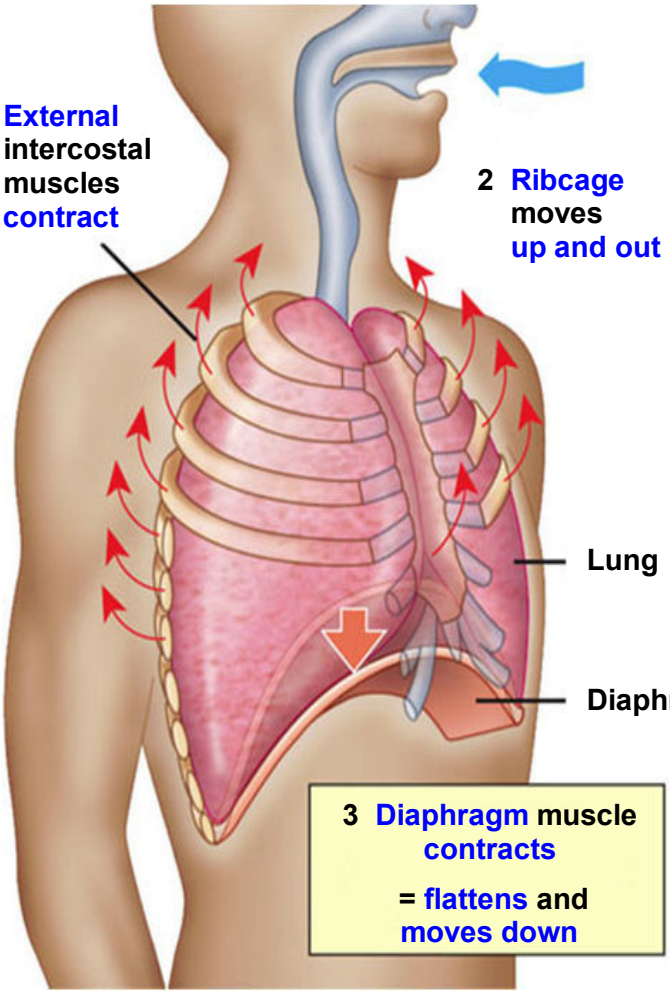
- This is the **physical movements** that happen in the **chest** that **allow air** to **enter** or **leave**.

Some quick reminders

1. **Atmospheric (air) pressure** outside the body is relatively **constant**.
2. **Air pressure inside** the **body** must therefore **change** if gases are to enter or leave.
3. **Air** moves from **high → low pressure**.
4. **Higher** volume = **lower** pressure (and vice versa).

How we inhale (= 'inspiration')

- More **energy** is needed for **inhaling** than exhaling as **more muscles are contracting** and the **ribcage** is **moved up and out**.

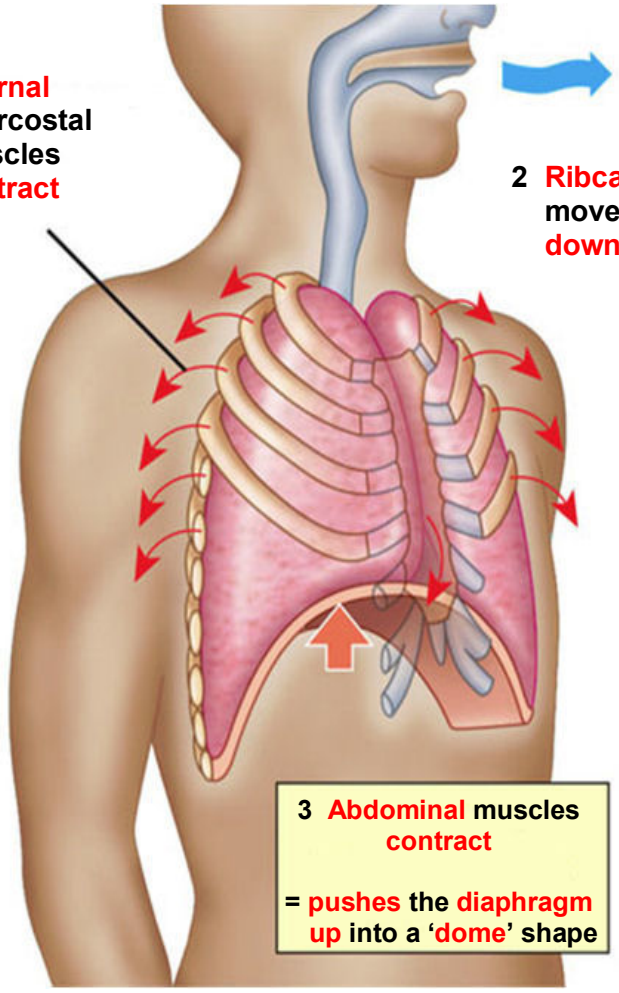


4 Volume in chest (thorax) increases

5 Pressure in chest (thorax) decreases to below atmospheric pressure

6 (So) air enters chest moving from high → low pressure

How we exhale (= 'expiration')



4 Volume in chest (thorax) decreases

5 Pressure in chest (thorax) increases to above atmospheric pressure

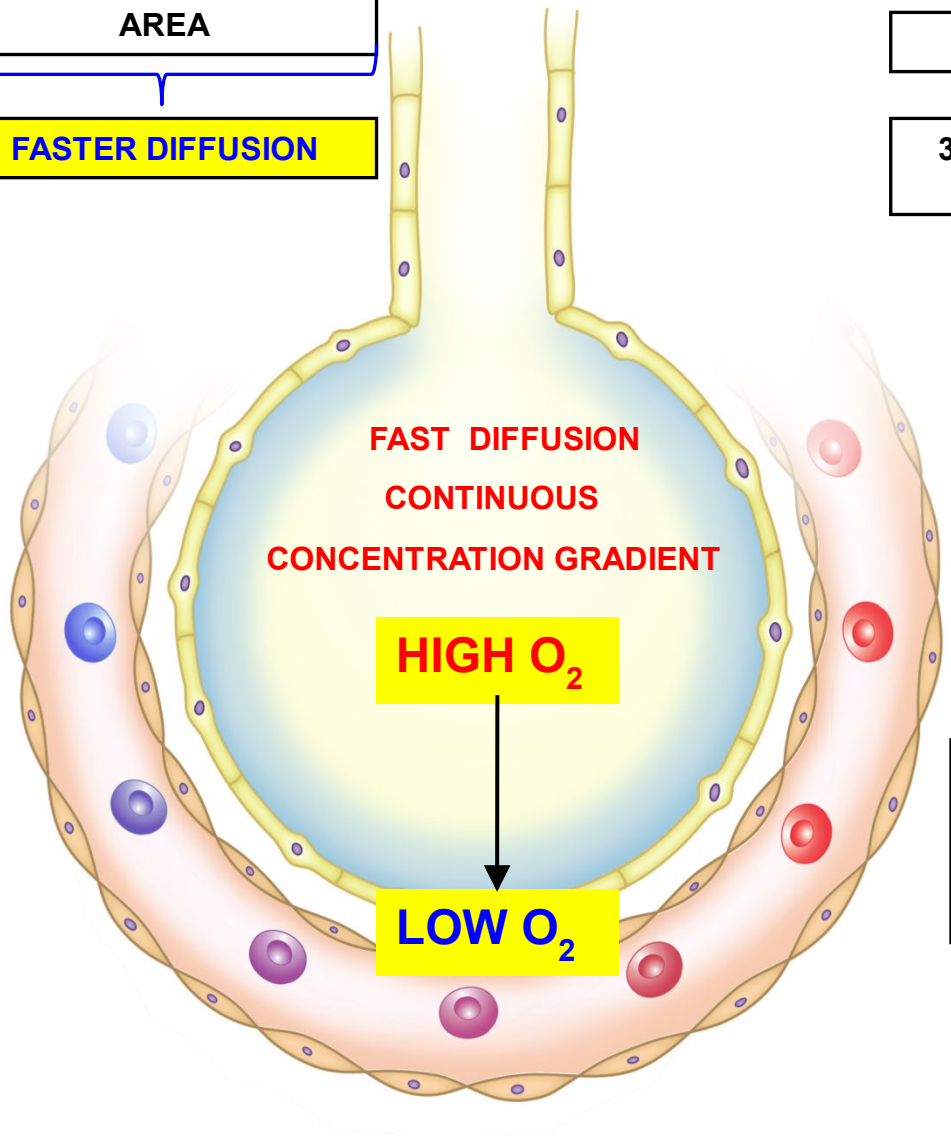
6 (So) air leaves chest moving from high → low pressure

	INHALING	EXHALING
EXTERNAL INTERCOSTAL MUSCLES	CONTRACT	RELAX
INTERNAL INTERCOSTAL MUSCLES	RELAX	CONTRACT
RIBCAGE MOVES	UP AND OUT	DOWN AND IN
DIAPHRAGM MUSCLE	CONTRACTS = flattens and moves down	RELAXES = pushed up into a 'dome' shape
ABDOMINAL MUSCLES	RELAX	CONTRACT
VOLUME IN CHEST	INCREASES	DECREASES
PRESSURE IN CHEST	DECREASES (below atmospheric)	INCREASES (above atmospheric)
SO, **AIR**	ENTERS CHEST DOWN PRESSURE GRADIENT	LEAVES CHEST DOWN PRESSURE GRADIENT

D. GAS EXCHANGE AT THE ALVEOLI

1. Many small alveoli = a LARGE SURFACE AREA

FASTER DIFFUSION



2. THIN WALL

3. ALVEOLI ARE CLOSE TO BLOOD CAPILLARIES

→ SHORTER DIFFUSION DISTANCE

4. MOIST

→ TO DISSOLVE O_2 AND CO_2

5. PERMEABLE WALL

→ TO O_2 AND CO_2

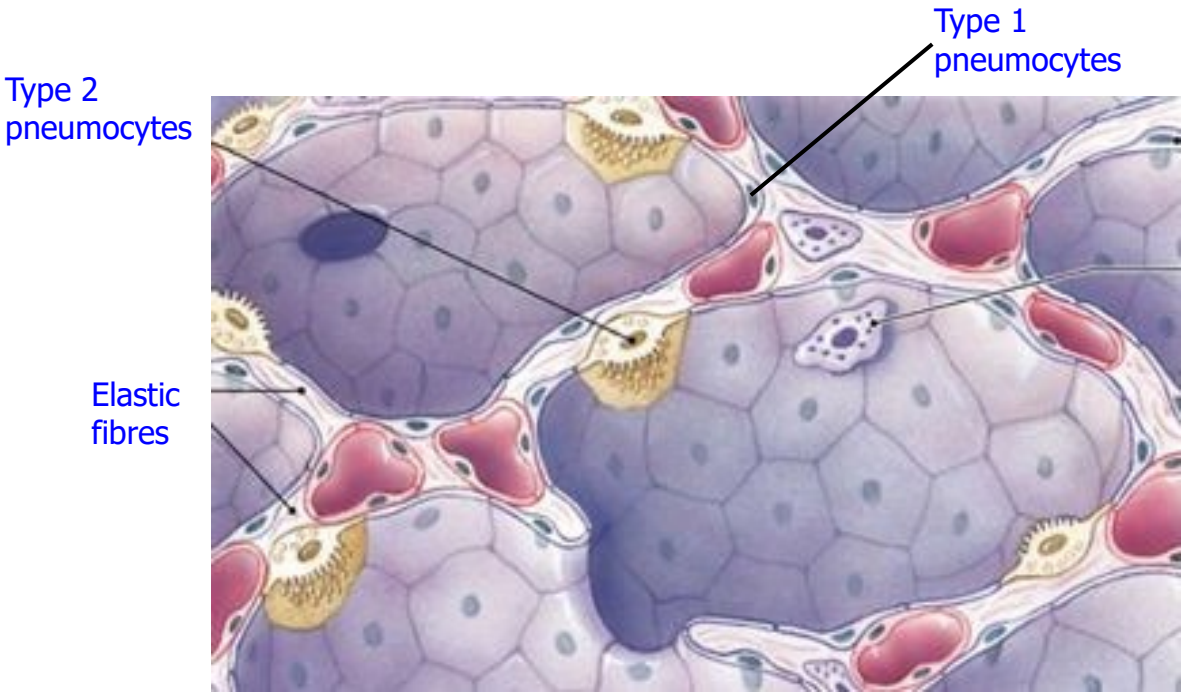
6. VENTILATION

- ensures a high oxygen concentration in the alveoli

→ MAINTAINS CONCENTRATION GRADIENTS OF O_2 AND CO_2 BETWEEN ALVEOLI AND BLOOD IN CAPILLARIES

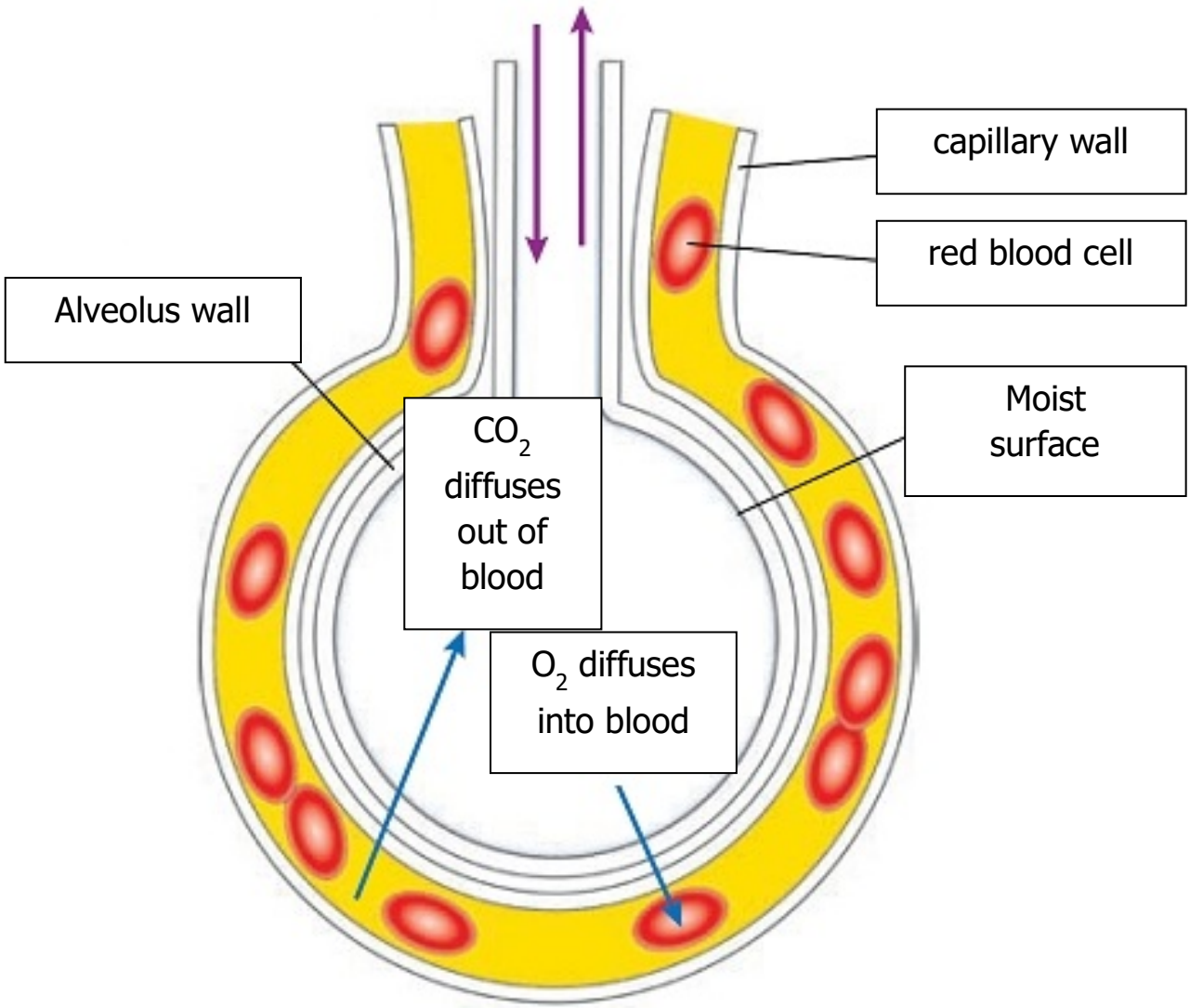
E. ALVEOLI CELLS

- Alveoli are made up of **two** types of cell, which are called **Type I** and **Type II pneumocytes**.



TYPE I PNEUMOCYTES	TYPE II PNEUMOCYTES
• Thin **and** permeable **cells** • **Make up** most **of the** wall • **Wall** has a **single layer** of these cells • Where **gas exchange** occurs	• Secrete a **fluid** to keep the **inner** surface **moist** • To **dissolve gases** • Fluid contains **surfactant** • To **reduce surface tension** • This **prevents** the **sides** of the **alveoli** from **sticking together**

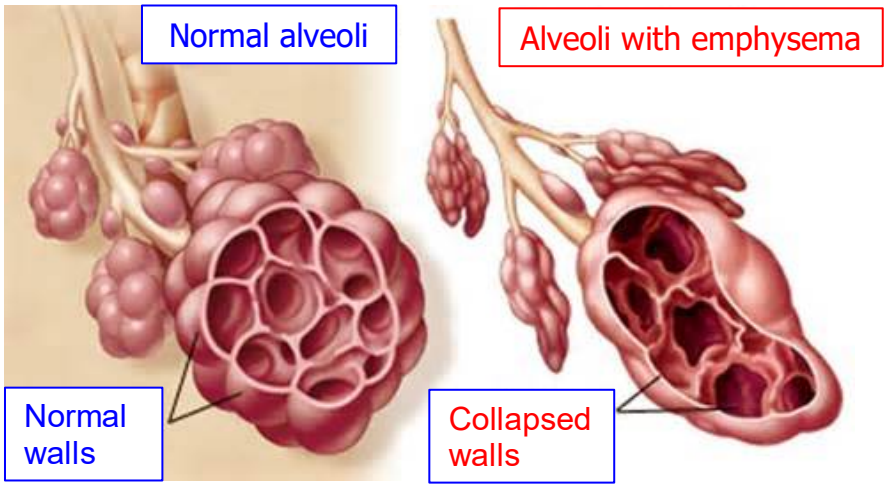
F. DRAWING AN ALVEOLUS AND BLOOD CAPILLARY



G. LUNG DISEASE 1: EMPHYSEMA

Overview

- Affects the **alveoli**:



Specifics

Toxins in cigarette smoke and polluted air:

- **cause inflammation**
- **damage white blood cells**

↓

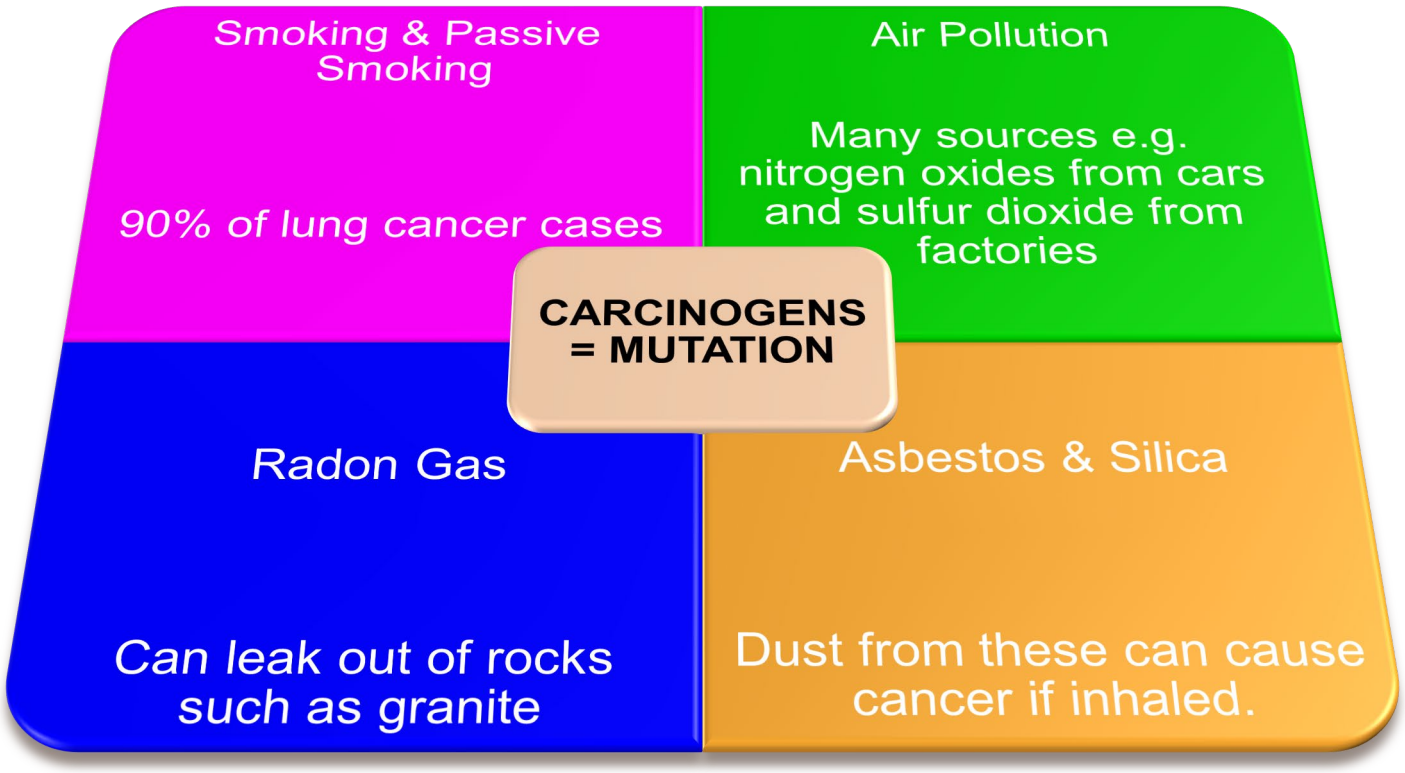
Inflamed cells and damaged white blood cells release trypsin enzyme

↓

Trypsin is a protease that digests elastic fibres in the alveoli walls, so they break down (collapse)

- **Less surface area** = **slower diffusion** of oxygen into blood = **more tired**
- **Larger alveoli / less permeable walls** = **longer diffusion distance** for oxygen = **more tired**
- **Loss of elastic tissue** = **lungs lose elasticity** so **more difficult to exhale** = **more tired**
- **Cilia damaged** so **mucus builds up** in **lungs** = **more chest infections**

H. LUNG DISEASE 2: LUNG CANCER



Cause:

Mutation of:

- **proto-oncogene** that **switches on cell division** = protein is **even better** at switching it on

OR:

- **tumour suppressor gene** that **switches off cell division** = protein is **not able** to switch it off

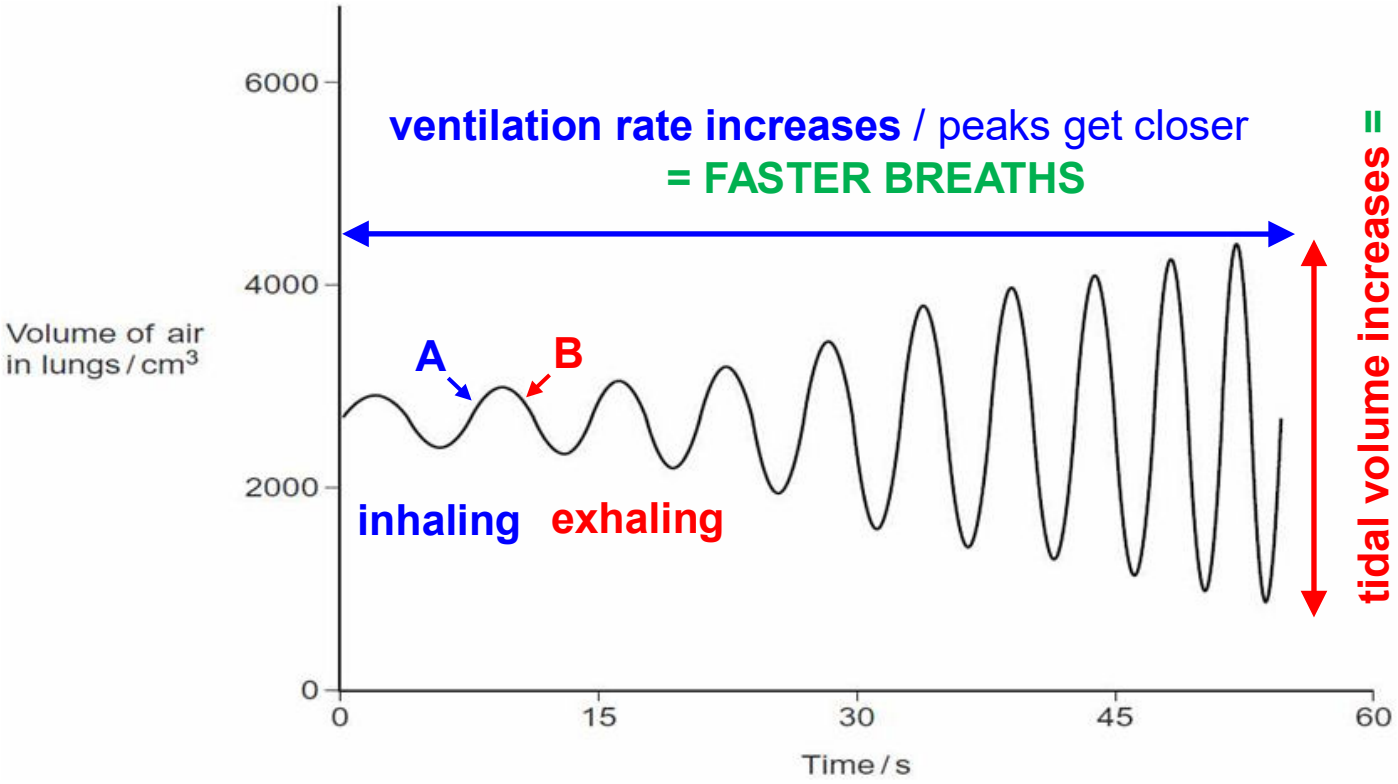
Symptoms

- Persistent cough
- Coughing up blood
- Tiredness
- Breathing difficulties
- Chest pain
- Loss of appetite
- Weight loss

I. VENTILATION RATE & TIDAL VOLUME

VENTILATION RATE = NUMBER OF BREATHS PER MINUTE

TIDAL VOLUME = VOLUME OF AIR INHALED OR EXHALED PER BREATH



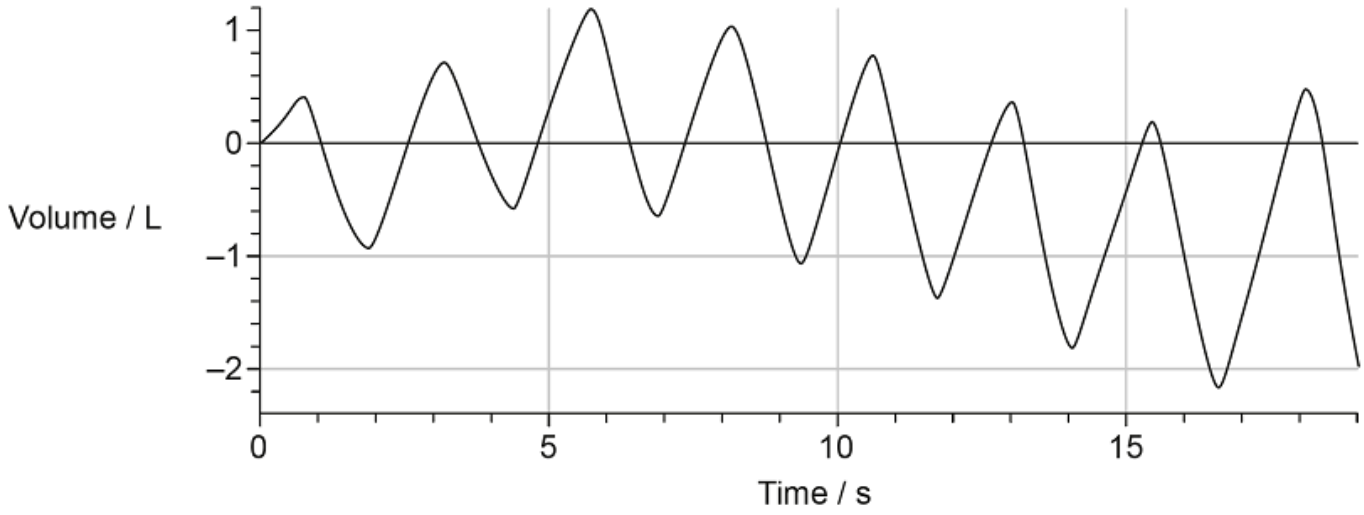
J. CALCULATIONS FROM GRAPHS

Mean tidal volume

- **Mean tidal volume** = **Maximum** value – **Minimum** value for **one breath**
- **Repeat** for **several breaths** and calculate the **mean** value

Ventilation Rate

- **One breath = inhale + exhale**



- **4 breaths** in **10s <u>or</u> 6 breaths** in **15s;**
- (So) **<u>24</u> breaths per min;**

K. SPIROMETER = ACCURATE MEASUREMENTS