

General Functions of Respiratory System

- takes up O_2 and eliminate CO_2
- maintenance of body pH
- a reservoir of blood (about 1 L)
- Lung Defence mechanisms
 - ❖ Particles ($>10 \mu m$) : hair in the nasal cavity
 - ❖ Particles (2-10 μm) : ciliary escalator
 - ❖ Particles ($< 2 \mu m$) : PAM - phagocytosis
 - ❖ IgA in bronchial secretion : secretory Ig

- URT : humidify, cool and warm the inspired air
- Filters small blood thrombi
- Water vaporization : thermoregulatory function

Metabolic functions

- Surfactant synthesis
- Fibrinolytic activity
- Release of some chemicals (e.g. PGs, histamine, kallikrein)
- Removes some chemicals from blood (e.g. PGs, bradykinin, adenine nucleotides, serotonin, NA, Ach)
- ACE
- Alveolar Macrophages : synthesize protein
- Participate in CH_2O metabolism

RESPIRATORY FUNCTION TESTS

1. Tests of ventilation

Measurement of volume and flow

1.1. Lung volumes and capacities

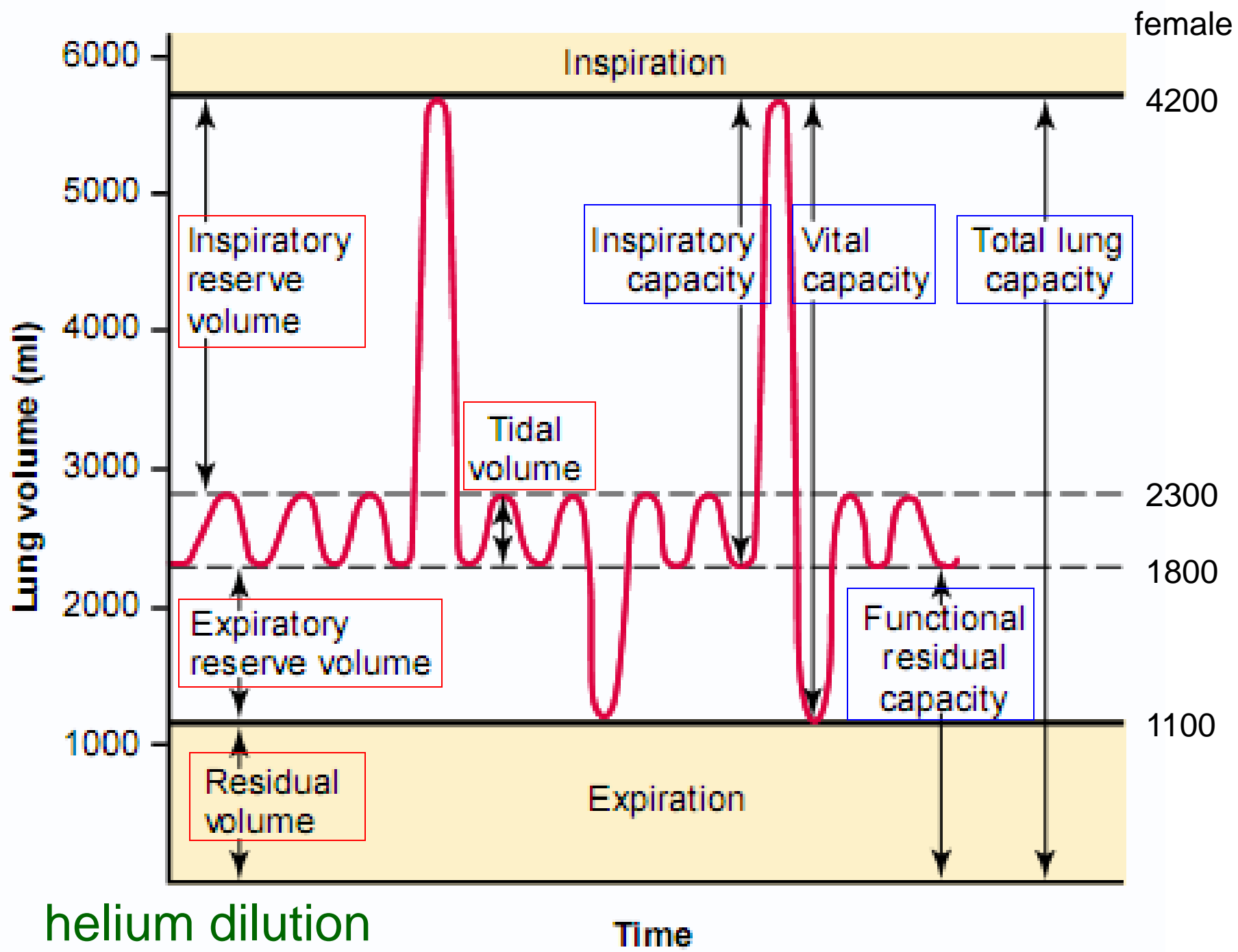
1.2. Forced expiration

1.2.1. Timed vital capacity (FEV_1)

1.2.2. Peak expiratory flow rate (PEFR)

1.2.3. maximum voluntary ventilation (MVV)

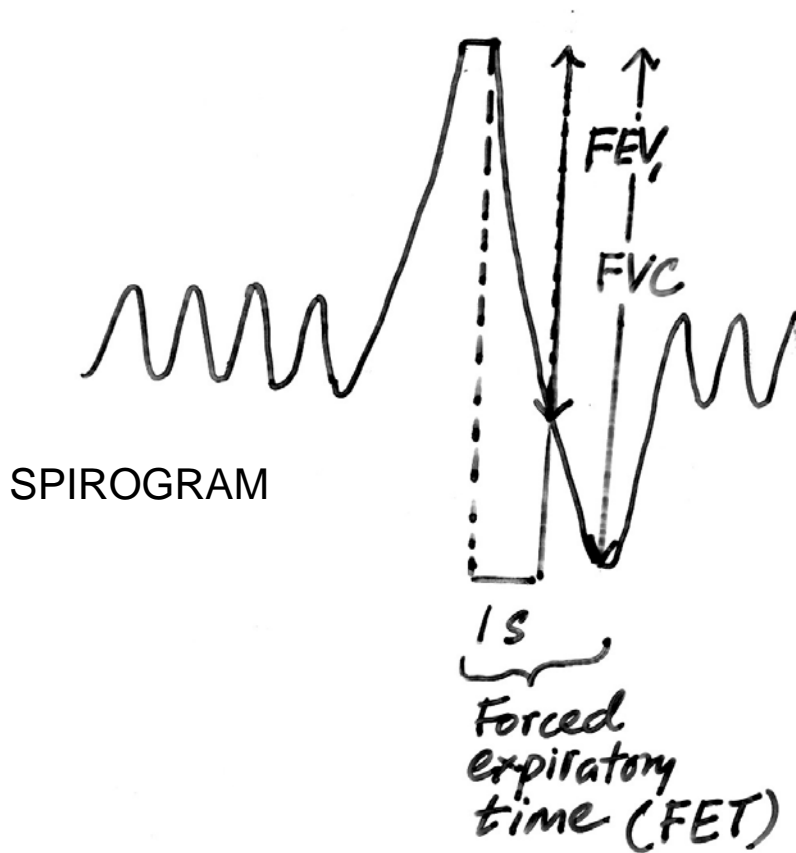
1.2.4. forced expiratory time (FET)



LUNG DISEASES

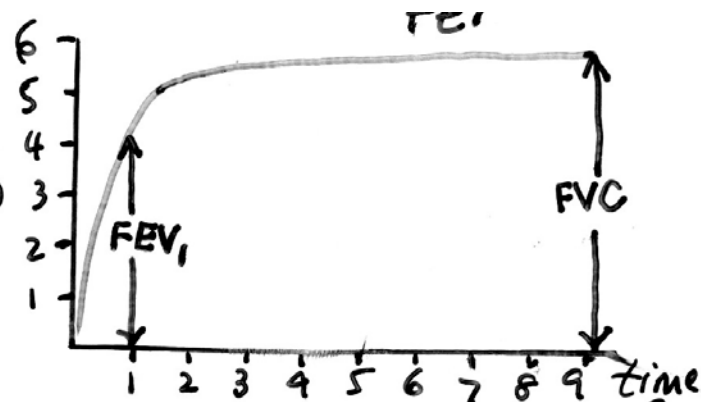
- **Restrictive lung diseases: decrease in LVs**
 - Lung expansion limited
(eg. Diffuse pulmonary fibrosis)
 - Immobility of the thoracic cage
(eg. Kyphoscoliosis)
 - Weakness of respiratory muscles
(eg. Myasthenia gravis)
- **Obstructive lung diseases** (eg. Bronchial asthma or emphysema): **increase in RV**

Timed vital capacity (FEV_1)



VITALOGRAM

Vol. (L)



FET: 4 seconds

FEV₁: at FIRST seconds
- 75 – 80% of FVC
- remaining 2-3 s

FVC : decrease in
RLD and OLD

FEV₁ : decrease in
RLD and OLD

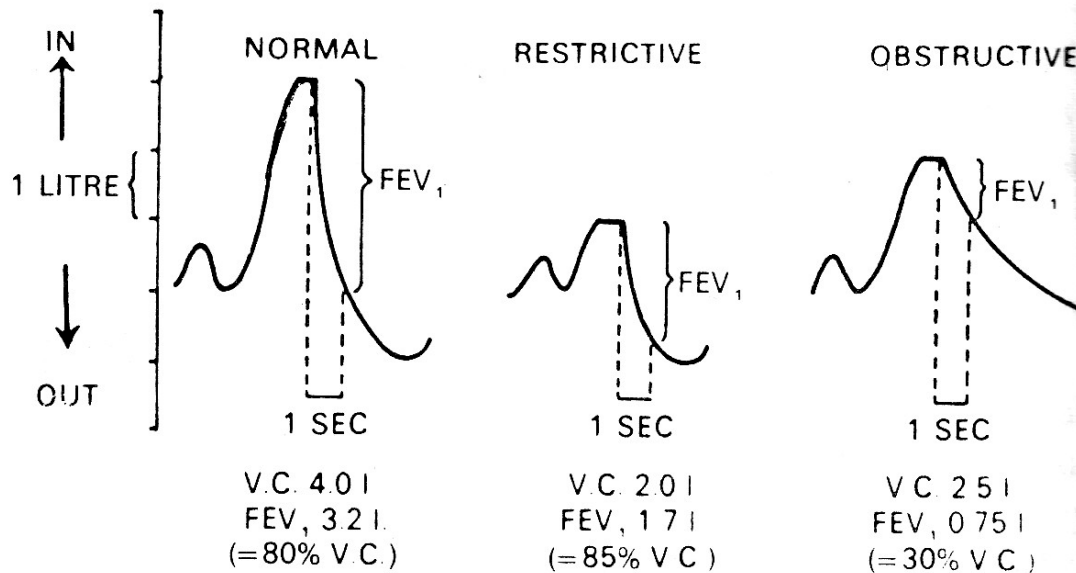
FEV₁ / FVC ratio

Obstructive airway diseases

- FEV₁ : reduced
- FVC : reduced
- RV : increased
- FEV₁/FVC : low

Restrictive lung diseases

- FEV₁ : reduced
- FVC : reduced
- RV : reduced
- FEV₁/FVC : normal



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1.2.4. forced expiratory time (FET)

2. Tests of gas exchange

2.1. Arterial blood gases (P_{O_2} , P_{CO_2} , pH)

2.2. Measurement of diffusion capacity for carbon monoxide:

$$T_{CO} = 25 \text{ ml/min/mmHg}$$

3. Tests of mechanics of breathing

3.1. Measurement of lung compliance

3.2. Measurement of airway resistance

4. Others

4.1. Distribution of V and Q

4.2. Measurement of dead space, RV

Respiratory insufficiencies: **HYPOXIA**

Definition: O₂ deficiency at the tissue level

Types: FOUR

(1) hypoxic

(2) anaemic

(3) ischaemic (stagnant)

(4) histotoxic

HYPOXIA

Type	Pa _{o2}	RBCs (Hb)	Blood flow	Tissue toxicity	Examples
Hypoxic	reduced	Normal	Normal	Normal	High altitude Ventilatory failure - narcotic drug overdose - mechanical defects - fatigue of muscles Gas exchange failure - lung diseases
Anaemic	Normal	reduced altered	Normal	Normal	Anaemia CO poisoning
Ischaemic	Normal	Normal	reduced	Normal	Circulatory failure (hypovolemia) Cardiac failure
Histotoxic	Normal	Normal	Normal	++	Cyanide poison

CYANOSIS : blue discolouration of the skin and mucous membrane
(HHb more than 5g/dl)

O₂ therapy

Effects of Hypoxia

- **Acute changes:** a sudden drop in inspired air <20 mmHg
 - loss of consciousness in 10-20 seconds, death in 4-5 minutes
 - less severe hypoxia: a variety of mental aberrations
- **Chronic changes:**
 - hyperpnoea and dyspnoea on exertion
- **Adaptive changes:**
 - hyperventilation, respiratory alkalosis, increased erythropoietin
 - Increased RBC 2-3 BPG content, increased mitochondria

Respiratory failure

(inadequate ventilatory performance)

$P_{O_2} : < 60 \text{ mmHg (8.0 kPa)}$

$P_{CO_2} : > 50 \text{ mmHg (6.6 kPa)}$

Effects of barometric pressure

- Decreased
- Increased

Effects of decreased barometric pressure

Above sea level	PA O ₂	Pa CO ₂	Remarks
At sea level	100	40	1 ATM = 760 mmHg
3050 m (10,000 ft)	60	Fall	Hyperventilation Respiratory alkalosis
3700 m			Mental symptoms (breathing air)
6100 m (20,000 ft)			Loss of conscious (breathing air)
10400 m (34,000 ft)	100	40	Barometric pressure = 187 mmHg Breathing 100% O ₂
14000 m			Loss of conscious (breathing 100% O ₂) Artificial atmosphere: life possible
19200 m			Body fluid boiled at 37°C

Human habitations: 5500 m (barrel-chest and marked polycythaemia)



Top of Mt Everest: 8854 m

Delayed effects of high altitude

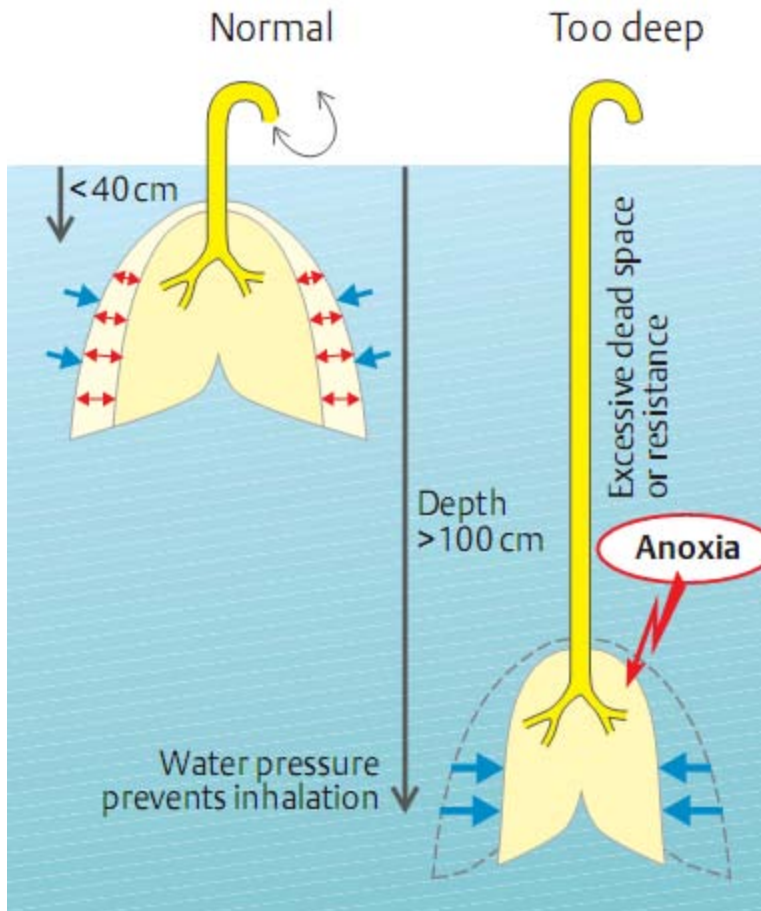
MOUNTAIN SICKNESS

- appears within 8-24 hours
- lasts for 4-8 days
- symptoms: headache, irritability, insomnia, breathlessness, nausea, vomiting
- associated with cerebral edema
- pulmonary edema
- is prone to occur in individuals who ascend quickly to altitude

Acclimatization to altitude

- Hyperventilation
- Respiratory alkalosis (plasma pH decreased)
- Oxygen dissociation curve: shift to the left
- Concomittent increase in RBC 2-3 BPG: decrease in O₂ affinity
  more available to the tissue
- Steady increase in ventilation over next 4 days and then decline steadily  decline to initial level
- Erythropoietin: increased promptly and then fall
- RBCs: increased begins in 2-3 days and sustained as long as remains in high altitude
- Compensatory changes in tissue: an increase in mitochondria, myoglobin, cytochrome oxidase

Effects of increased barometric pressure



1 ATM :

every 10 m of depth in sea water

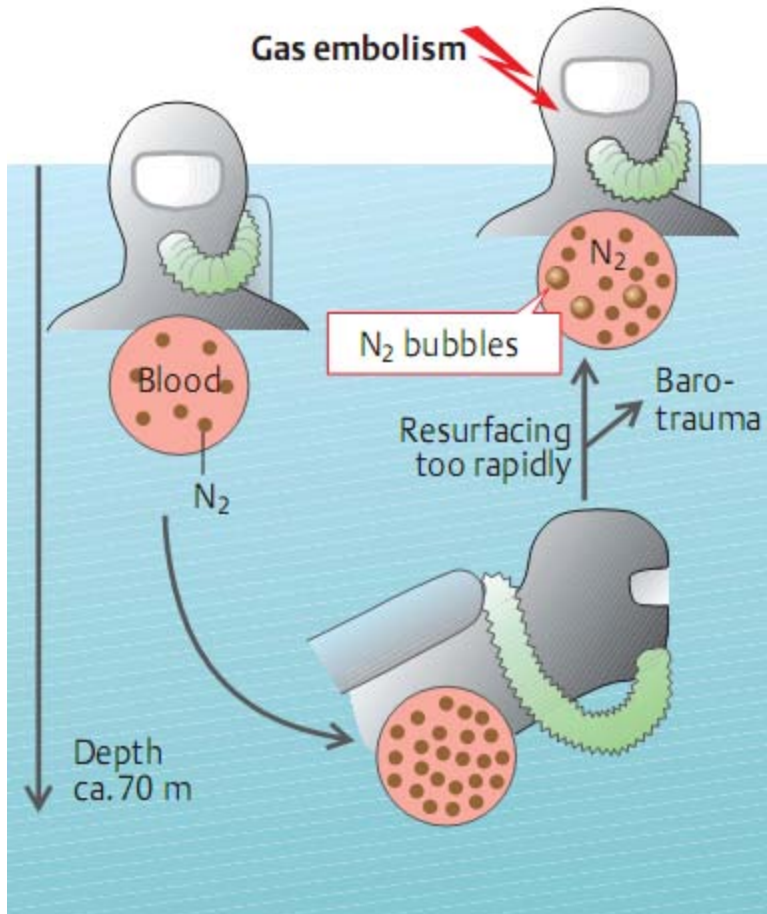
every 10.4 m in fresh water

Divers: 31 m in the ocean (4 ATM)

must breathe air or gases at

increased pressure

Breathing compressed air: P_{N_2} increased



N_2 narcosis (Rapture of the deep)

Definite euphoria (at 30-40 m in the ocean)

Manual dexterity: maintained

Intellectual functions: impaired

Decompression sickness

- rapid ascend
- N_2 escapes from solution
- N_2 bubbles in the tissues and blood
- the bends and the chokes

