Ministry of Higher Education and
Scientific Research
Al-Mustaqbal University College
Department of Medical Physics

Physics of the lung and Breathing
Part 2

By

Dr. Noor AL-huda Talib AL-aaraji

Objectives: after the end of this lecture, the student must know:

1 How blood and lungs interact

2 Role of surfactant in preventing lung collapse

3 Physics of certain lung diseases.

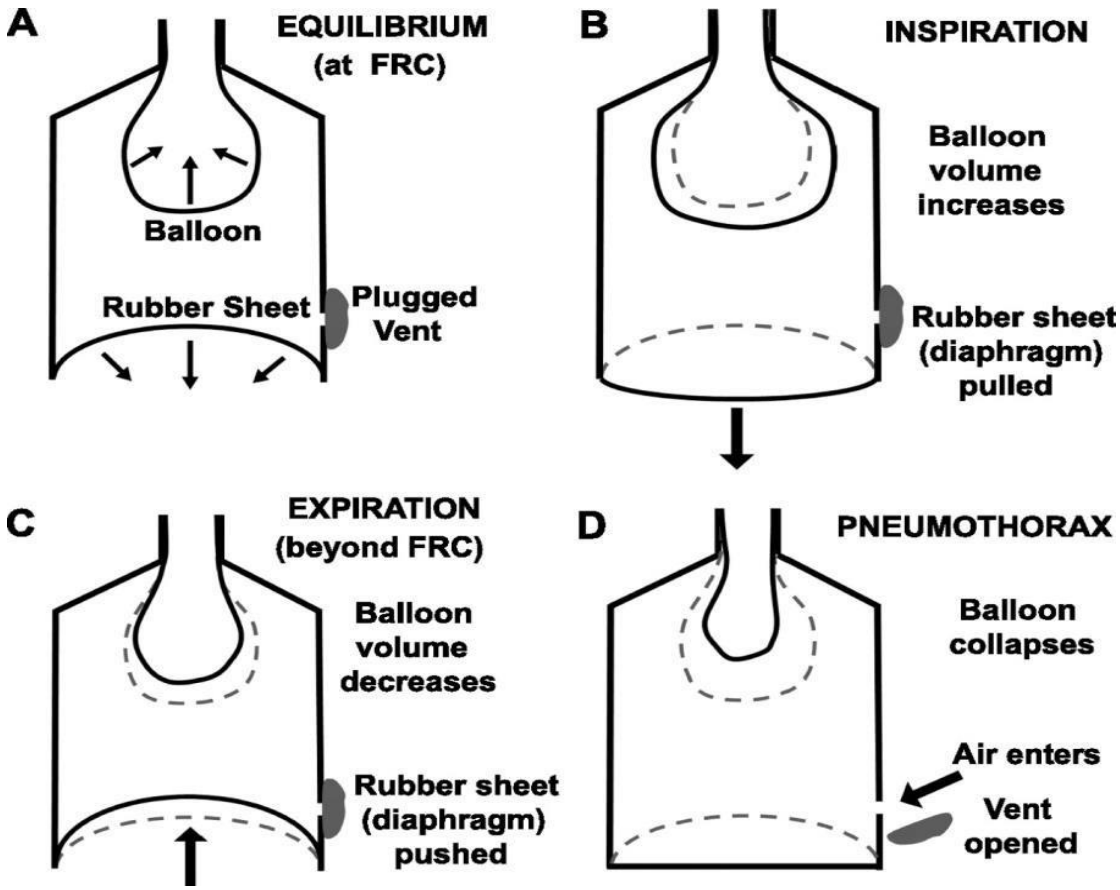
Two Forces Keep Lungs From Collapsing

1 surface tension between lungs and chest

2 Air pressure inside the lungs.

Since each lung is its own sealed compartment, it is possible to collapse one lung only. This is done by inserting a hollow needle between ribs and allowing air to flow into intrathoracic space, the air trapped in the space is gradually absorbed by tissue and lung expand to normal over few weeks, sometimes lung collapses spontaneously with no known cause.

The lungs returns to normal as the air is absorbed into surrounding tissues. Since both lung and chest are elastic we can represent them with springs.



Simple model for mechanism of breathing during (A) normal conditions, B inspiration, C expiration and D pneumothorax.

Air Way Resistance

During inspiration the forces on airways tend to open them further, during expiration the forces tend to close the airways and restrict flow.

Voltage replaced by pressure difference ΔP Current replaced by rate of air flow or V

Air way resistance

$Rg = \Delta P / V$

Most of resistance in the upper airway passages.

10 % of Rg is in the terminal airways (bronchioles and alveoli) do not affect air way resistance until they are far advanced.

Physics of Common Lung Diseases

Emphysema the division between alveoli break down produces large lung spaces, this destruction of lung tissue reduces the springiness of lungs. The lungs become more complaint, small change in pressure produces larger than normal change in volume .

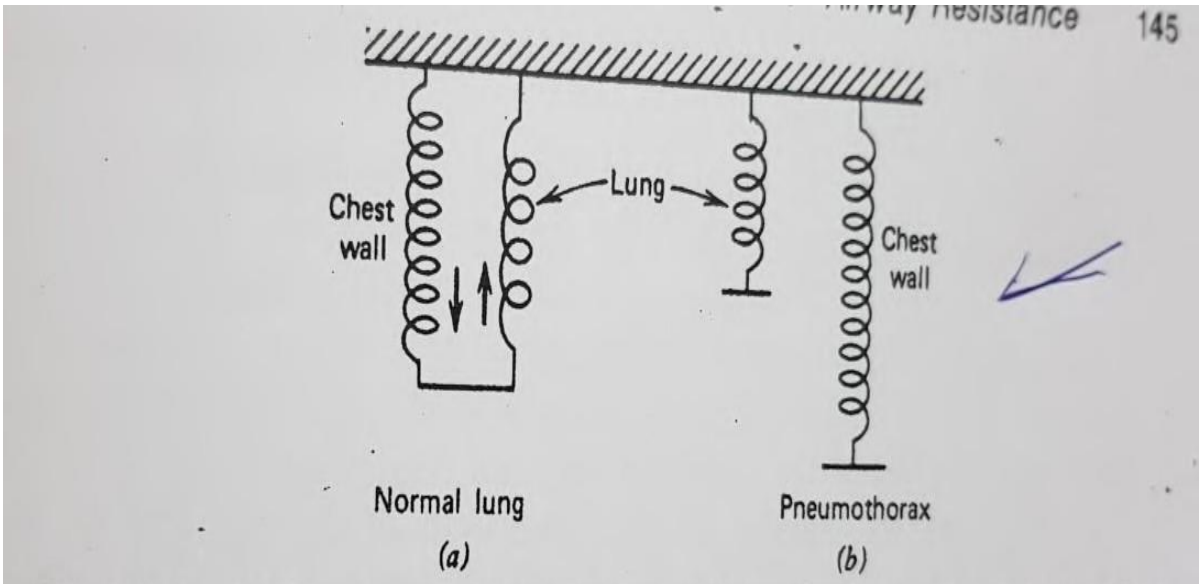


Figure 7.22. (a) A spring model for the lungs. The arrows show the direction of the spring forces. Normally the lung and chest wall are coupled together. (b) During a severe pneumothorax, the springs go to their relaxed positions—the chest enlarges and the lung collapses.

Emphysema Produces two changes:

1 The lungs become flabby and expands

2 The tissues do not pull very hard on the airways permitting the narrowed airways to collapse easily during expiration

In asthma due to increasing airway resistance, some of resistance is due to swelling (edema) and mucus in the smaller airways but much of it is due to contraction of smooth muscles round the large air ways.

Fibrosis of lungs, the membranes between alveoli thicken. This has two effects

1 the compliance of the lungs decreases

2 The diffusion of O2 into capillary decreases