

Pressure

It is the force per unit area in a gas or liquid. (For solid the term pressure is replaced by "stress").

Units: In metric system pressure is measured in units

- a. Dynes per square centimeters
- b. Newton per square meter (Pascal) or (Pa)

Note: none of the above units is in common in medicine.

The used unit is the height of a column of mercury (Hg)

The peak systolic pressure = 120mm Hg = a pressure of a liquid mercury of this height on its base. While the atmospheric pressure = 760mm Hg

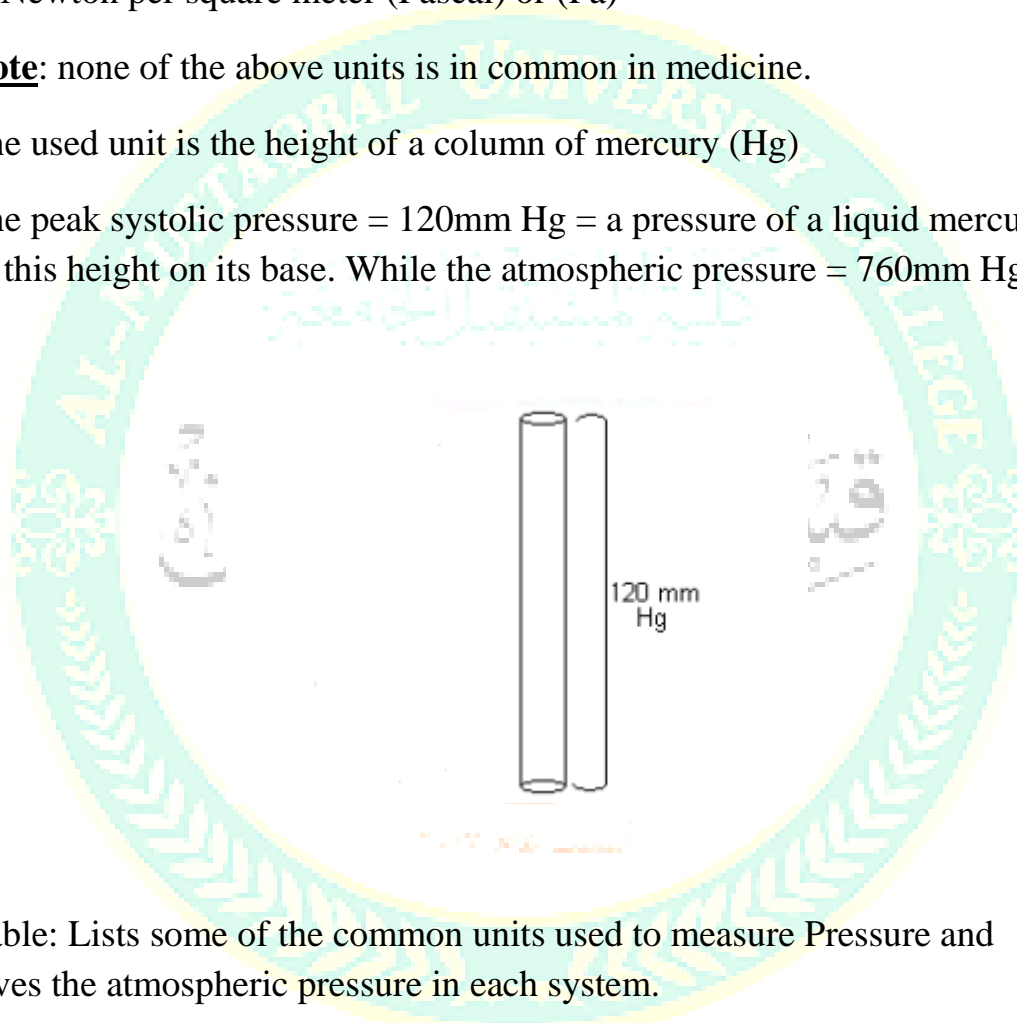


Table: Lists some of the common units used to measure Pressure and gives the atmospheric pressure in each system.

	Atmospheres	N/m ²	cm H ₂ O	mmHg
1 Atmospheres	1	1.01*10 ⁵	1033	760
1 N/m ²	0.987*10 ⁻⁵	1	0.0102	0.0075
1 cm H ₂ O	9.68*10 ⁻⁴	98.1	1	0.735
1mm Hg	0.00132	133	1.36	1

Pressure (p) under column

$$P = \rho gh$$

ρ : the density of liquid

for mercury $\rho = 13.6 \text{ g/cm}^2$

for water $\rho = 1 \text{ g/cm}^2$

g : the acceleration due to gravity h : the height of the column

Question: Calculate the length of water column that can produce the same pressure of a column of mercury of (1mm) length. (Answer =13.6 mm)

What is blood pressure?

Blood pressure is the force of blood moving through your arteries . Arteries are the blood vessels that carry blood from your heart to the rest of your body.

What do blood pressure numbers measure?

Blood pressure is measured with 2 numbers. An example is shown below. Ideally, we should all have a blood pressure below 120 over 80 (120/80). This is the ideal blood pressure for people wishing to have good health. At this level, we have a much lower risk of heart disease or stroke. If your blood pressure is above 120/80mmHg, you will need to lower it.

BLOOD PRESSURE BASICS

120

80

The top number measures the force of blood in your arteries when your heart contracts (beats). This is called systolic pressure. The bottom number measures the force of blood in your arteries while your heart is relaxed. This is called diastolic pressure.

Manometer: This is a U-shaped tube containing a fluid that is connected to the pressure to be measured, The levels in the arms change until the difference in the levels (h) is equal to the pressure.

* this type of manometer can measure both (positive) and (negative) pressure. * The fluid used can be:

1. Mercury for high pressure measurements.
2. Water or other low density fluid for low pressures.

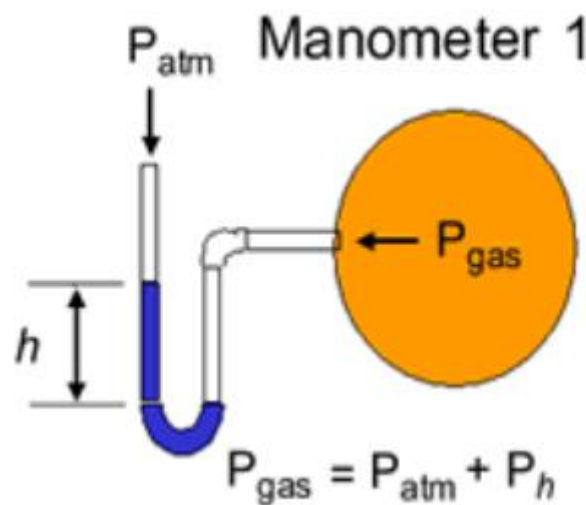


Figure. A U tube manometer for measuring pressure P can be expressed as the height of the fluid.

Sphygmomanometer: is the clinical instrument used for measuring the blood pressure.

It can be provided by one of two types of gauges. Mercury gauge: the pressure is indicated by the height of mercury inside a glass tube.

Aneroid type: the pressure changes the shape of a sealed flexible container, which cause a needle to move on a dial.

Pressure inside the skull: The brain contains approximately 150 cm³ of cerebrospinal fluid (CSF) in a series of interconnected opening called ventricles. CSF is generated inside the brain and flows through the ventricles into the spinal column and eventually into the circulatory system.

* If at birth the narrow opening of the ventricle (aqueduct) is blocked then the CSF is trapped inside the skull and hence increases the internal pressure and causes the skull to enlarge (A case named hydrocephalus).

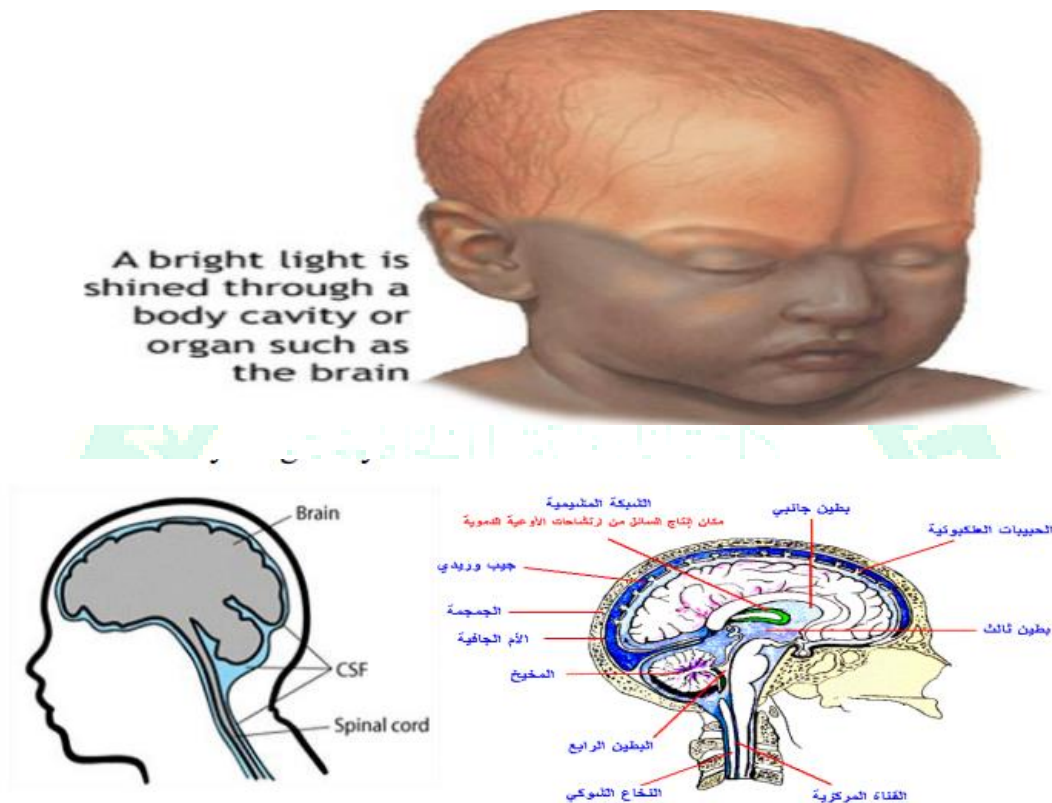


Figure. A cross-section of the brain showing the location of the cerebrospinal fluid (shaded area) and the aqueduct (arrow).

There are two methods to detect hydrocephalus :

1. By measuring the circumference of the skull just above the ears.
2. Transillumination, making use of light-scattering properties of the clear CSF inside the skull.

Eye Pressure:

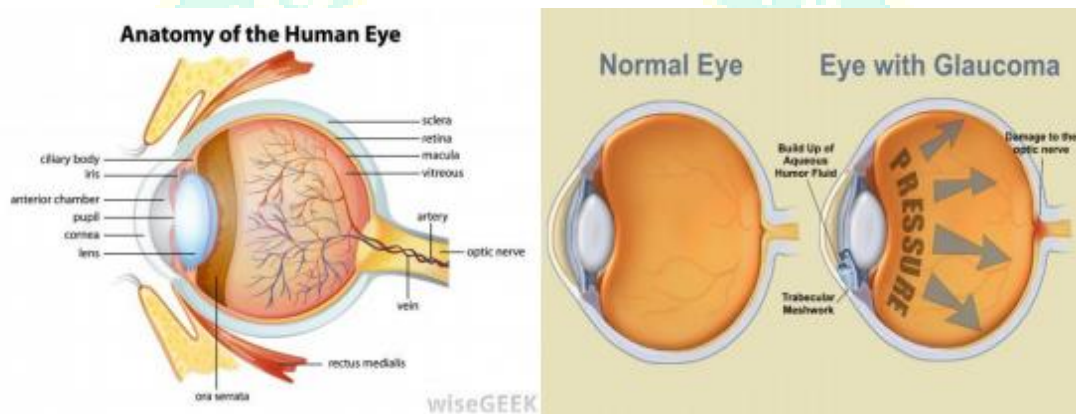
The clear fluids in the eyeball (the aqueous and vitreous humors) that transmit light to the retina are under pressure

* This pressure maintain the eyeball in a fixed size & shape. →A change of only 0.1mm in the eye diameter has a significant effect on the clarity of vision.

* The pressure in normal eyes range from 12 to 23mm Hg.

* The eye continuously produces aqueous humors and a drain system allows escaping.

If the pressure increased due to a partial blockage then the blood supply to the retina will be restricted and thus affecting vision (glaucoma) which produce tunnel vision in moderate cases and blindness in sever cases.



Ton meters: These are instruments used for measuring the amount of indentation produced by a certain force.

Pressure in the digestive system: The digestive system is an opening through the body with about 6 meter length from the mouth to anus

* It has several valves and sphincters (circular muscles) which open for the passage of food, drink, and their by-products, in a unidirectional flow.

Esophagus: The pressure is less than the atmospheric because it is coupled to the pressure between the lungs and chest wall (intra-thoracic pressure).

Stomach: The pressure is higher than the atmospheric pressure because of the stretching of the stomach walls and due to air swallowed during eating.

Gut: gas flatus generated by the bacterial action increases the pressure, and hence it is higher than atmospheric.

* Occasionally a blockage forms in the small or large intestine and a pressure build up between the blockage and the pylorus. If this pressure becomes great enough to restrict blood flow to critical organs, it can cause death. And can be solved by:

1. Intubation: - passing of a hollow tube through nose, stomach, and pylorus.
2. Surgery: - chosen when the intubations don't work.

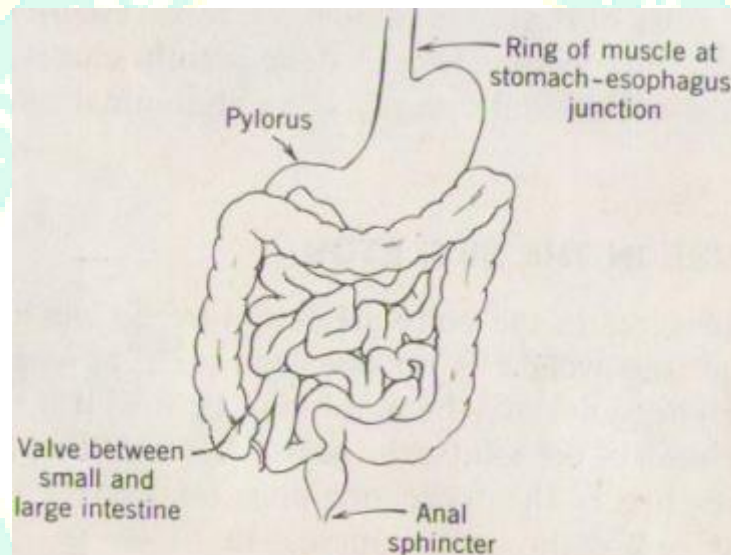


Figure. The valves and sphincters of the digestive tract.

Pressure in the skeleton:- This is the highest pressure that can be found in the body-for example when all the weight of the body is on one leg, such as when walking, the pressure in the knee joint may be more than 10 atmospheres!!

* The surface area of a bone at the joint is greater than its area either above or below the joint. The larger area at the joint distributes the force, thus reducing the pressure.

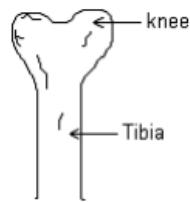


Figure. The surface area of a bone at the joint is greater than its area either above or below the joint.

*Healthy bone joints are better lubricated than the best man-made bearings. The human joints system is such that; the higher pressure → the better lubrication.

Fingers: The finger bones are flat rather than cylindrical on the gripping side, and the force is spread over a large surface, thus reduces pressure in the tissues over the bones.

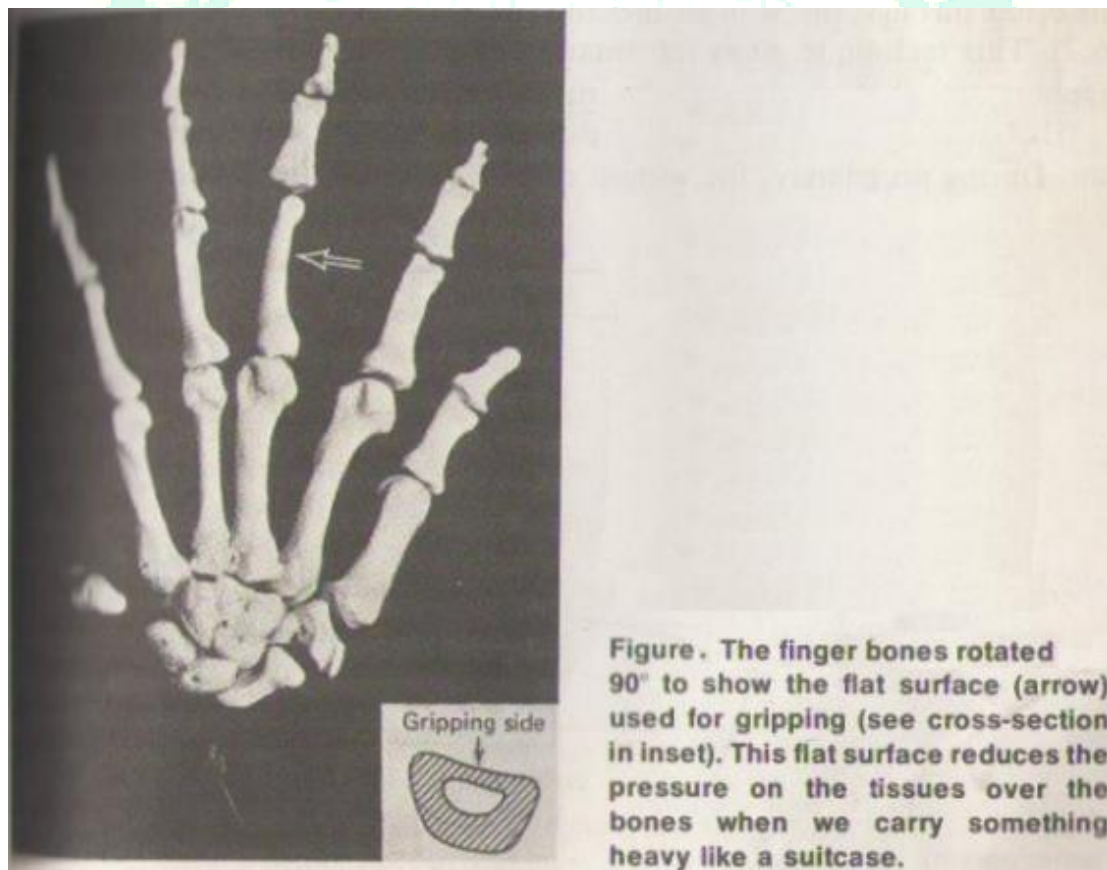
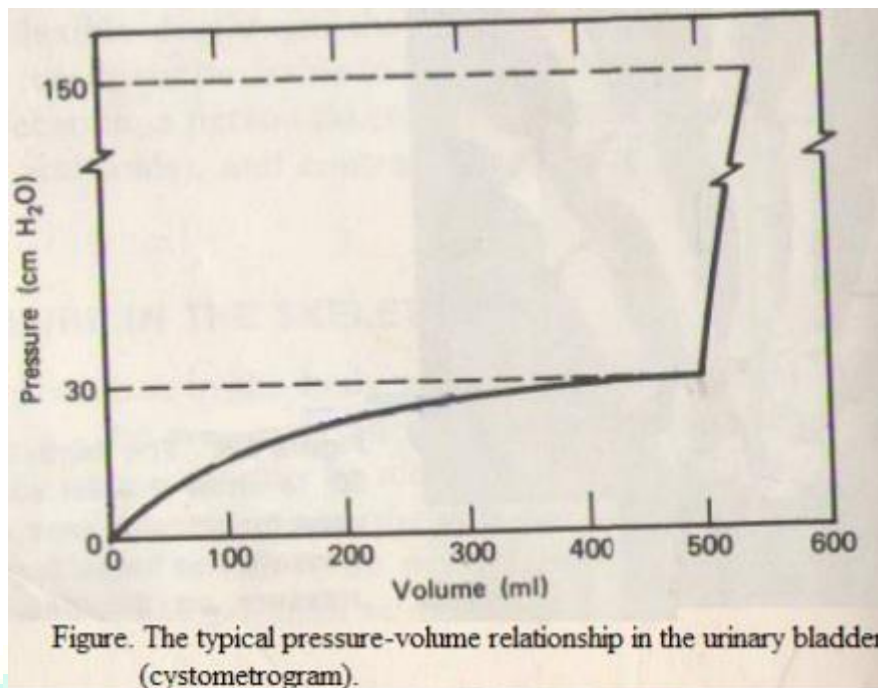


Figure. The finger bones rotated 90° to show the flat surface (arrow) used for gripping (see cross-section in inset). This flat surface reduces the pressure on the tissues over the bones when we carry something heavy like a suitcase.

Pressure in the urinary bladder:- The figure below shows the typical pressure-volume curve for the bladder



*An increase in the radius of the bladder R will cause:

*An increase in the volume R^3

*An increase in the pressure R^2

The above relationship accounts for the relatively low slope in the major portion of the figure.

→ For adults, the typical maximum volume of the bladder before voiding is 500 ml and at some pressure (~ 30 cm H₂O) the micturation reflex occurs

→ The resulting sizable muscular contraction in the bladder wall produce a momentary pressure up to (150cm H₂O.)

→ Normal voiding pressure is fairly low (20 to 40 cm H₂O) but for men who suffer from prostatic obstruction of the urinary passage it may be over 100 cm H₂O.

Measurement:

1. The pressure in the bladder is measured by passing a catheter with a pressure sensor to the bladder through the urinary passage (Urethra).
2. Direct cystometry: A needle is inserted through the walls of the abdomen directly to the bladder.

During pregnancy, the weight of the fetus over the bladder increase the bladder pressure and causes frequent urination.

