Lecture (4)

Medical Physics

Fourth Stage

Department of Physics

College of Science

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Medical Physics

Pressure in the body

Pressure: is force per unit area in gas or liquid. Body pressure is measured in terms of mm of Hg.

$$1\,(atm) atmosphere = 1.01 \times 10^7 \frac{N}{m^2}$$

$$= 760\ mm\ of\ Hg$$

$$= 1033\ cm\ of\ H_2O$$

$$P = h\,\rho\,g$$

Note: Hg density is equal to $13.6 \frac{g}{cm^3}$ and density of water $1 \frac{g}{cm^3}$.

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Problem: At what height of water will produce the same pressure as 120 mm of Hg?

Sol.

$$P = \rho\, g\, h$$

$$P\,(120\ mm\ of\ Hg) = (13.6\ g/cm^3) \times\ (980\ g/s^2)\ \times (12\ cm)$$

$$= 1.6 \times 10^5\ dyne/cm^2$$

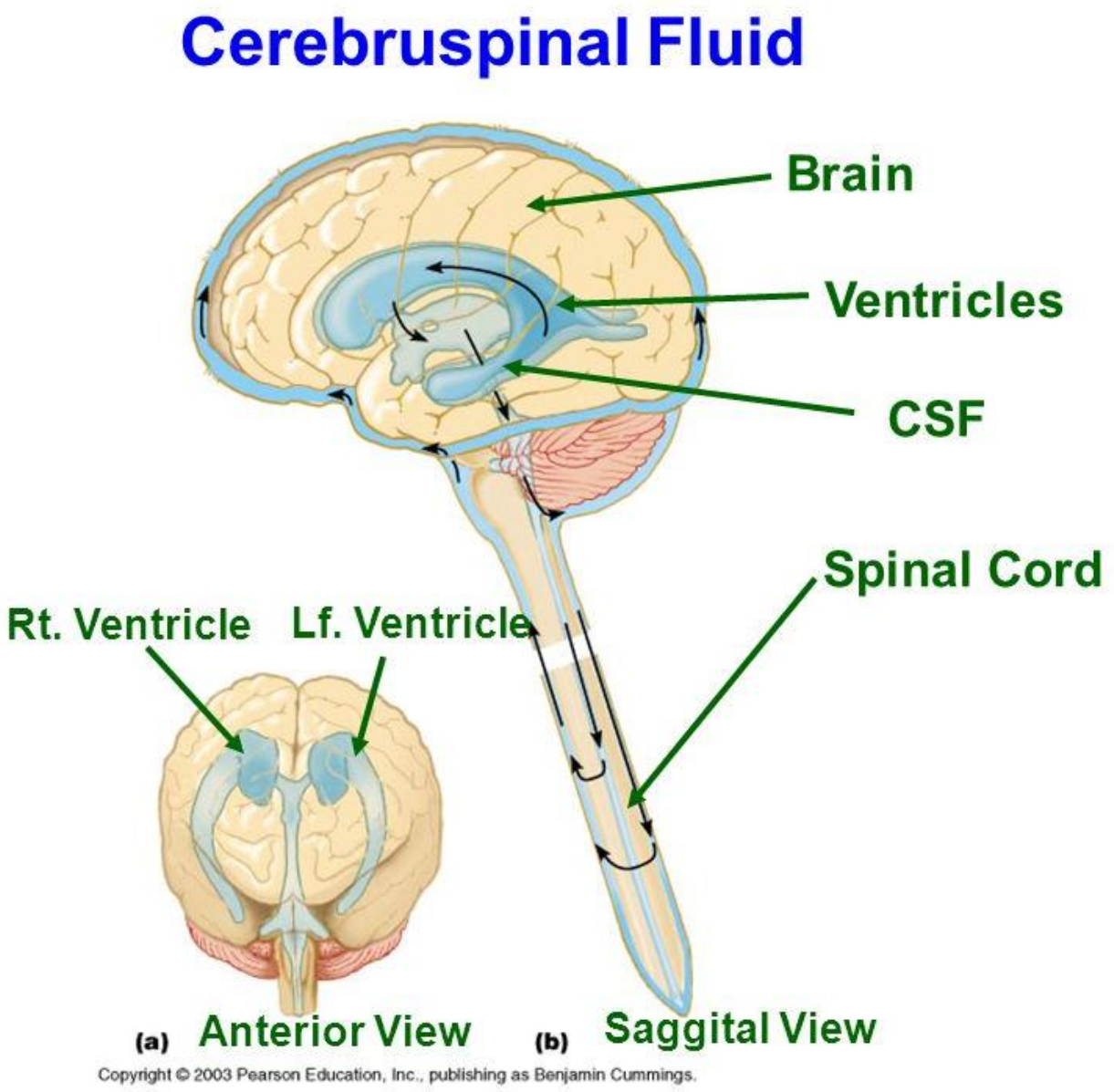
For water

$$1.6 \times 10^5 = \rho g h$$

$$1.6 \times 10^5 = 1\frac{g}{cm^3} \times 980\ g/s^2\ \times h$$

$$h = 163\ cm\ of\ H_2O$$

Measurement of pressure in body:



a) Pressure inside skull

Brain contains 150 cm^3 of CSF (Cerebra Spinal Fluid). CSF generated inside brain and flows through ventricles of spinal column.

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Measurement of pressure in body:

b) Fluid in eyeball - aqueous humor (mostly water) and vitreous humor keep eyeball in fixed size and shape.

- A change of 0.1 mm of Hg has significant effect on clarity of vision.

- Pressure in normal eye is 12 to 23 mm of Hg.

- Eyes continuously produces aqueous humor (water) and drain system allows the surplus to escape.

- Practical blockage in drain system occurs the pressure increases and the increased pressure can restrict the blood supply to the retina and thus affect the vision. This condition is called **Glaucoma**.

- Eye pressure measured by **Tonometers**.

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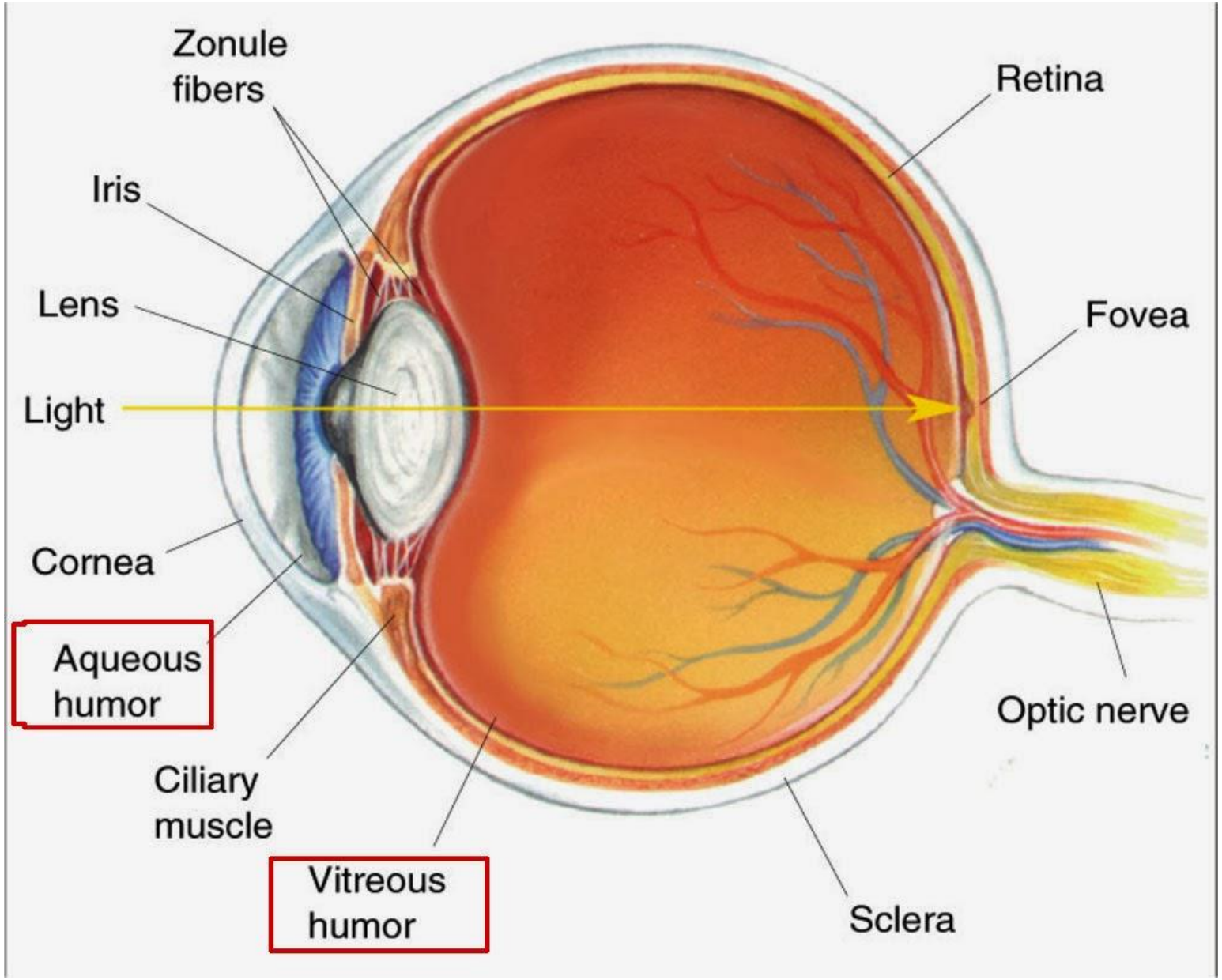

c) Pressure in the digestive system

d) Pressure in the skeleton

e) Pressure in the urinary bladder

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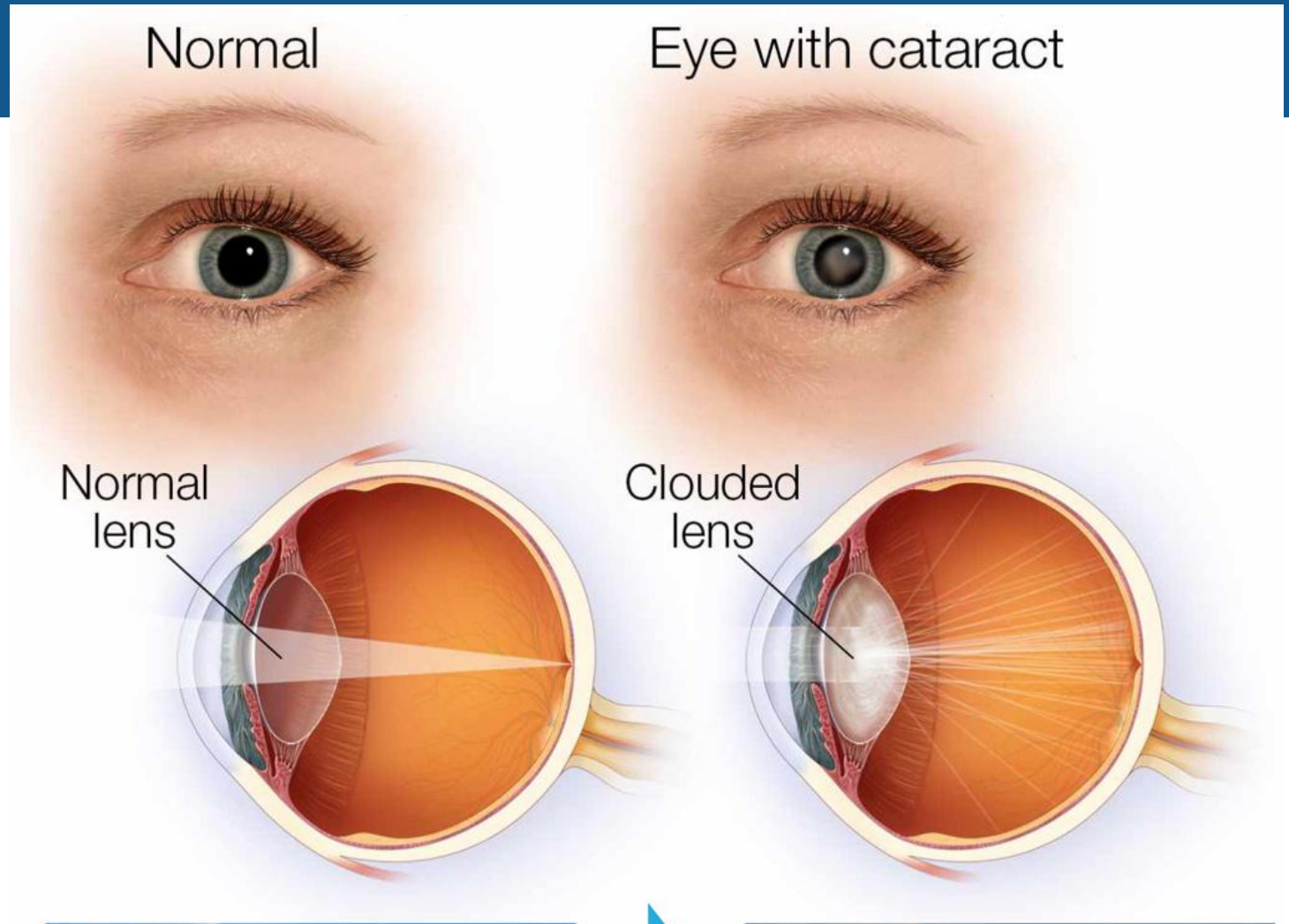
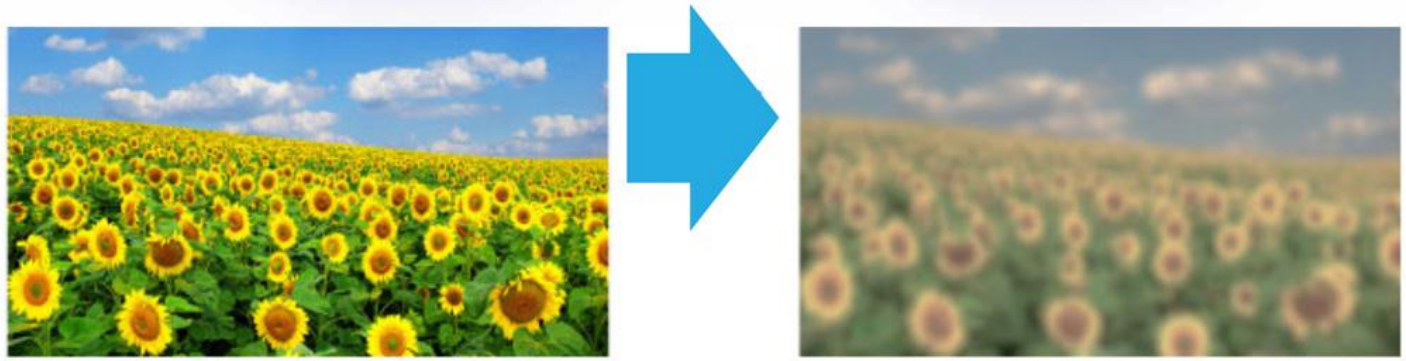
Glaucoma





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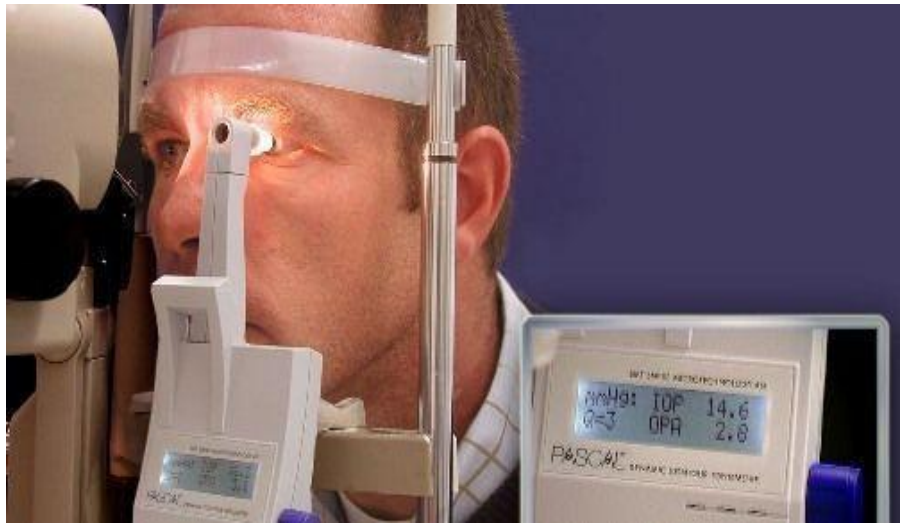
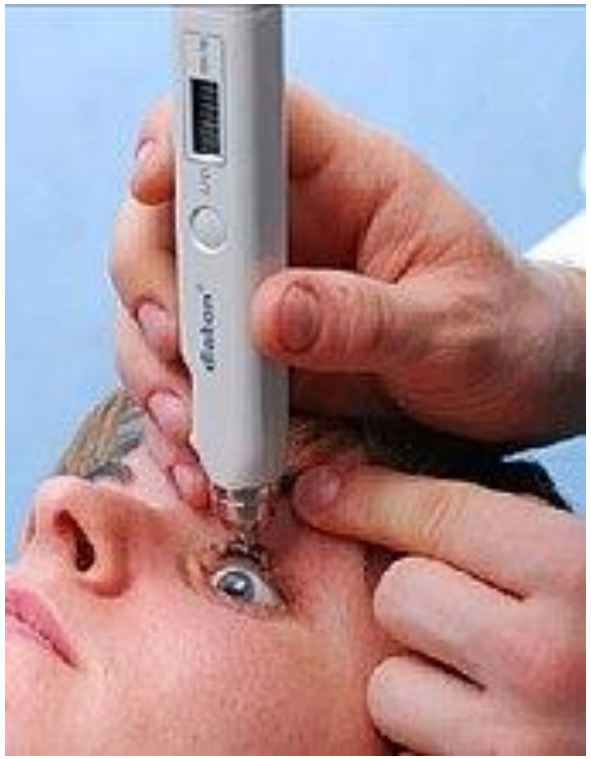
TONOMETER





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Blood Pressure

Sphygmomanometer: is an instrument by which we can measure blood pressure of body.

Doctors call them systolic (the top number) and diastolic (the bottom number) blood pressure.

- **<u>Systolic Blood Pressure</u>: When your heart beats, it squeezes and pushes blood through your arteries to the rest of your body. This force creates pressure on those blood vessels, and that's your systolic blood pressure.**
- A normal systolic pressure is below 120. A reading of 120-129 is elevated.
- 130-139 is stage 1 high blood pressure (also called hypertension).
- 140 or more is stage 2 hypertension.
- 180 or more is a hypertensive crisis.

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- **<u>Diastolic Blood Pressure</u>: The diastolic reading, or the bottom number, is the pressure in the arteries when the heart rests between beats. This is the time when the heart fills with blood and gets oxygen.**
- A normal diastolic blood pressure is lower than 80. But even if your diastolic number is lower than 80, you can have elevated blood pressure if the systolic reading is 120-129.
- 80-89 is stage 1 hypertension.
- 90 or more is stage 2 hypertension.
- 120 or more is a hypertensive crisis.

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Blood Pressure Stages			
Blood Pressure Category	**Systolic mm of Hg (upper)**		**Diastolic mm of Hg (lower)**
Normal	Less than 120	and	Less than 80
Elevated	120-129	and	Less than 80
High Blood Pressure (hypertension) Stage 1	130-139	or	80-89
High Blood Pressure (Hypertension) Stage 2	140 or Higher	or	90 or Higher
Hypertensive Crisis (Seek Emergency Care)	Higher than 180	and/or	Higher than 120

Blood Pressure Measurement

- Blood pressure is measured with a small gauge attached to an inflatable cuff. It's simple and painless.
- The person taking your ***blood pressure wraps the cuff around your upper arm***. Some cuffs go around the forearm or wrist, but often they aren't as accurate.
- Your doctor or nurse will use a stethoscope to listen to the blood moving through your artery.
- She'll inflate the cuff to a pressure higher than your systolic blood pressure, and it will tighten around your arm. Then she'll release it. As the cuff deflates, the first sound she hears through the stethoscope is the systolic blood pressure. It sounds like a whooshing noise. The point where this noise goes away marks the diastolic blood pressure.
- In a blood pressure reading, the systolic number always comes first, and then the diastolic number. For example, your numbers may be "120 over 80”
  or written as 120/80.

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Sphygmomanometer

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Pressure generated on the spinal column

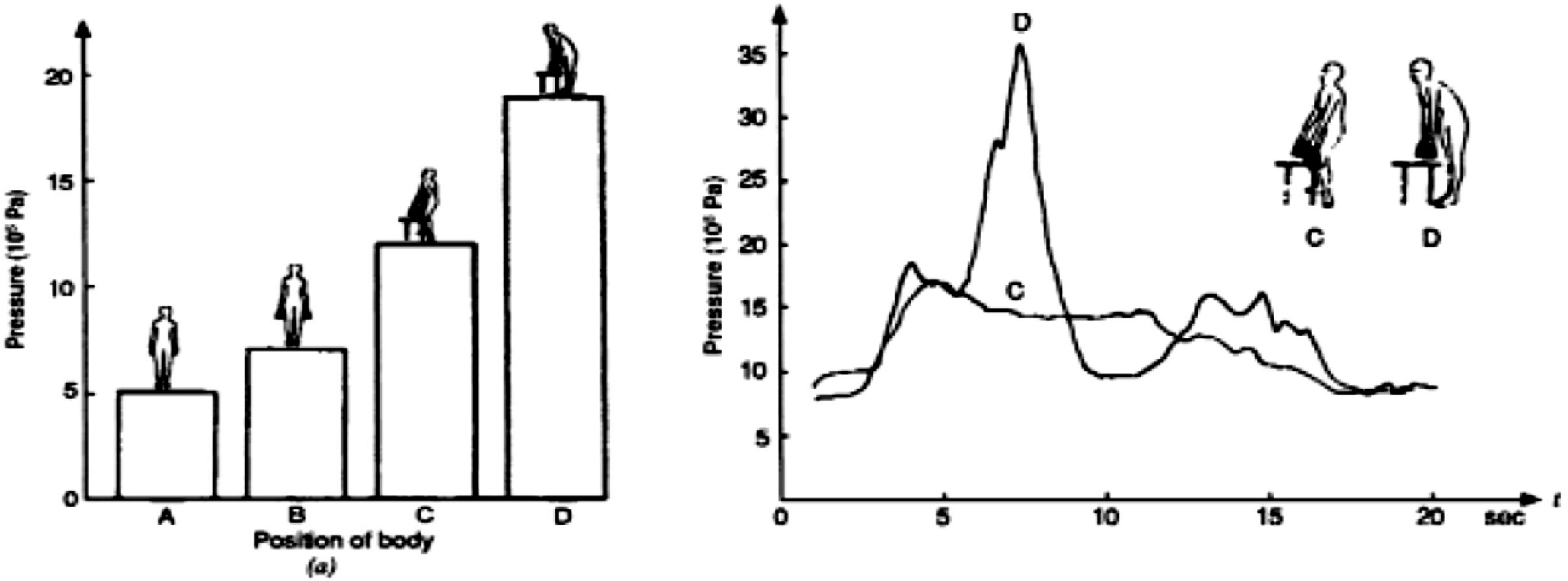

Figure Pressure on the spinal Column

- Figure (a) P on third lumbar disc for a subject:

A- Standing. **B-** Standing and holding 20 kg. **C-** Picking up 20 kg by bending knees. **D-** Picking up 20 kg incorrectly without bonding knees.

- Figure (b) instantaneous pressure in the third lumbar disc while picking up 20 kg weight. Correctly (C) and incorrectly (D). Note larger peak pressure during incorrect lifting.
- When standing correct there is relatively large P in disc due to combined effects of weight and muscular tension.
- If disc is over loaded in lifting it can rupture cause pain either from the rupture or by allowing irrupting material from inside the disc to teak out. Sometimes vertebral bone collapse rather disc damage out to age causing a hunchback stature.

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Typical pressure in normal body

Typical pressure in normal body	Typical pressure in mm of Hg
Average blood pressure (BP) - Maximum (systole) - Minimum (diastole)	 100-140 60-90
Venous BP	3-7
Great vein	<1
Capillary BP - Arterial end - Venous end	 30 10
Middle ear pressure	<1
Eye pressure - aqueous humor	20
Cerebrospinal fluid in brain	5-12
Gastrointestinal pressure	10-20
Intrathoracic pressure (between lung and chest wall)	≈10

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