Salahaddin University – Erbil
Education College
Physics Department

Medical Physics

Lecture Two

Forces on and in the Body

Fourth Stage

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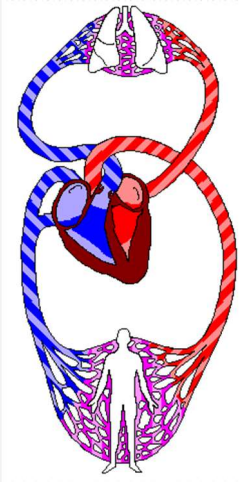
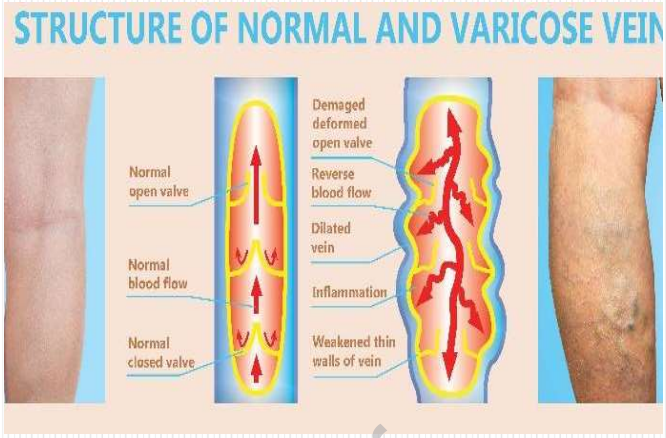
2. Forces on and in the Body

- **Examples:**
  1. Muscular forces that cause the blood to circulate and the lungs to take in air.
  2. Molecular forces: A calcium atom will become part of crystal if it get close to a natural place for calcium where the electrical forces are great enough to trap it.
- **Gravitation forces:** it's Medical effects are:
  1. The formation of varicose veins in the legs as the venous blood travels against the force of gravity on its way to the heart.
  2. Effect on the bone: If a person becomes weightless such as in orbiting satellite, he may lose bone mineral (make problems in long space journeys)(?). Long term bed rest removes much of the force of the body weight from bones(?).

2. Forces on and in the Body

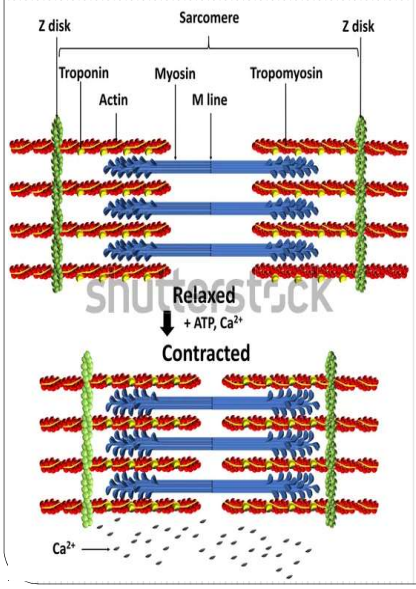


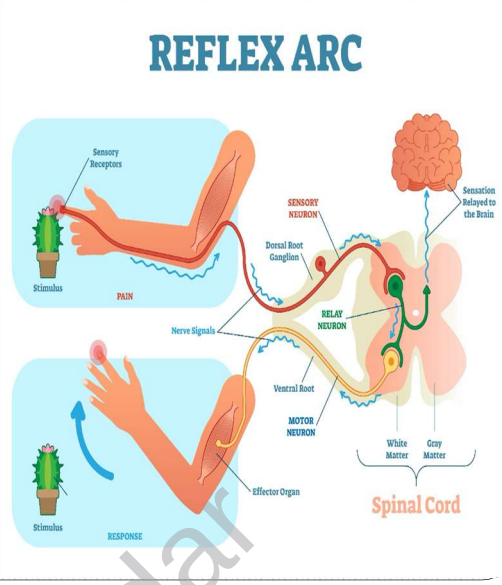


2. Forces on and in the Body

- **Electrical forces:** our bodies are basically electrical machines. Examples:
  1. The forces produced by muscles are caused by electrical charges attracting/repelling other electrical charges.
  2. Control of muscles is primarily electrical.
  3. Each of billions of living cells in the body has an electrical potential difference across the cell membrane. It's amounts to less than 0.1 v, but because of very thin cell wall it produce a filed large as 10^5 v/cm(d=?).
- **Forces on the Body**
  1. Static force : where the body is in equilibrium.
  2. Dynamic force : where the body is accelerated .

2. Forces on and in the Body





2. Forces on and in the Body

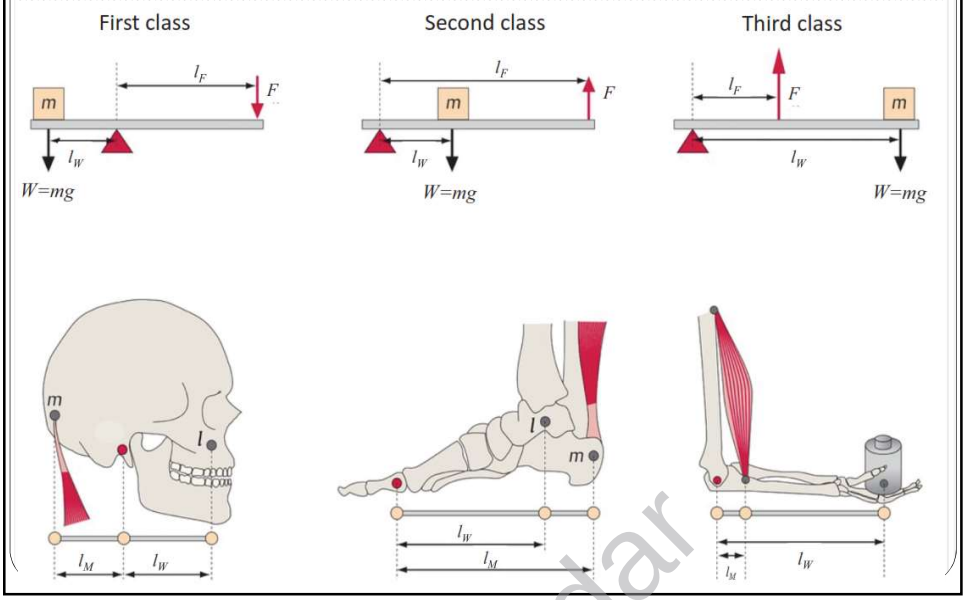
2.1 Static Force

- When objects stationary (static) they are in state of equilibrium. The sum of the forces(vector) in any direction is equal to zero: $\Sigma F_n = 0$ …1
- The sum of the torque's about any axis is equals to zero:

$$\Sigma T_n = 0 \quad \ldots 2$$

- In the body, many of the muscles and bones systems acts as levers. Levers are classified as first , second, and third - class systems.

2. Forces on and in the Body

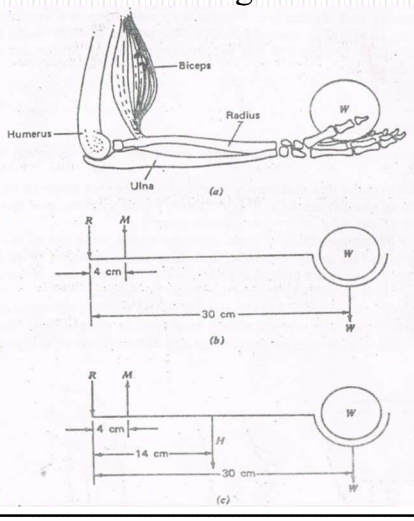


2. Forces on and in the Body

Example 2.1

- Find the force supplied by biceps for a 100 N weight?

sol: there are only two torques:
$T = r \times F$; T_W=30W(clockwise)
T_M=4M (counterclockwise)
$\Sigma T=0$ (arm in equilibrium)
4M-30W=0, M=7.5W
M=750 N
- the weight of forearm and hand are neglected, to consider them, the center of gravity is taken(H). Typically, H= 15 N
4M=15H+30W, M = 806.25 N



2. Forces on and in the Body

Example 2.2

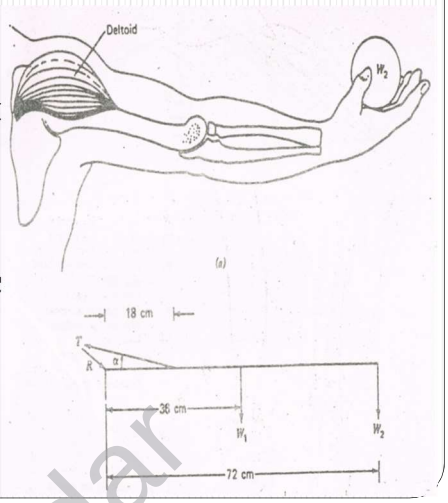
- Find the force for the arms raised horizontally from the shoulder by deltoid muscle?

sol: by taking the sum of torques about the shoulder point the T can be calculated:

$18\ T \sin\alpha = 36\ W1 + 72\ W2$

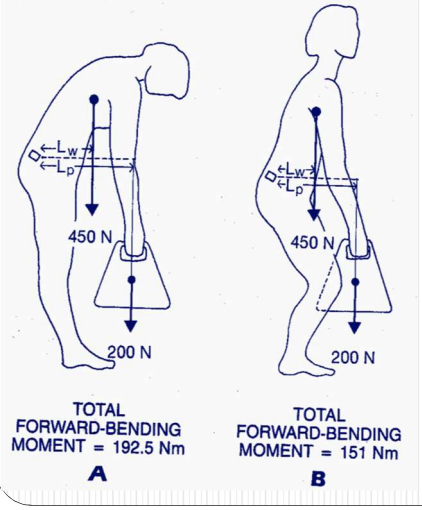
$T = 1145\ N$

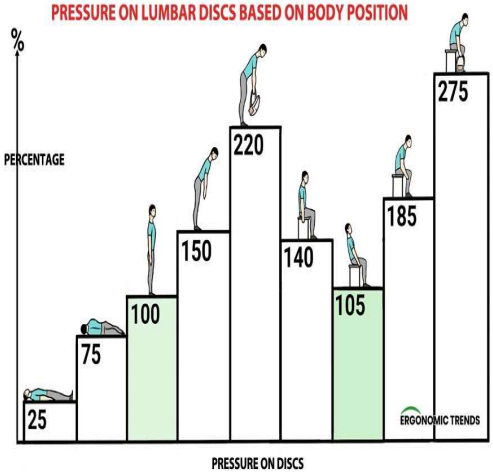
- the force needed to held up the arm is surprisingly large.



2. Forces on and in the Body

- Bending and lifting:





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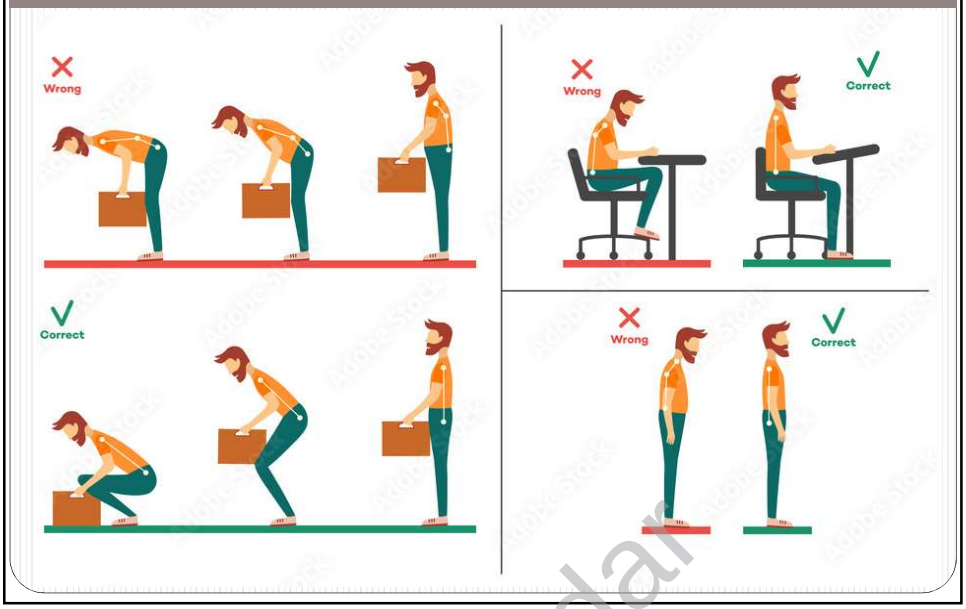
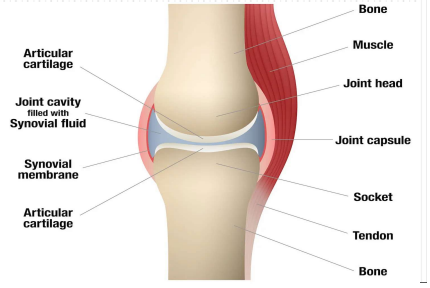
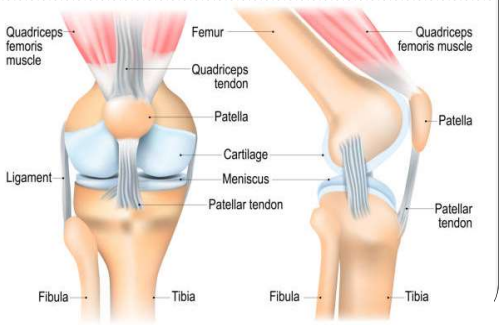


2. Forces on and in the Body

- The **forces** of muscles in the body are transmitted by tendons.
- Tendons minimize the bulk at a joint.
- Example: in the leg, tendons pass over grooves in the knee cap(patella) and connect to shin bone (tibia). With your leg extended you can move the patella with your hand but with your knee fixed you cannot-the patella is held rigidly in place.





2. Forces on and in the Body

- The **patella** also serves as a pully for changing the direction of force.

2.2 Frictional forces

- The frictional force is large enough both when the heel touches down and when the toe leave the surface to prevent from slipping.
- Friction must be overcome when joints move. If a disease of the joints exists, the friction may become large.
- The **synovial fluid** in the joint is involved in the lubrication.
- The **saliva** we add when we chew food as a lubricant.
- Heart beats (moving), lung moving inside chest in breathing, intestines rhythmic motion(as they move food forward it's final destination), are lubricated by a slippery mucus covering to minimize friction.