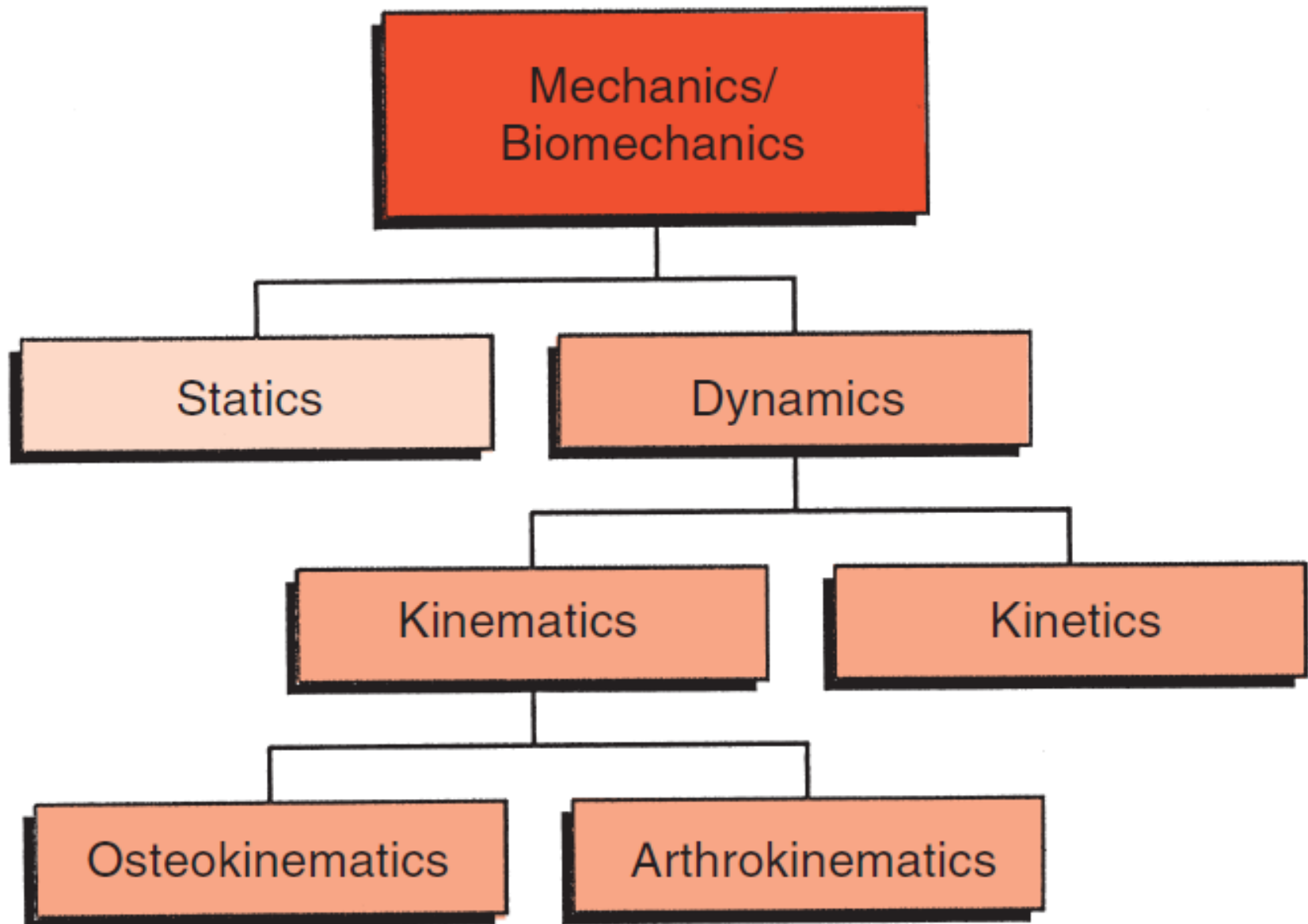
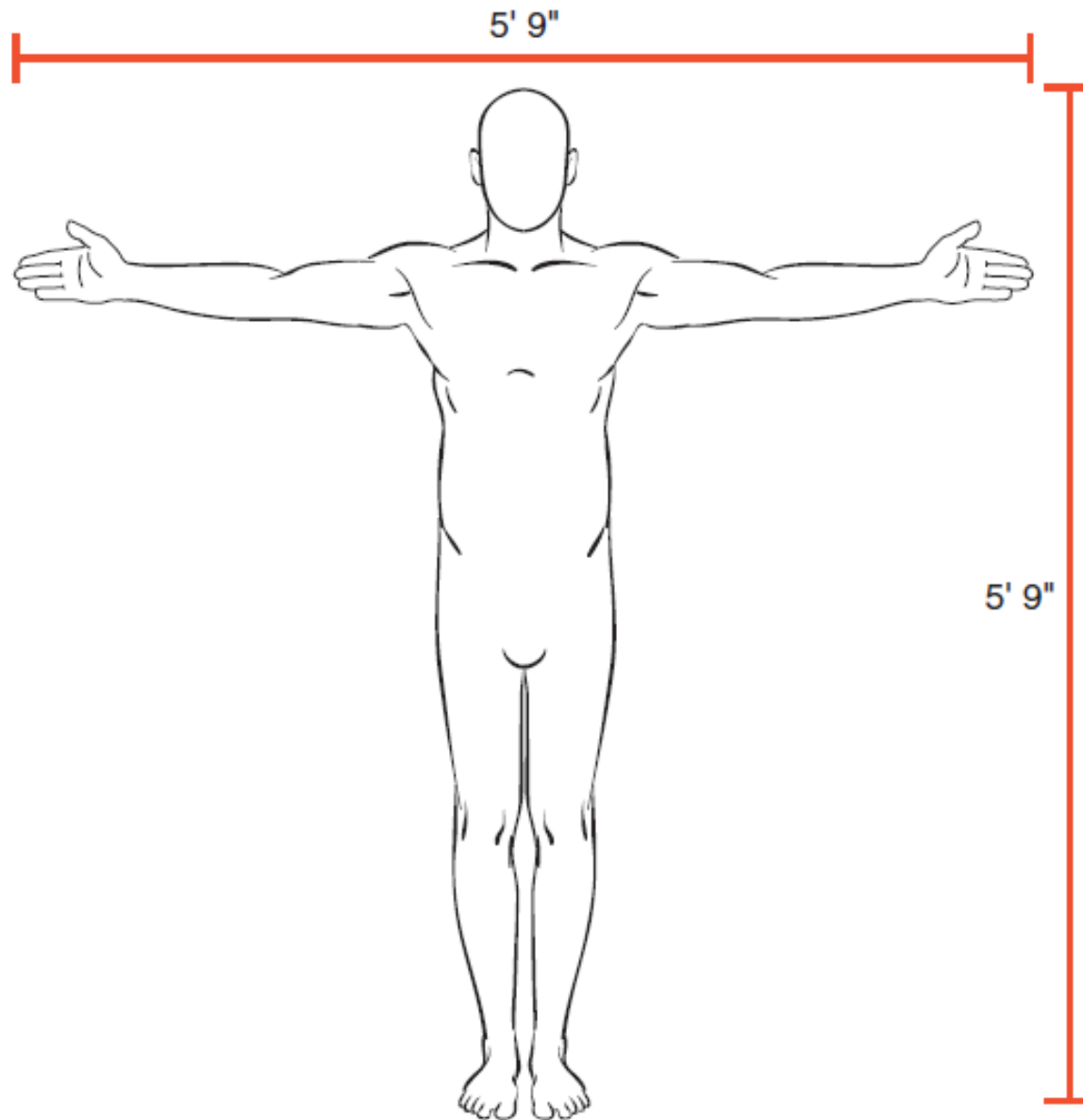


# BIOMEKANIKA

dr. Al-Muqsith, M.Si





In an adult, arm span and body height are equal.

# 6 jenis mesin sederhana :

1. LEVER
2. PULLEY
3. WHEEL & AXLE
4. INCLINED PLANE
5. WEDGE
6. SCREW

Ad. 1,2 & 3 jenis yang terdapat pada tubuh manusia

**LEVER**

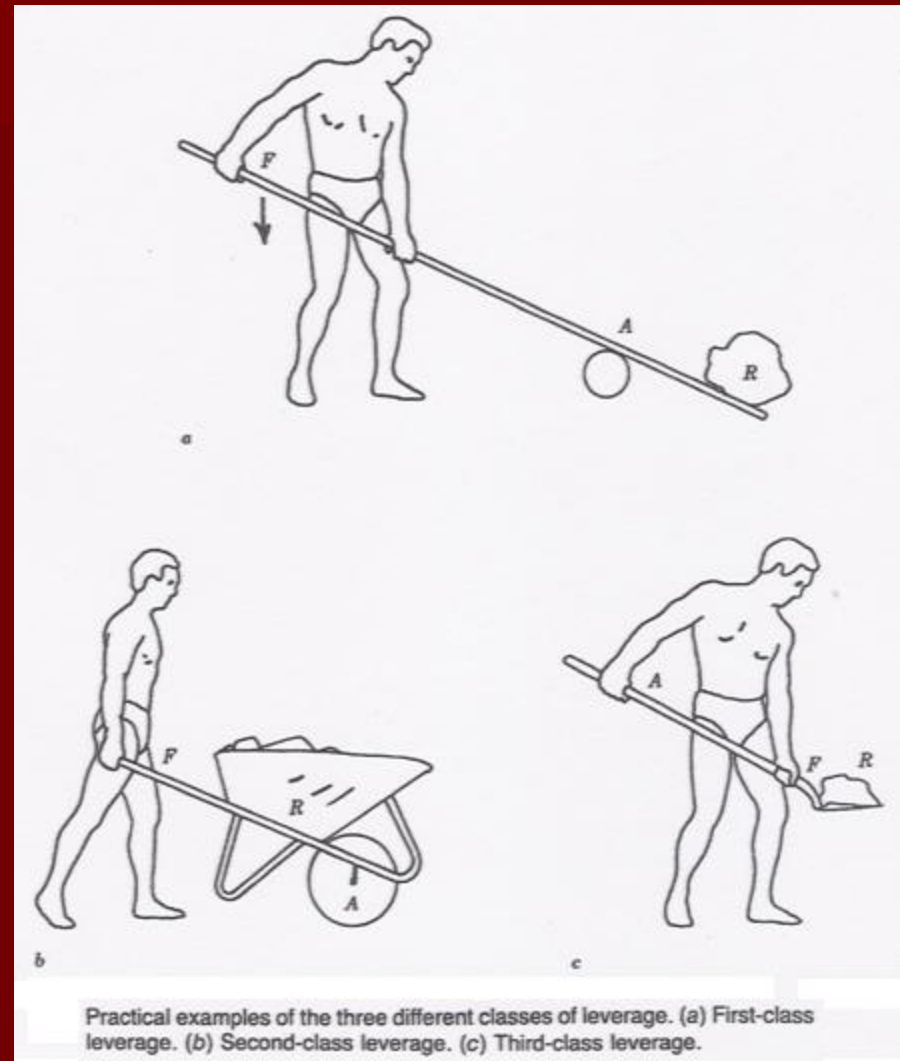
**(PENGUNGKIT)**

# Pengertian :

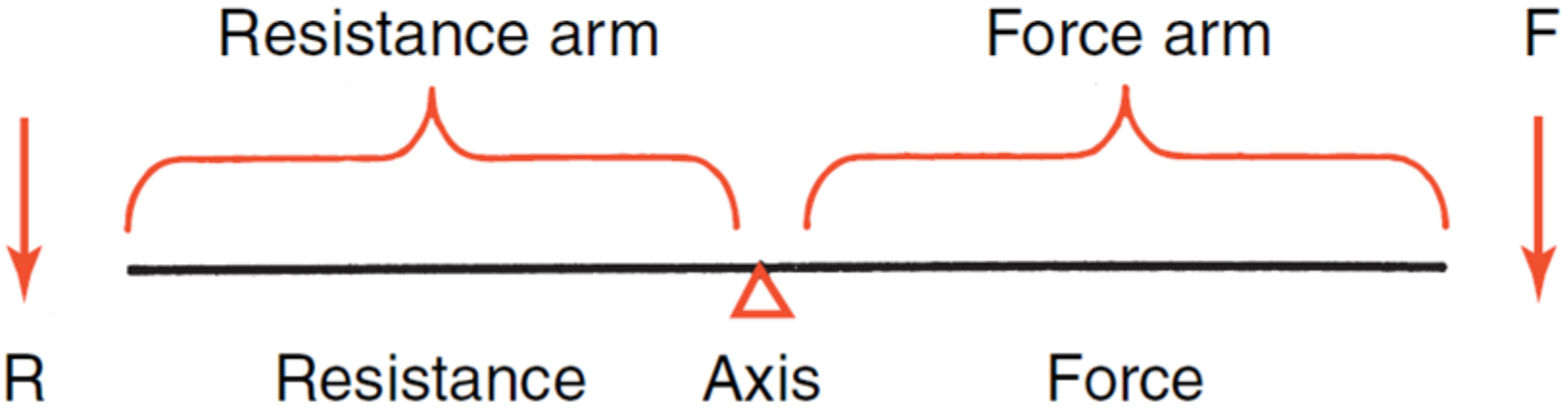
- Skeleton tersusun oleh kombinasi tulang yang merupakan rigid bar yang membentuk lever (pengungkit).
- Axis gerakan melalui sendi yang merupakan titik putar di mana lever bekerja.
- Force ditimbulkan oleh kontraksi sebuah atau lebih otot yang melekat padanya.
- Resistance adalah pusat gravitasi segmen tubuh yang bergerak + pusat gravitasi beban external

# LEVER

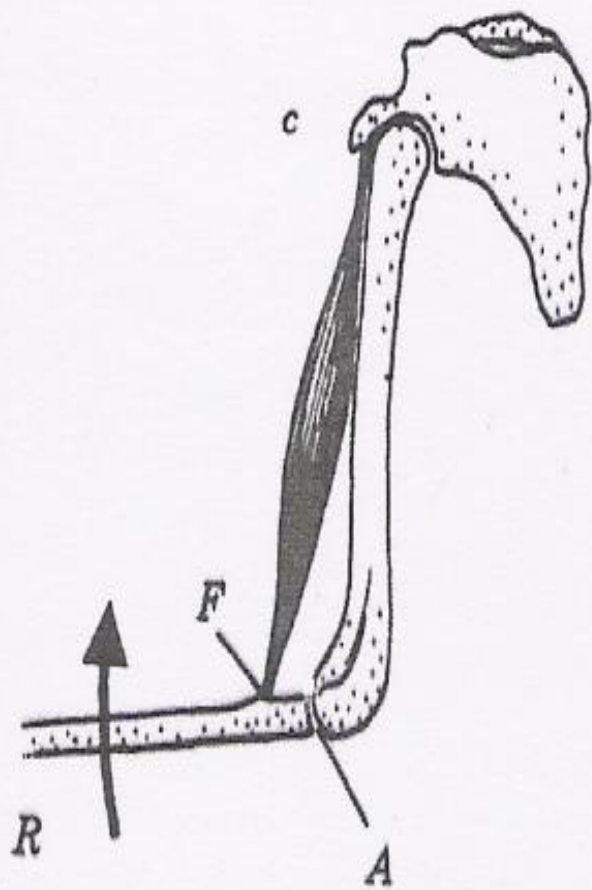
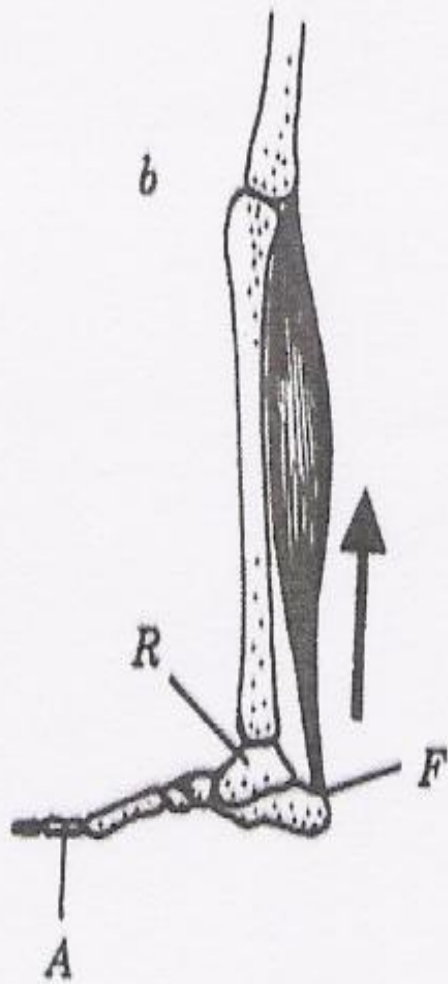
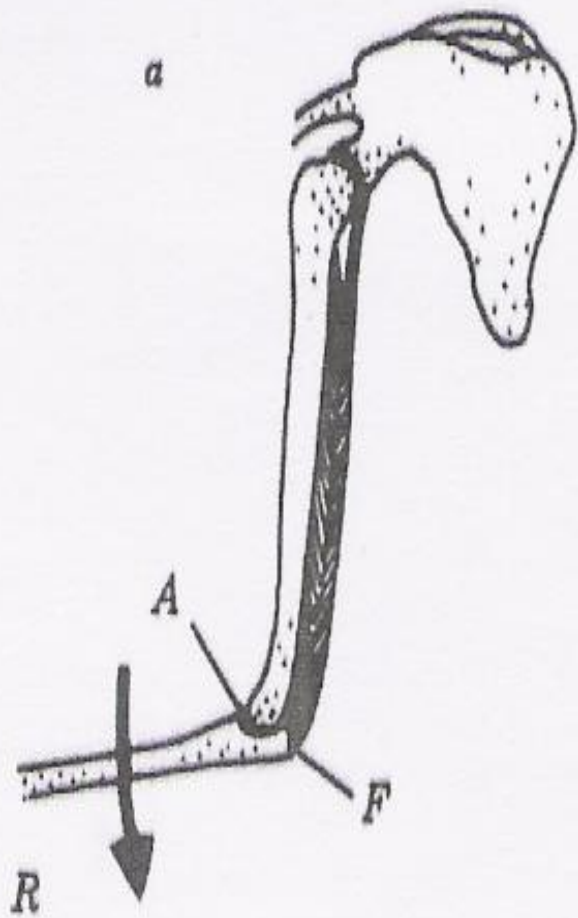
- Suatu rigid bar yang bergerak memutari suatu titik putar (*fixed point*) sebagai sumbu gerak
- Terdapat 3 komponen dalam mesin lever :
  - Axis (A) atau Fulcrum (F) sebagai pusat rotasi
  - Weight (W) atau Resistance (R)
  - Force (F), sebagai penggerak
- Terhadap A terdapat 2 lengan :
  - FA, Force Arm
  - WA, Weight Arm atau RA Resistance Arm



# Components of a lever







# 3 jenis lever :

## 1. FIRST CLASS LEVER : F-A-R

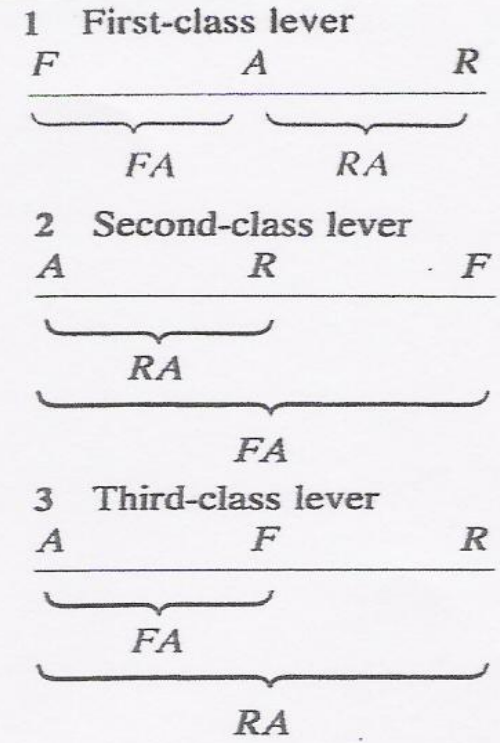
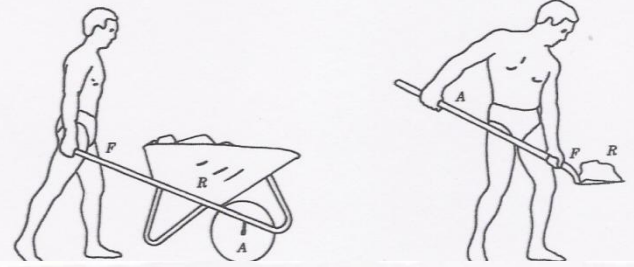
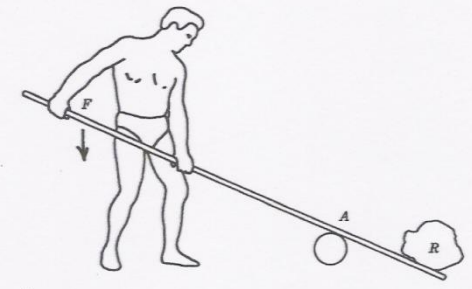
- Masing2 lengan dapat lebih panjang dari lainnya, tgt letak A (Axis)

## 2. SECOND CLASS LEVER : F-R-A

- FA Arm selalu > RA Arm

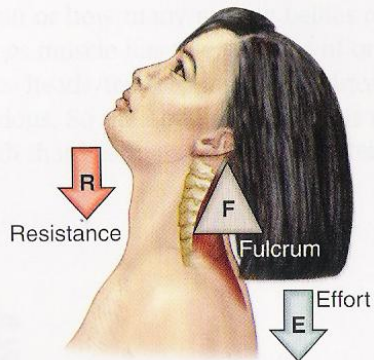
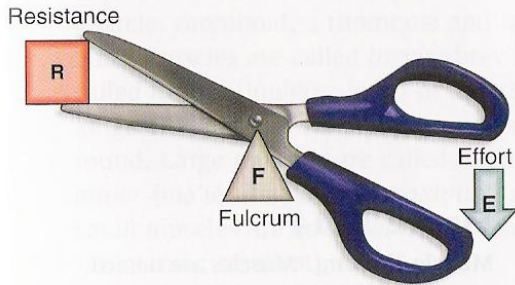
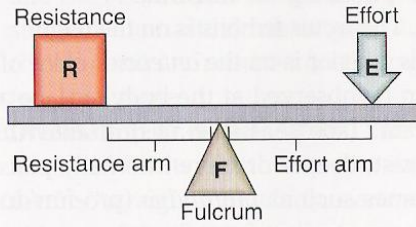
## 3. THIRD CLASS LEVER : A-F-R

- RA Arm selalu > FA Arm

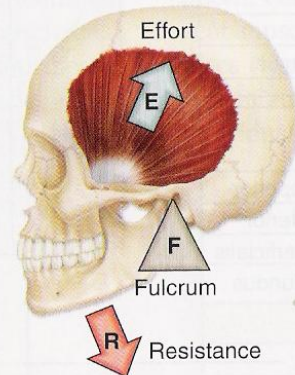
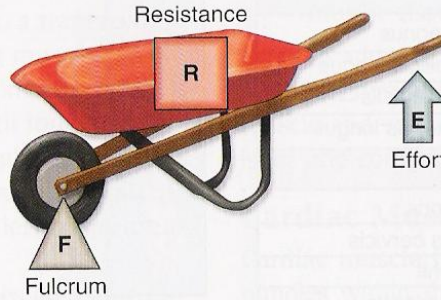
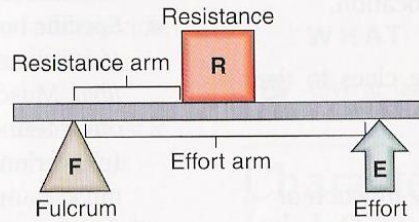


# LEVERS

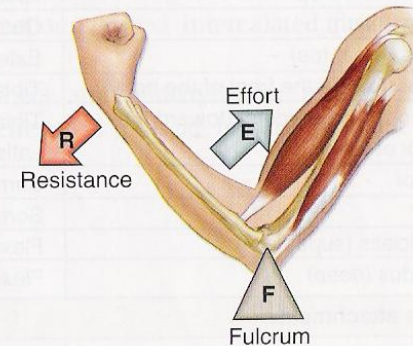
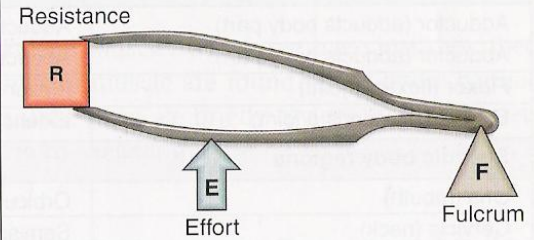
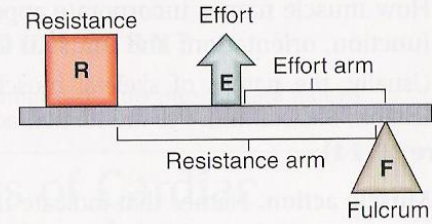
First-class lever



Second-class lever



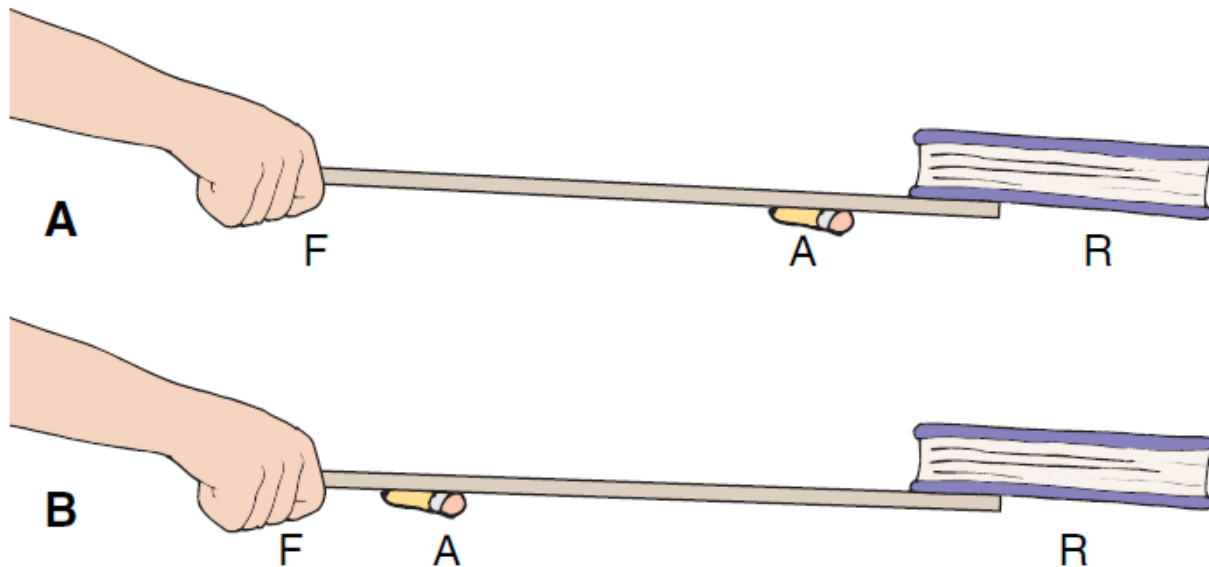
Third-class lever



First-class lever F ————— R

A

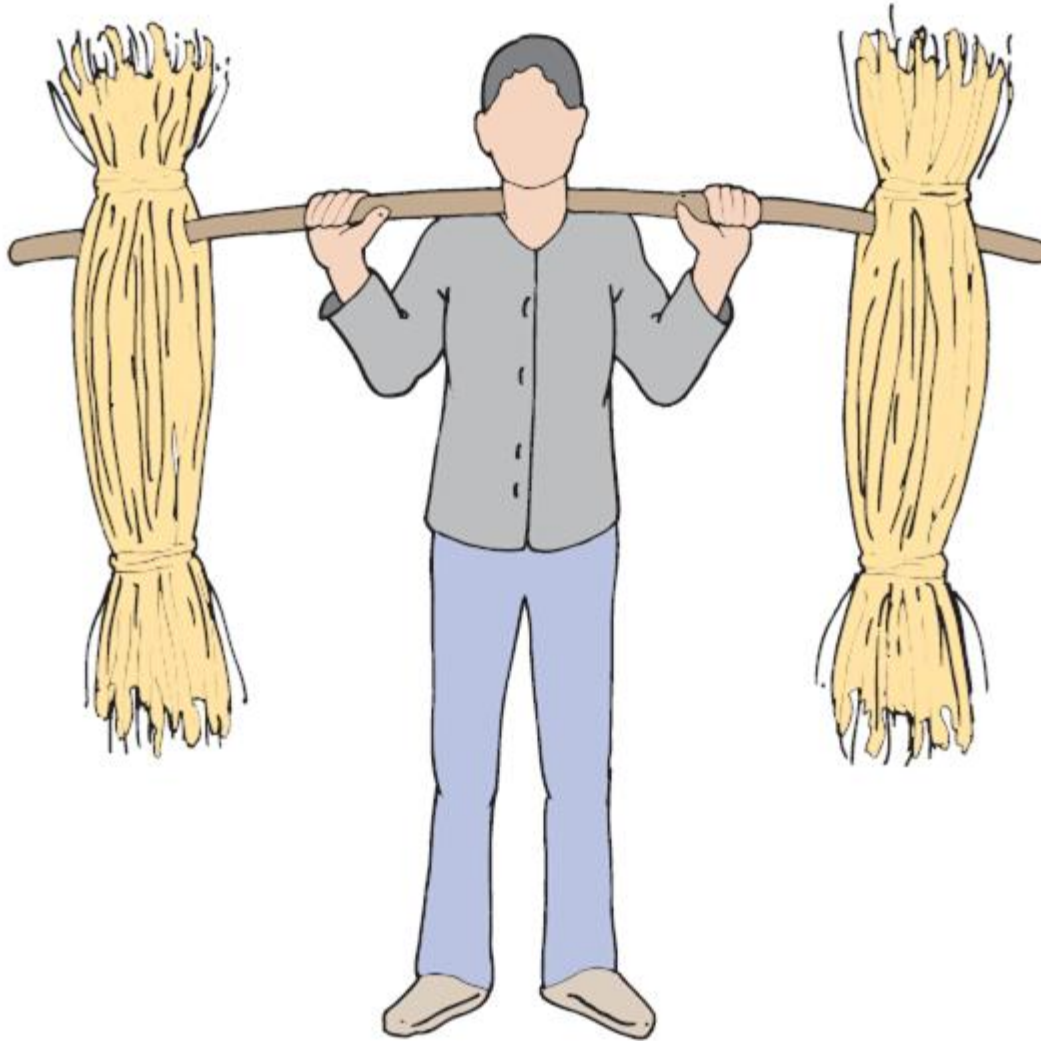
First-class lever



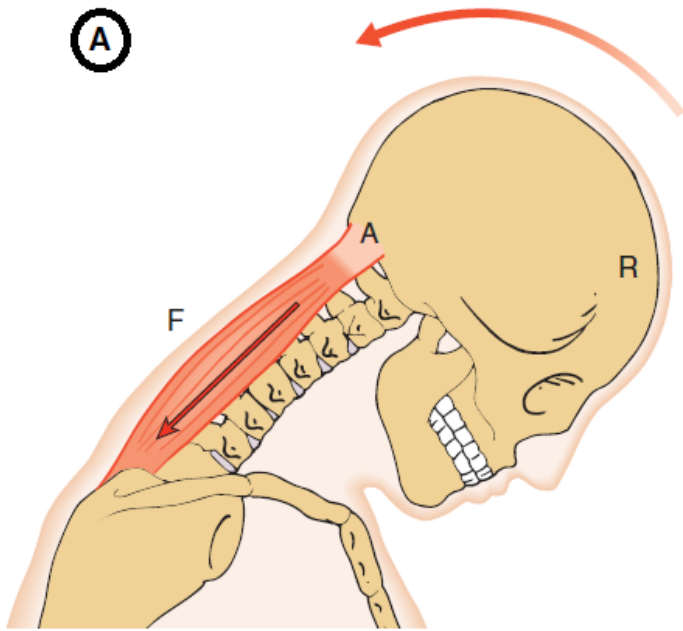
FAR (F = force; A = axis; R = resistance).

**(A)** A is closer to R. **(B)** A is closer to F.

First-class lever.

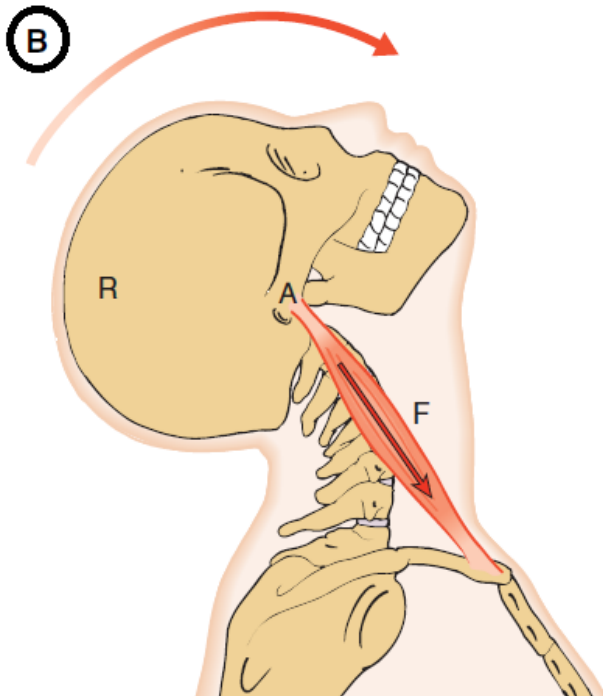


The two loads (F and R) are balanced on the shoulders.

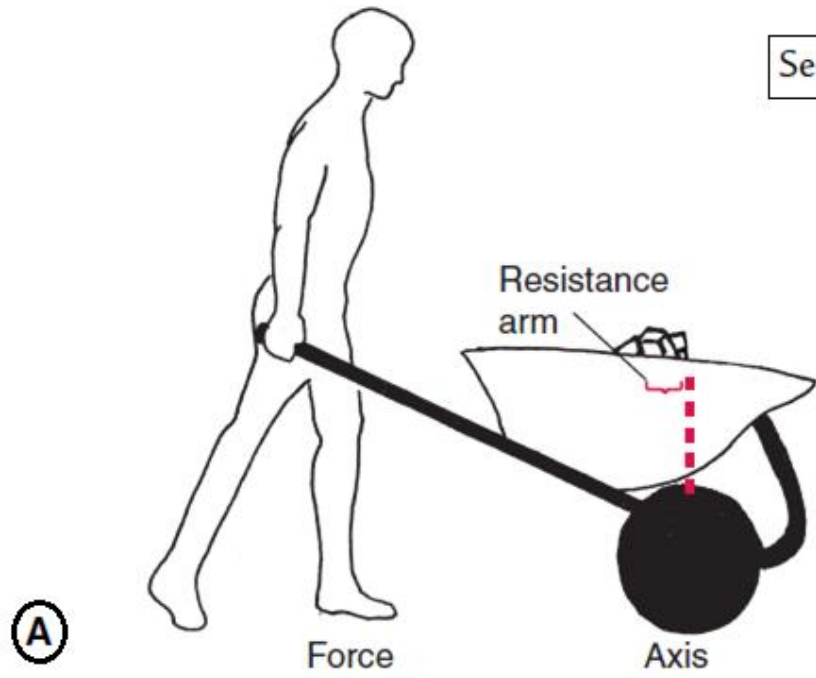
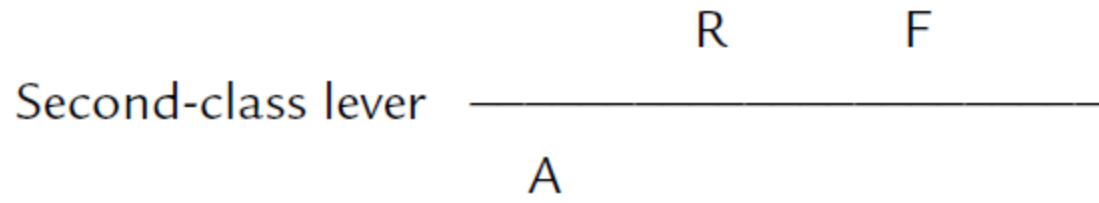


Head moving on neck demonstrates a first-class lever

In (A), the axis is the head posteriorly moving on the vertebral column and is located between force (the extensor muscles), and resistance (weight of the head itself).

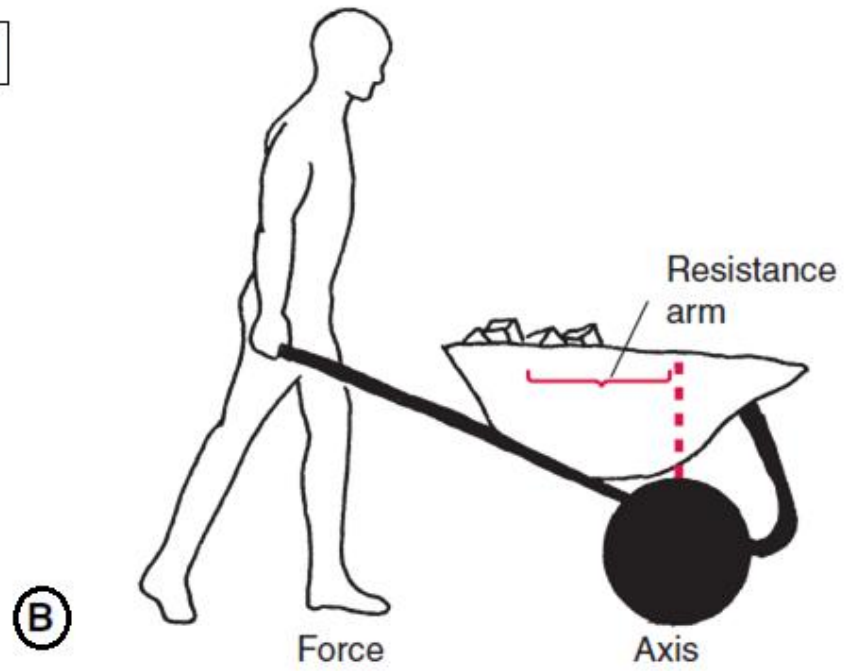


In (B), the axis is the head moving anteriorly on the vertebral column and is located between the force (flexor muscles) and the resistance (weight of head).

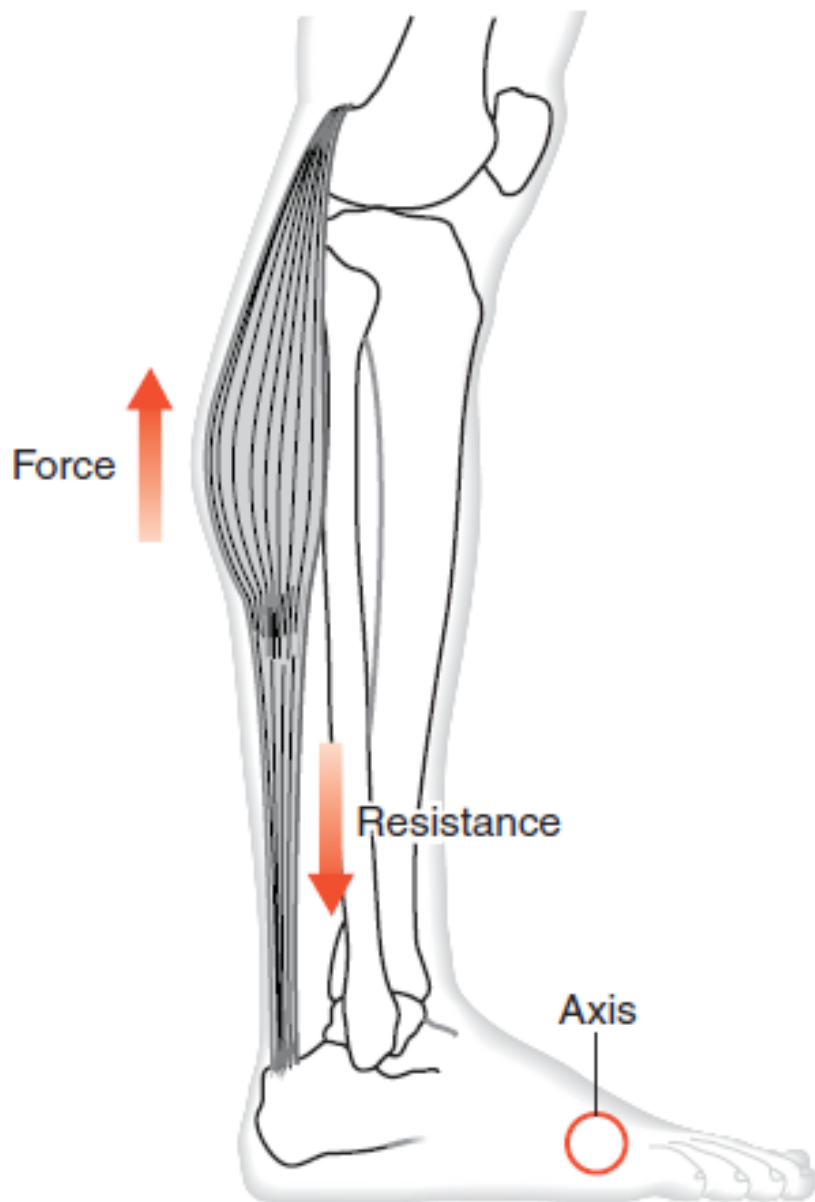


(A) RA is shorter.

Second-class lever



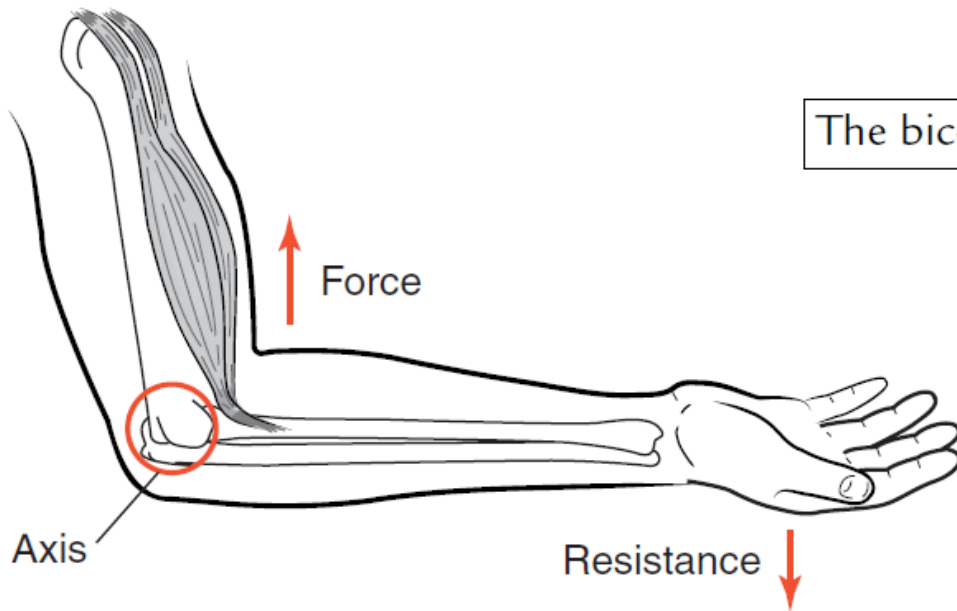
(B) RA is longer.



Plantar flexors lifting body weight demonstrates a second-class lever

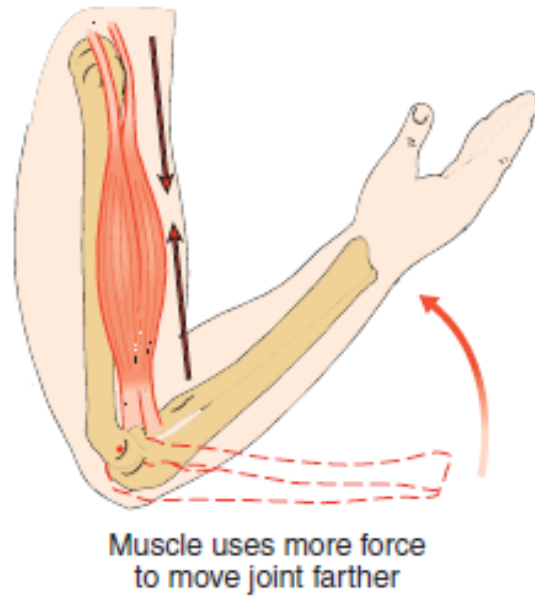
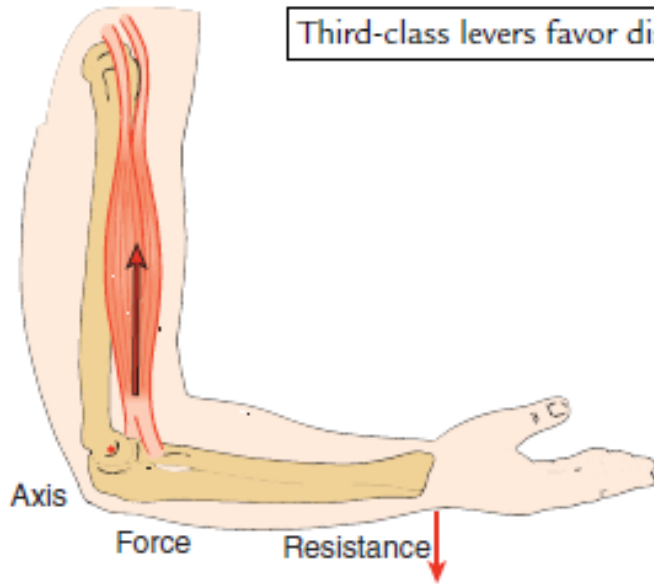


Third-class lever  $\frac{\quad F \quad R}{A}$

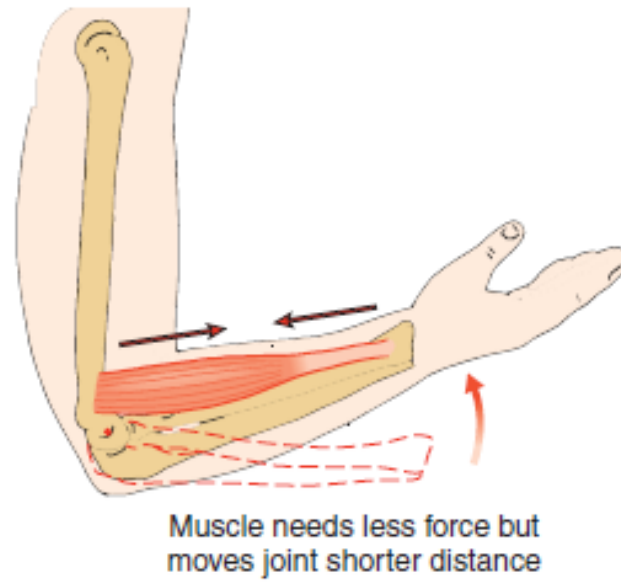
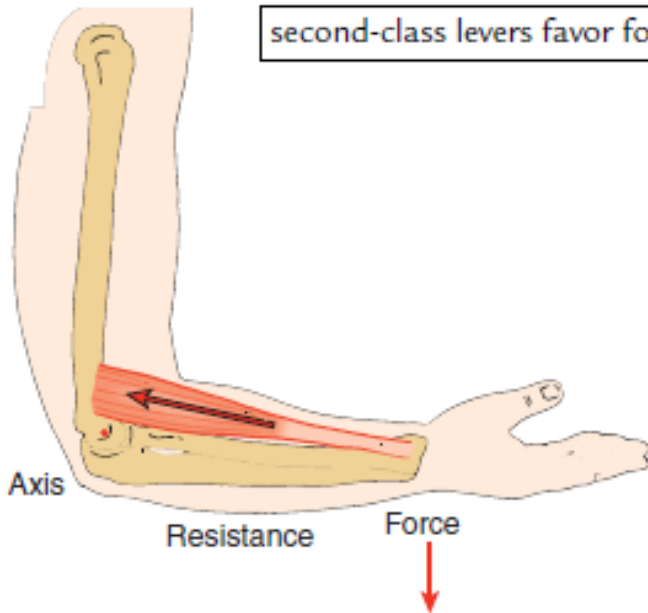


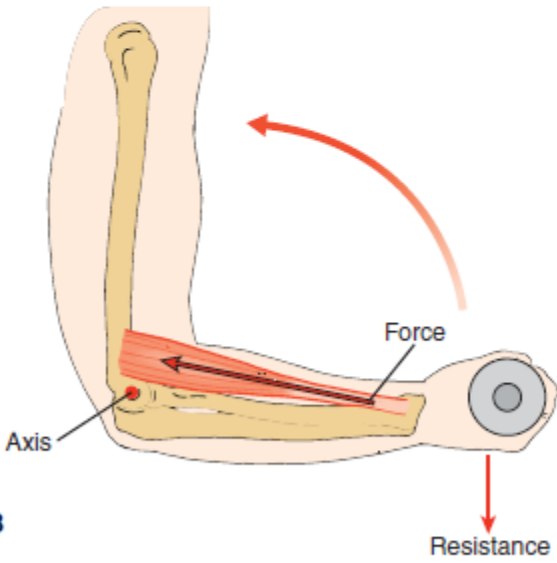
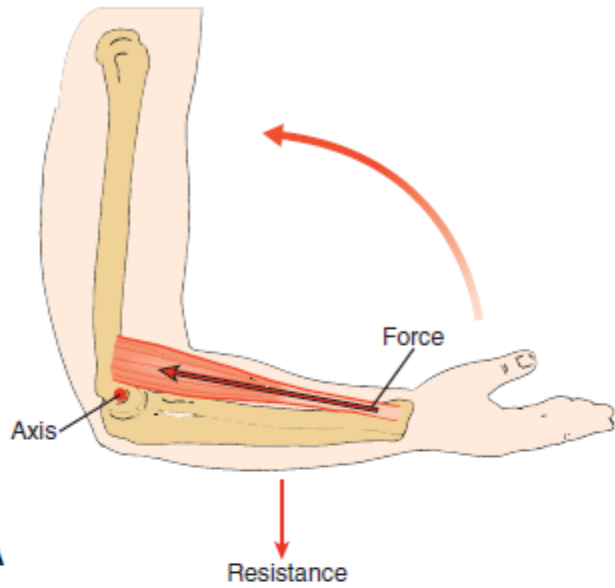
The biceps demonstrating a third-class lever

Third-class levers favor distance

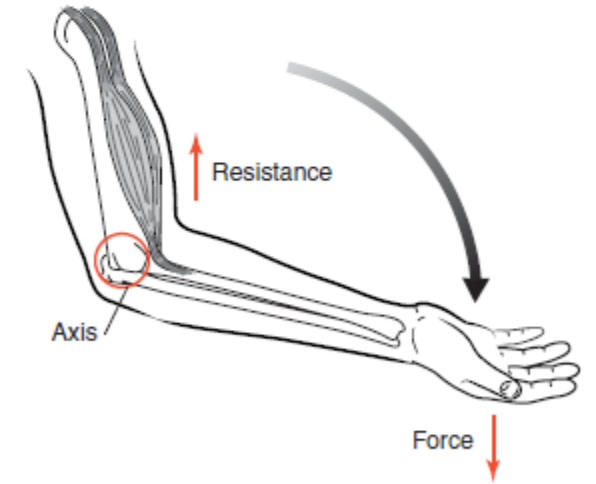
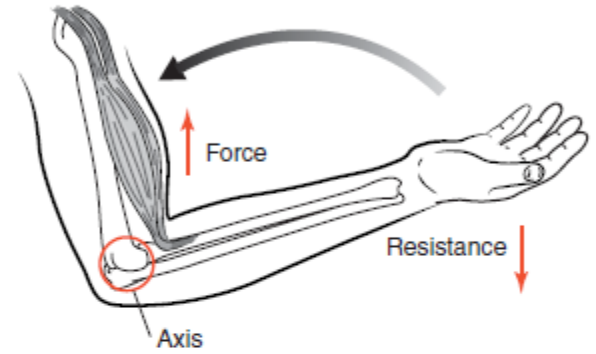


second-class levers favor force





(A) The brachioradialis as a second-class lever.  
 (B) It becomes a third-class lever when a weight is placed in the hand.



(A) The biceps acts as a third-class lever when contracting concentrically.  
 (B) a second-class lever when contracting eccentrically.

# MECHANICAL RATIO

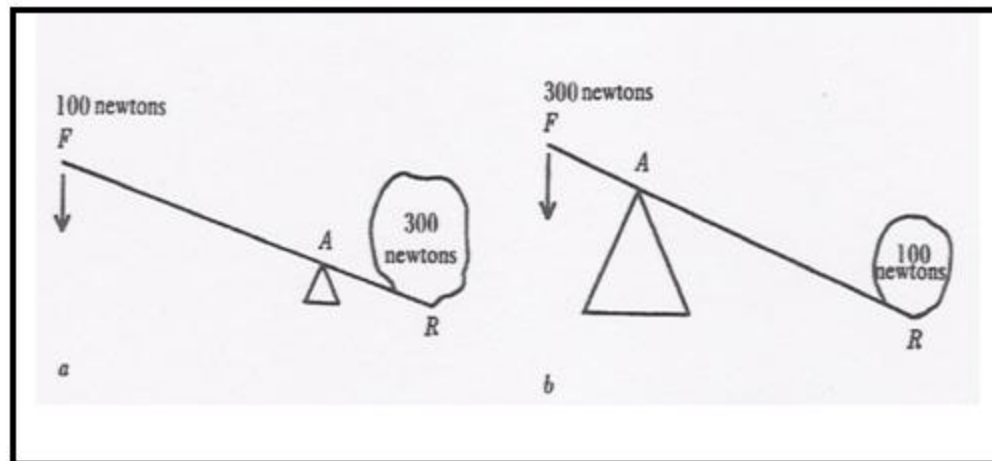
- Mechanical ratio  $\rightarrow$  mechanical advantage :  $\frac{FA}{RA}$
- MR :  $FA = RA \rightarrow MA = 0$
- MR :  $FA > RA \rightarrow MA \rightarrow FA$
- MR :  $FA < RA \rightarrow MA \rightarrow RA$
- Pada tubuh manusia MR berbeda pada tiap gerakan dan tiap sendi  $\rightarrow$  Range of Motion
- Penting dari bagian tehnik olahraga untuk mengatur lever untuk memperoleh MA

## Summary Ranges of Joint Motion

<b>SHOULDER</b>	flexion <b>0° to 180°</b> (150° to 180°) extension <b>0°</b> hyperextension <b>0° to 45°</b> (40° to 60°) abduction <b>0° to 180°</b> (150° to 180°) internal rotation <b>0° to 90°</b> (70° to 90°) external rotation <b>0° to 90°</b> (80° to 90°)	<b>THUMB</b>	MCP flexion <b>0° to 45°</b> (40° to 90°) MCP abduction and adduction (NEGLIGIBLE) IP flexion <b>0° to 90°</b> (80° to 90°)
<b>ELBOW</b>	flexion <b>0° to 145°</b> (120° to 160°) extension <b>0°</b>	<b>HIP</b>	flexion <b>0° to 120°</b> (110° to 125°) hyperextension <b>0° to 10°</b> (0° to 30°) abduction <b>0° to 45°</b> (40° to 55°) adduction <b>0°</b> (30° to 40° across midline) external rotation <b>0° to 45°</b> (40° to 50°) internal rotation <b>0° to 35°</b> (30° to 45°)
<b>FOREARM</b>	supination from midposition <b>0° to 90°</b> (80° to 90°) pronation from midposition <b>0° to 80°</b> (70° to 80°)	<b>KNEE</b>	flexion <b>0° to 120°</b> (120° to 160°) extension <b>0°</b>
<b>WRIST</b>	neutral when the midline between flexion and extension is 0° and when forearm and third metacarpal are in line flexion <b>0° to 90°</b> (75° to 90°) extension <b>0° to 70°</b> (65° to 70°) radial abduction <b>0° to 20°</b> (15° to 25°) ulnar abduction <b>0° to 30°</b> (25° to 40°)	<b>ANKLE</b>	neutral with foot at a right angle to the leg and knee flexed plantar flexion <b>0° to 45°</b> (40° to 50°) dorsiflexion <b>0° to 15°</b> (10° to 20°) inversion and eversion (see Chapter 10).
<b>FINGERS</b>	MCP flexion <b>0° to 90°</b> (85° to 100°) MCP hyperextension <b>0° to 20°</b> (0° to 45°) MCP abduction <b>0° to 20°</b> MCP adduction <b>0°</b> PIP flexion <b>0° to 120°</b> (90° to 120°) DIP flexion <b>0° to 90°</b> (80° to 90°) IP extension <b>0°</b>	<b>TOES</b>	MTP flexion <b>0° to 40°</b> (30° to 45°) MTP hyperextension <b>0° to 80°</b> (50° to 90°) MTP abduction (present) IP flexion <b>0° to 60°</b> (50° to 80°) IP extension <b>0°</b>

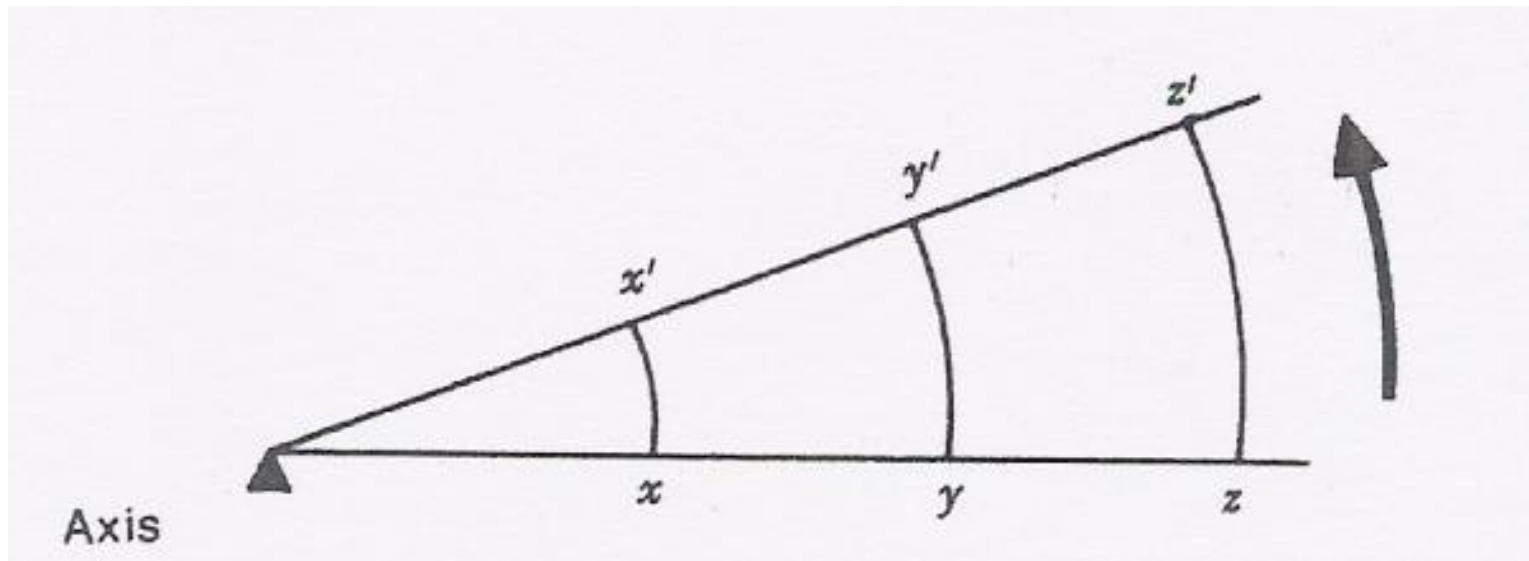
# Force & Speed Lever

- $FA > RA \rightarrow$  Force lever
- $RA > FA \rightarrow$  Speed lever
- Pada first class lever tergantung pada posisi A
- Pada second class lever di mana  $FA > RA \rightarrow$  Force lever
- Pada third class lever dimana  $RA > FA \rightarrow$  Speed lever
- Sebagian besar jenis lever pada tubuh manusia adalah first atau third class lever, dengan third class lever lebih banyak
- Pada manusia lebih banyak jenis Speed Lever
- Mencapai optimal lever merupakan dasar penting untuk memperbaiki performance

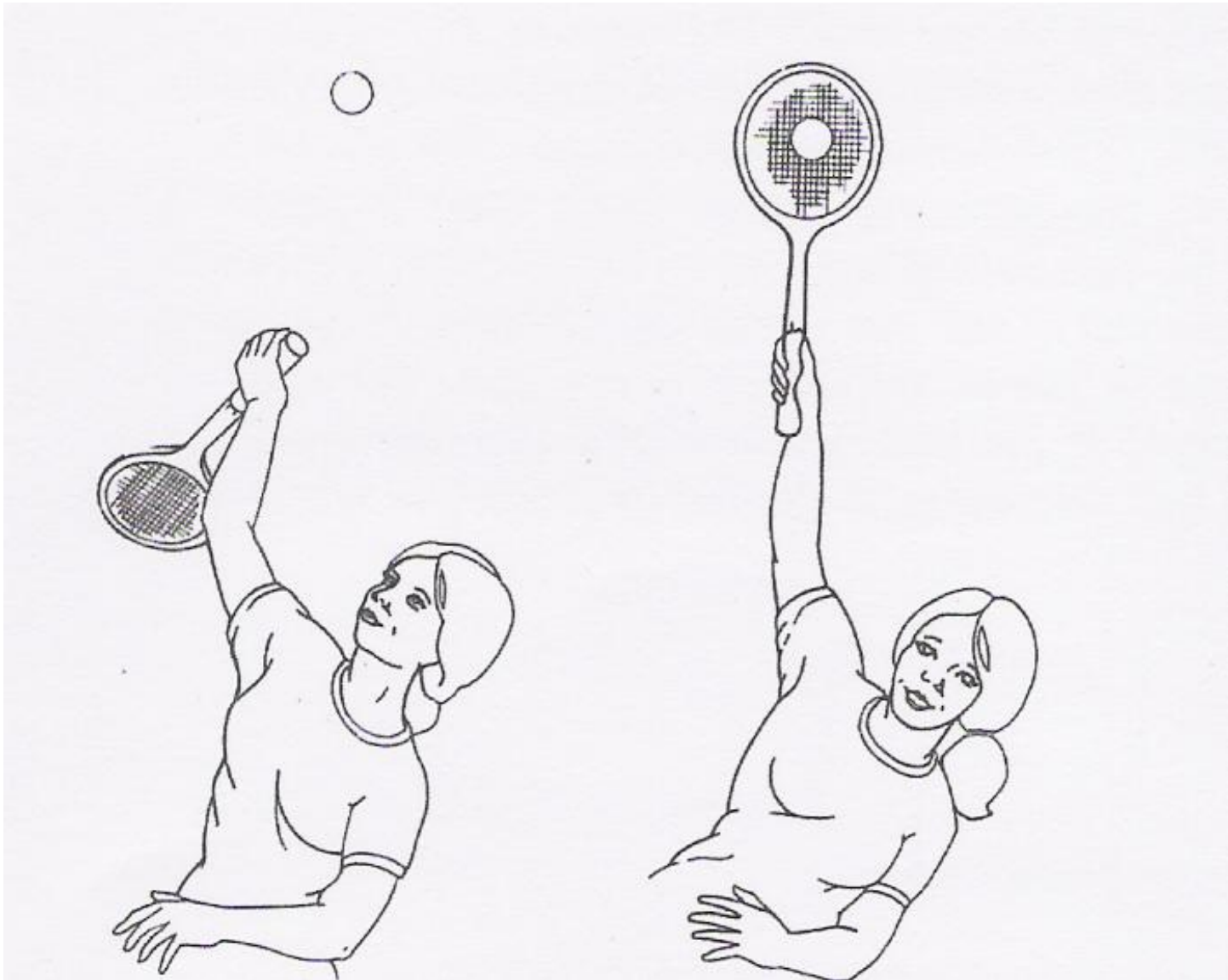


# Gerakan titik pada lengan lever

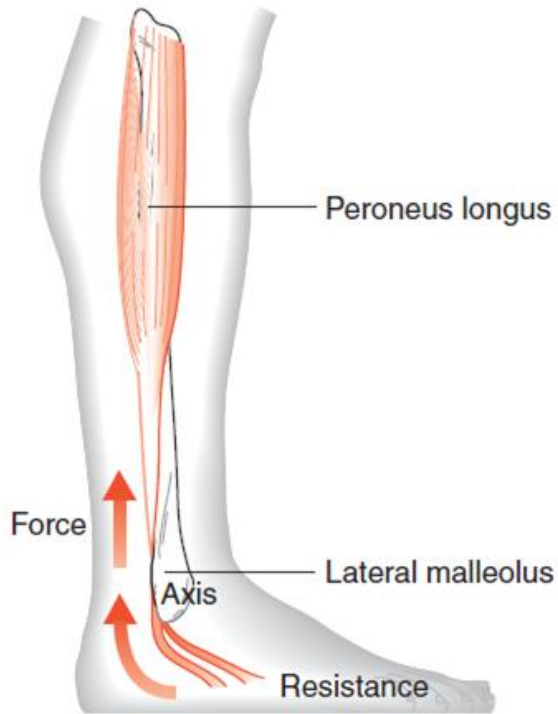
- Titik ( bagian ) dari arm lever yang letaknya makin jauh dari sumbu gerak / axis, bergerak makin cepat secara proporsional



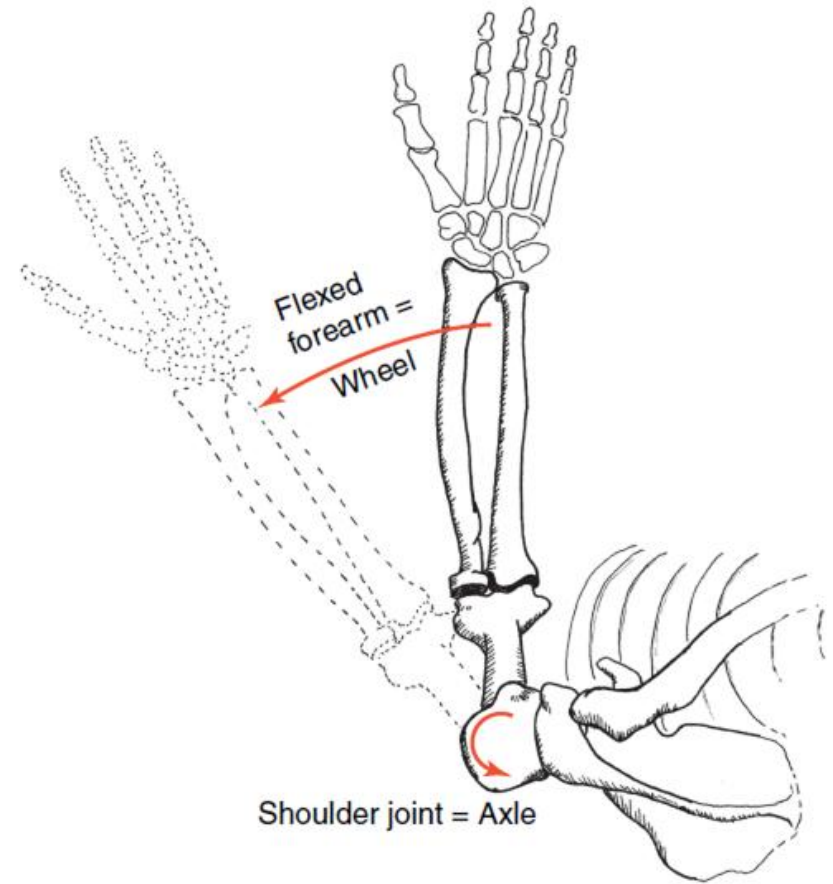
# Implementasi dalam sport





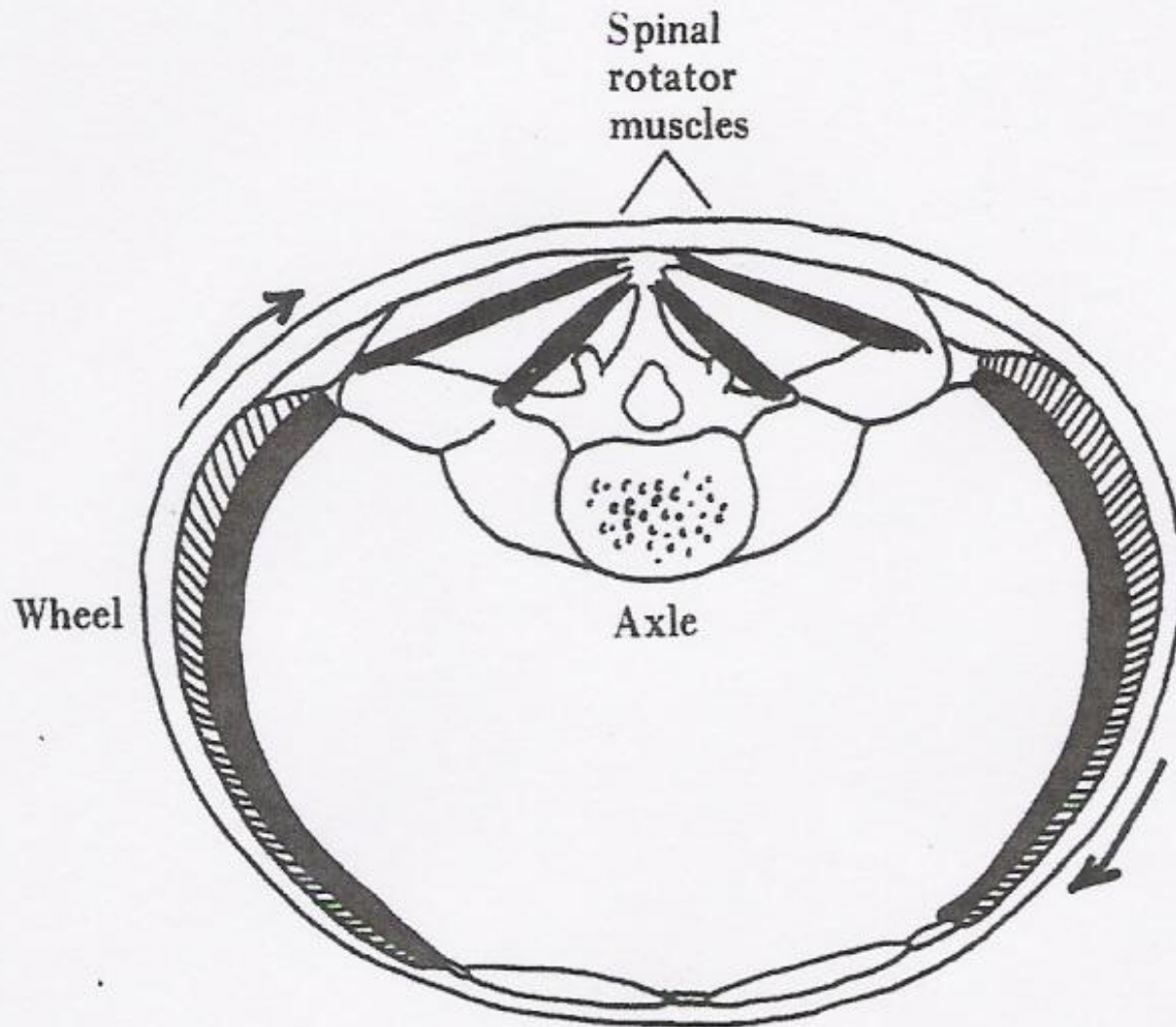


The lateral malleolus acts as a pulley, allowing the peroneus longus to change its direction of pull.



The upper extremity acting as a wheel and axle.

# Wheel & axle



*TERIMA KASIH*

