

# QUIZ

**What is a motor unit?**

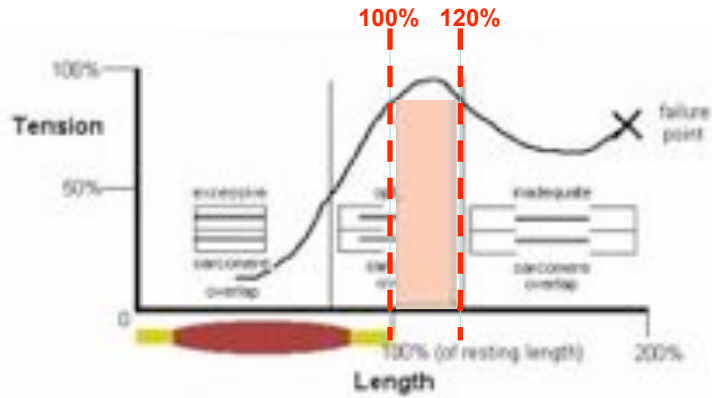
**What's the smallest contractile unit of a muscle?**

Neuromuscular Junction

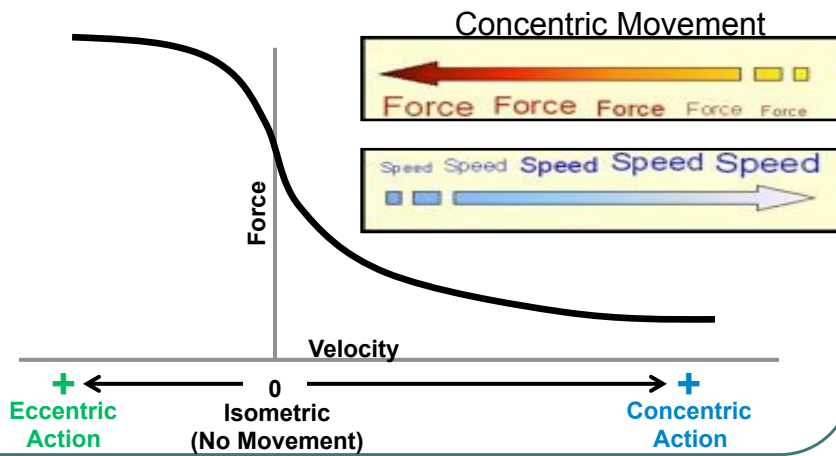
	Z Line	A Band	H Zone	I Band
Concentric action				
Eccentric action				

## Muscle Length-tension relationship

**Tension = Magnitude of a Force**



## Maximal Contraction Force-Velocity Relationship



# Quiz

What percent (range) of resting length in muscle generates the greatest tension?

In your own words, how does Sarcomere Length effect tension (force production)?



Draw the Force-Velocity Relationship

# Key Concepts

**Weight:** The effect gravity has on a given mass

**Force = Mass x Acceleration**

**Body Weight = Mass x Acceleration<sub>gravity</sub>**

Example:

Mass: 80 kg  
 Accel<sub>grav</sub>: 9.81 m/s/s

Answer: 785 Kg m/s<sup>2</sup>

**785 Newtons**



"Don't step on it... it makes you cry."

# Quiz

- What is the body weight of a person who has a mass of 60 kg here on earth?

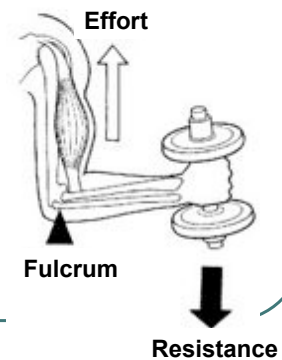
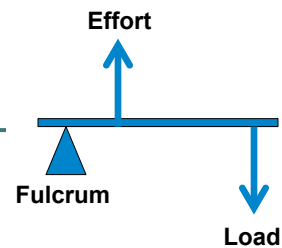


## Principles of Levers

To have movement levers must be engaged

Levers have:

1. **Axis of Rotation**
2. **Muscular Effort**
3. **Resistance**



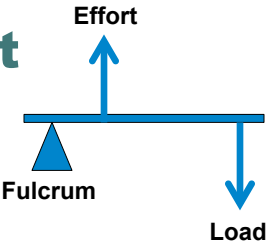
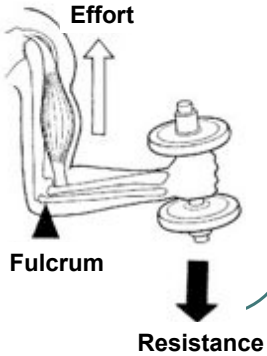
**Principles of Movement**

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Mechanical Aspects

1. Rotary Force
2. Stabilizing Force
3. Total Muscular Force

Basic Components of Force:  
Direction and Magnitude

The top diagram shows a horizontal blue bar representing a lever. A blue triangle labeled 'Fulcrum' is positioned below the bar. A blue arrow labeled 'Effort' points upwards from the bar, and a blue arrow labeled 'Load' points downwards from the bar.

The bottom diagram shows a skeletal structure with a muscle. A black triangle labeled 'Fulcrum' is at the joint. A black arrow labeled 'Resistance' points downwards from a weight. A black arrow labeled 'Effort' points upwards from the muscle.

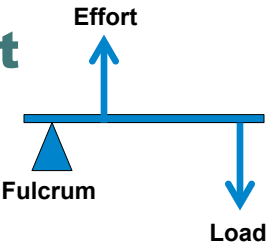
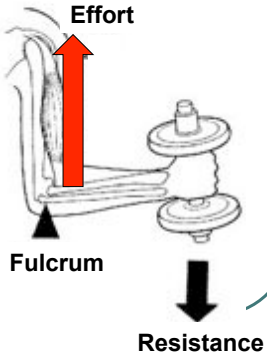
**Principles of Movement**

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Mechanical Aspects

1. Rotary Force
2. Stabilizing Force
3. Total Muscular Force

Basic Components of Force:  
Direction and Magnitude

The top diagram is identical to the one in the first slide, showing a lever with 'Fulcrum', 'Effort', and 'Load'.

The bottom diagram is identical to the one in the first slide, showing a skeletal system with 'Fulcrum', 'Effort', and 'Resistance'.

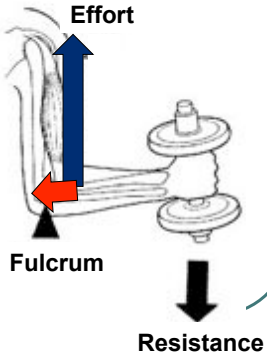
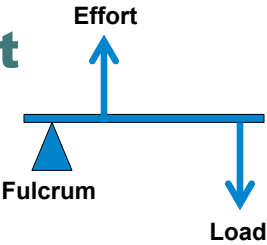
**Principles of Movement**

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**Mechanical Aspects**

1. Rotary Force
2. **Stabilizing Force**
3. Total Muscular Force

**Basic Components of Force:**  
**Direction and Magnitude**



The top diagram shows a horizontal blue line representing a lever. A blue triangle labeled 'Fulcrum' is positioned below the line. A blue arrow labeled 'Effort' points upwards from the line, and another blue arrow labeled 'Load' points downwards from the line. The bottom diagram shows a skeletal joint with a blue arrow labeled 'Effort' pointing upwards and a red arrow labeled 'Resistance' pointing downwards. A black triangle labeled 'Fulcrum' is at the joint's pivot point.

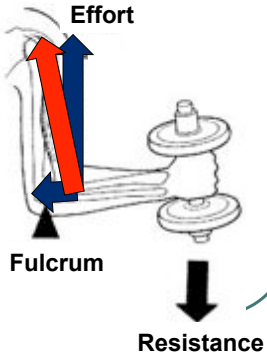
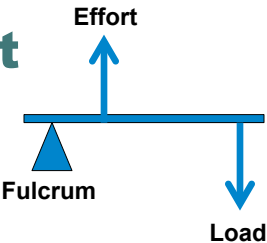
**Principles of Movement**

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**Mechanical Aspects**

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**Basic Components of Force:**  
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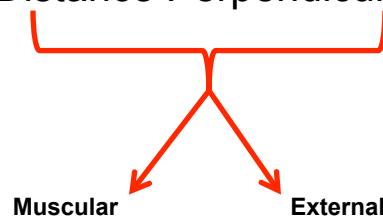
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## QUIZ

- Draw a lever arm including the following components:
  - Axis of Rotation
  - Muscular Effort
  - Resistance
- Include the following mechanical aspects:
  - Rotary Force
  - Stabilizing Force
  - Total Muscular Force

## Torque

Torque = Force x Distance Perpendicular



**\*\*To hold a weight with the elbow at 90°  
External Torque = Muscular Torque**

## External Torque = Muscular Torque (Elbow at 90 Degrees)

External Torque = Resistance x Resistance Arm

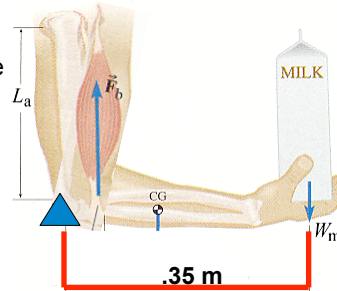
Muscular Torque = Muscular Effort x Effort Arm

How much External Torque is generated by the 1.5 kg Milk held in the hand .35 m from the elbow?

$$T_{\text{external}} = F \times D_{\perp}$$

$$T_{\text{external}} = 1.5 \text{ kg} \times 9.81 \text{ m/s}^2 \times .35 \text{ m}$$

$$T_{\text{external}} = 14.72 \text{ N} \times .35 \text{ m} \quad \boxed{5.15 \text{ Nm}}$$



## External Torque = Muscular Torque (Elbow at 90 Degrees)

How much force must the biceps create to overcome the weight held in the hand?

$$T_{\text{external}} = T_{\text{muscular}} \quad \leftarrow \text{To hold steady at 90 Degrees}$$

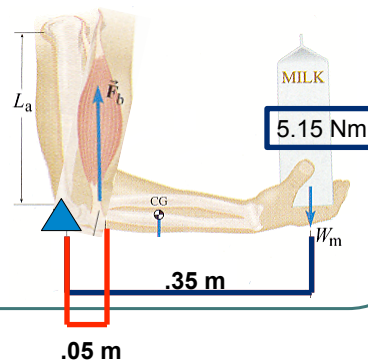
$$14.72 \text{ N} \times .35 \text{ m} = \text{Muscular Effort} \times \text{Effort Arm}$$

$$5.15 \text{ Nm} = \text{Muscular Effort} \times .05 \text{ m}$$

$$\frac{5.15 \text{ Nm}}{.05 \text{ m}} = \text{Muscular Effort}$$

$$\boxed{103 \text{ N} = \text{Muscular Effort}}$$

**>103 N**







## Quiz (Partner Collaboration!)

Diagram a lever arm with the muscular effort at 90 degrees .025m from the elbow

- How much external torque is generated by an object with a mass of 5 kg when it is held in the hand .4m from the elbow?
- How much force must the biceps generate to overcome the weight held in the hand?

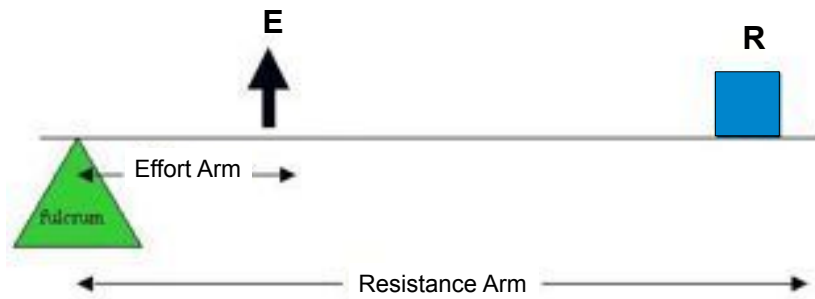
## Quiz

**Diagram a lever arm with the muscular effort at 90 degrees .025m from the elbow**

- How much external torque is generated by a 15 kg weight held in the hand .4m from the elbow?
- How much force must the biceps generate to overcome the weight held in the hand?



## Mechanical Advantage



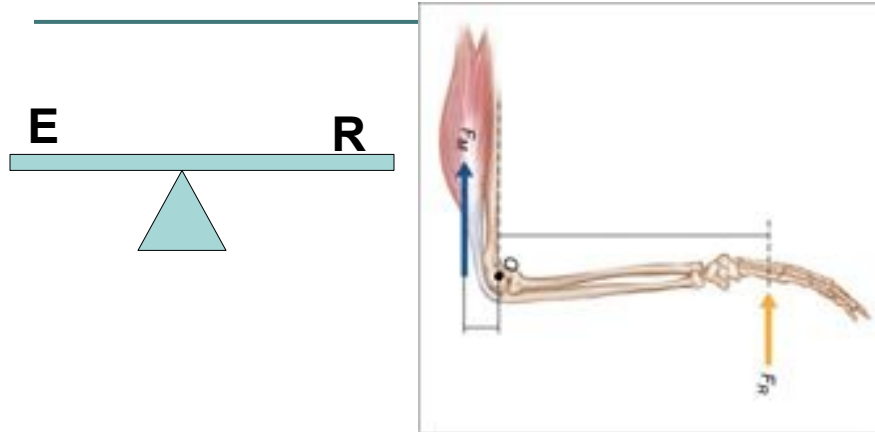
**A ratio between the length of the effort arm and the resistance arm**

$$\text{Mechanical Advantage} = \frac{\text{Effort Arm}}{\text{Resistance Arm}}$$

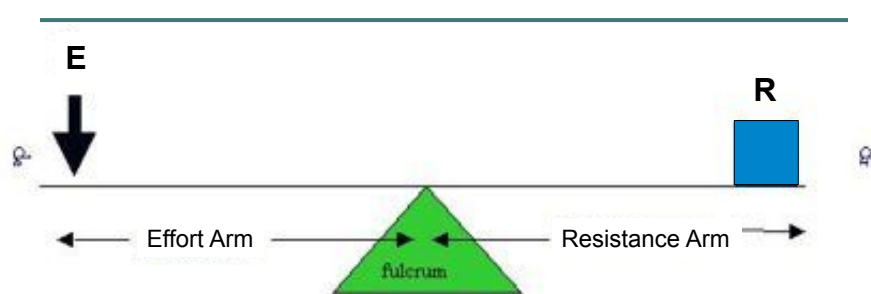
## Interpreting Mechanical Adv.

- If the MA ratio > 1.0
  - The required magnitude of force applied (effort) is **LESS** than the magnitude of the resistance
- If the MA ratio < 1.0
  - The required magnitude of force applied (effort) is **GREATER** than the magnitude of the resistance
  - Mechanical Disadvantage (less effective because more force required)

### ***A First-Class Lever (The Forearm)***



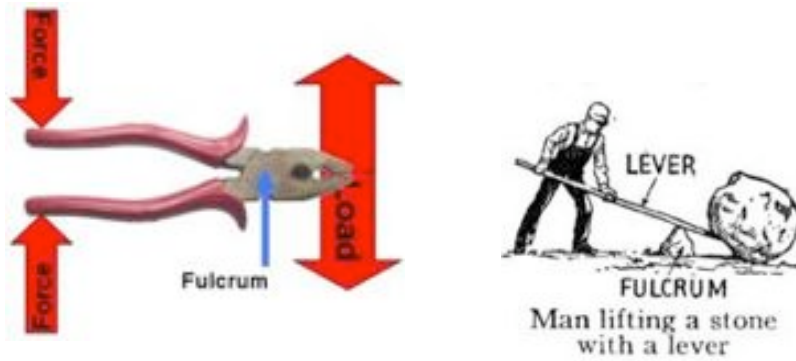
### **Mechanical Advantage**



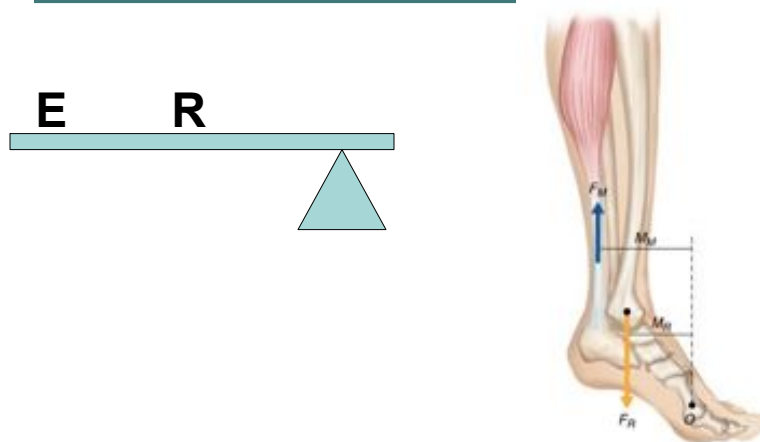
$$MA = EA/RA$$

If the lever stays balanced what does this tell me about the torques generated by the resistance and the effort?

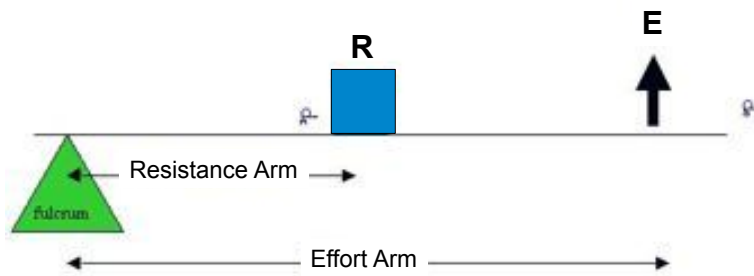
## 1<sup>st</sup> Class Levers



## A Second-Class Lever (The Foot)

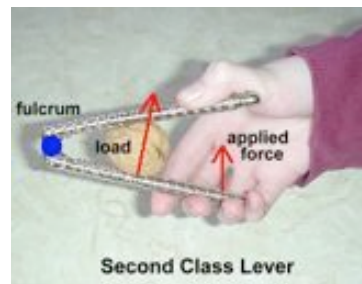
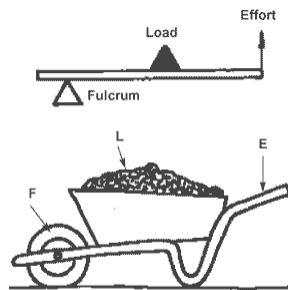


## Mechanical Advantage

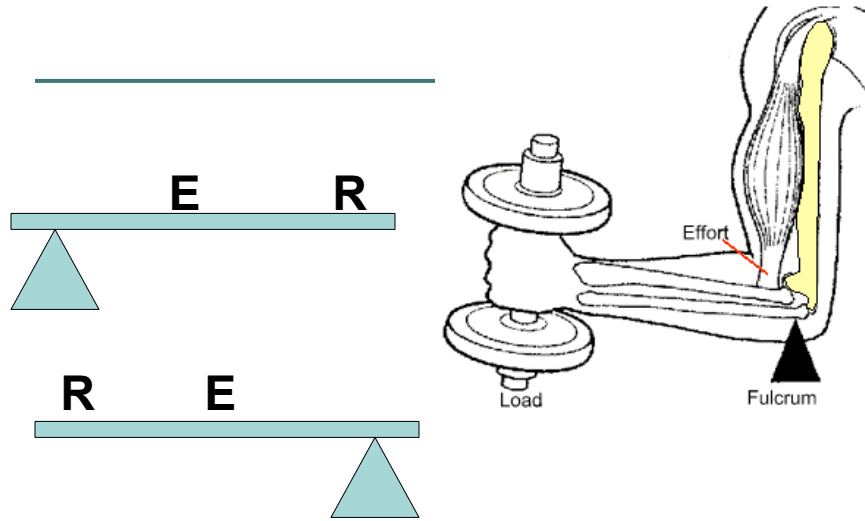


$$\text{Mechanical Advantage} = \frac{\text{Effort Arm}}{\text{Resistance Arm}}$$

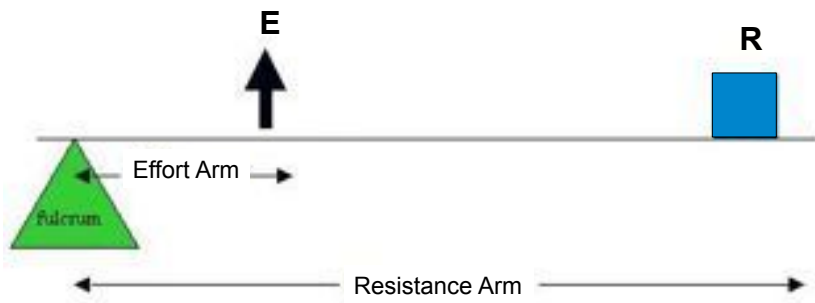
## 2<sup>nd</sup> Class Levers



**A Third-Class Lever (The Forearm)**



**Mechanical Advantage**



$$\text{Mechanical Advantage} = \frac{\text{Effort Arm}}{\text{Resistance Arm}}$$

### 3<sup>rd</sup> Class Levers

