Chapter 12 PART B: *INTERNAL* FORCES

KINESIOLOGY

Scientific Basis of Human Motion, 11th edition

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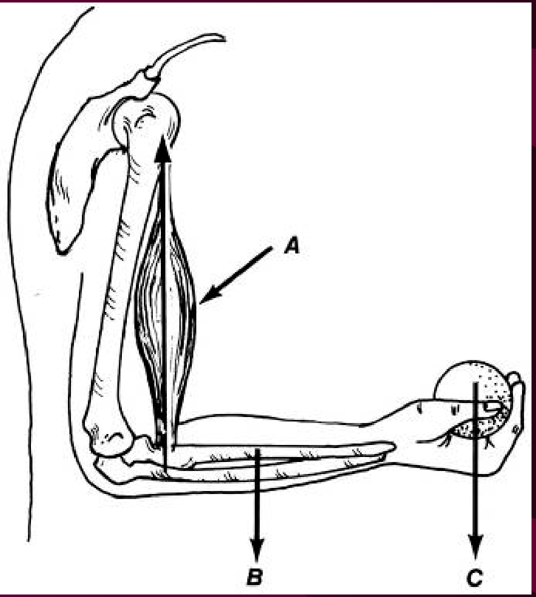
F O R C E

- <u>Internal</u> forces act on parts of the body
  - human biceps raising forearm
  - THIS LECTURE

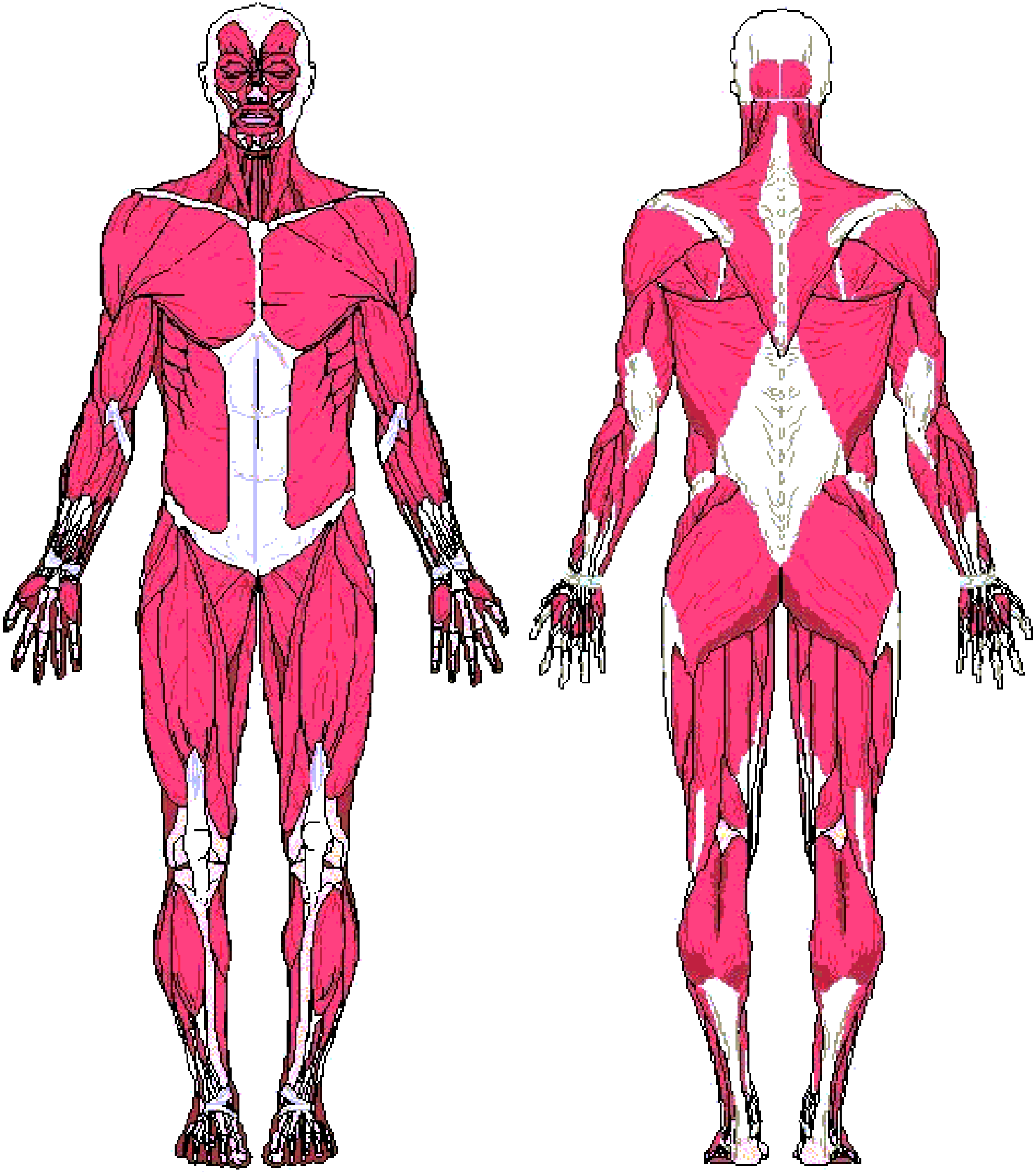


PREVIOUS LECTURE:

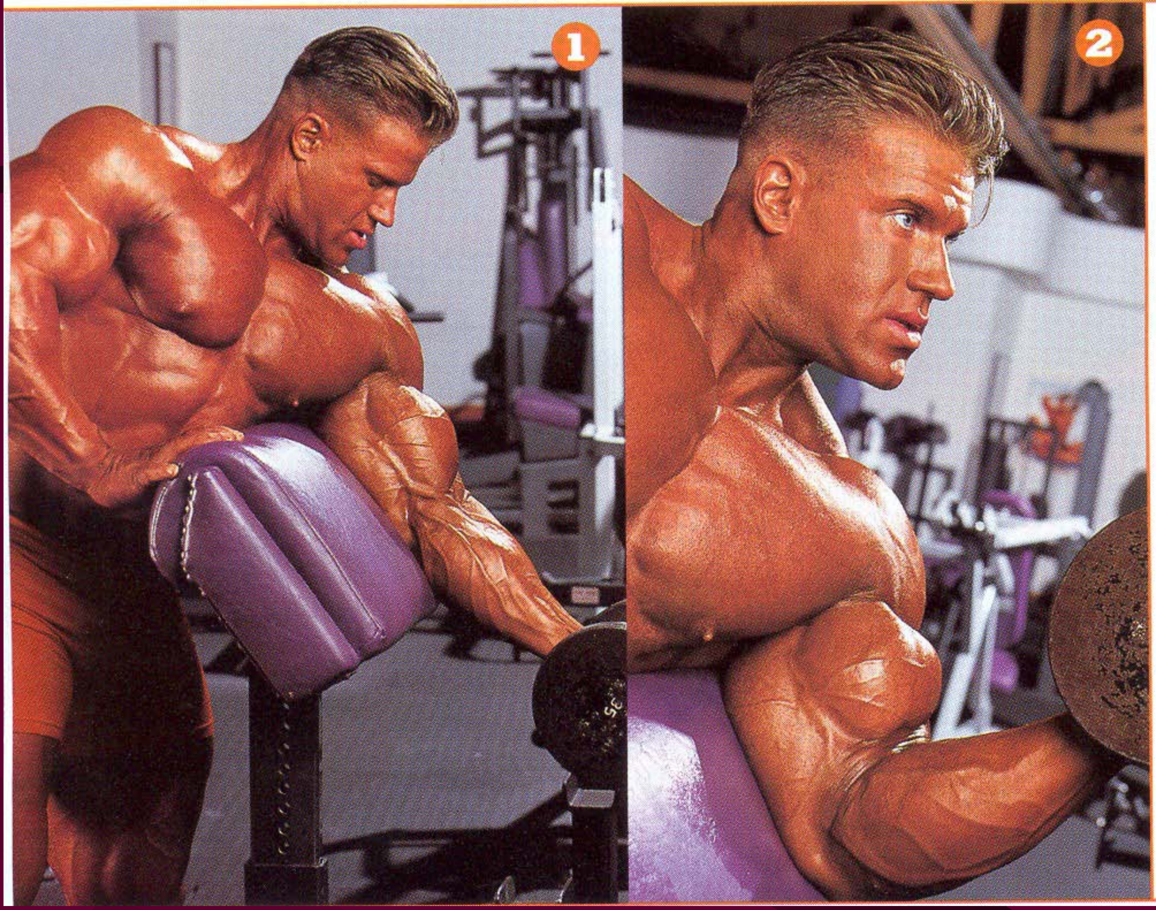
- <u>External</u> forces are outside the body:
  - Gravity (and weight)
  - Air or water resistance
  - Friction
  - Forces of other objects acting on the body

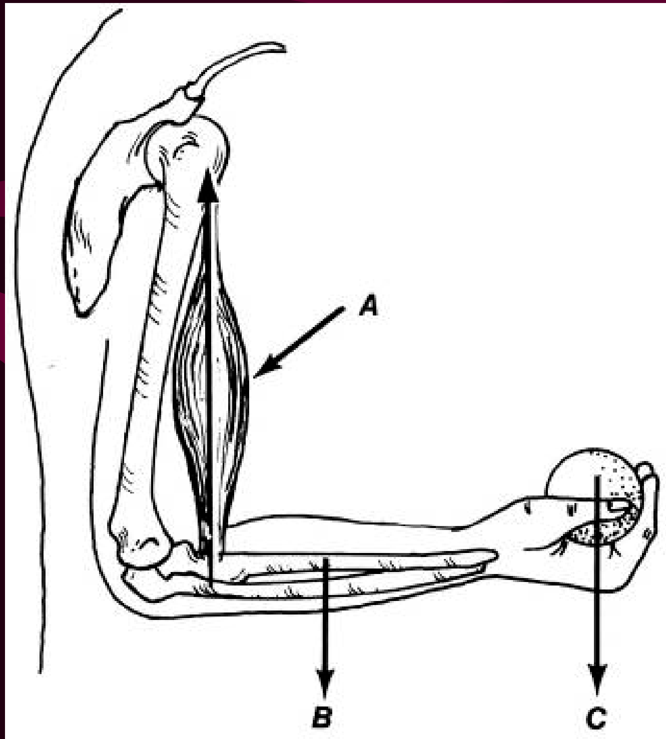
Internal Muscular Force

- Proportional to number & size of muscle fibers contracting
- Muscles normally act in groups whose force (*strength*) is measured collectively
- Measured by a dynamometer



Point of Application of FORCE

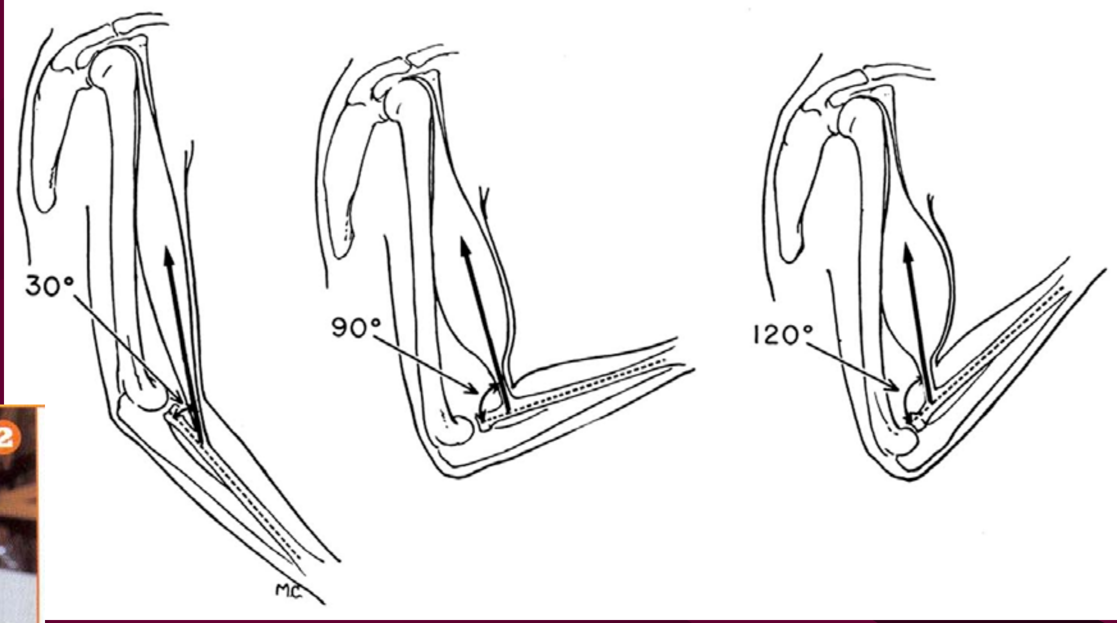




- For muscular force, point assumed to be the muscle's attachment to bone

internal Muscular Force

- Muscle <u>angle of pull</u>: angle between line of pull and <u>axis</u> of bone (dotted line)



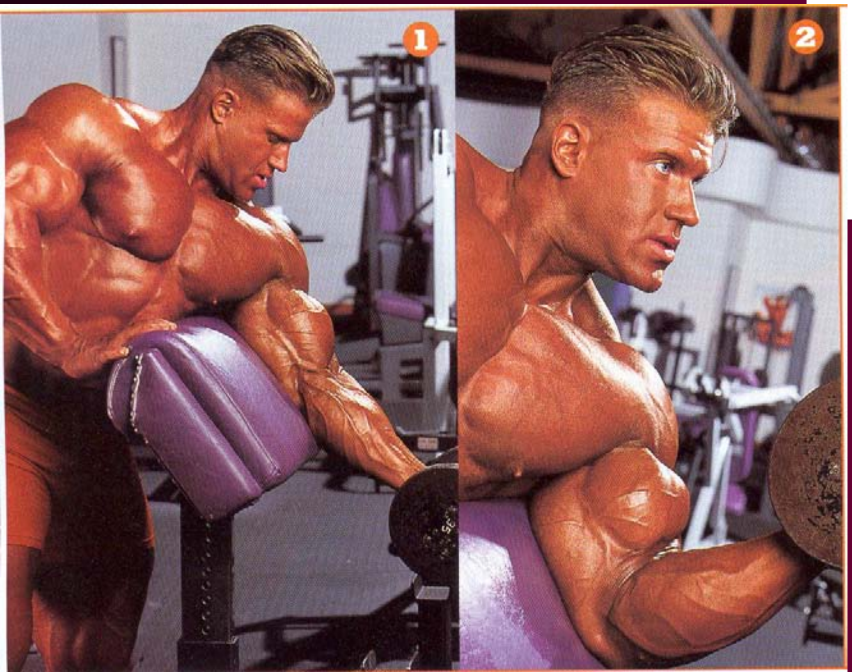
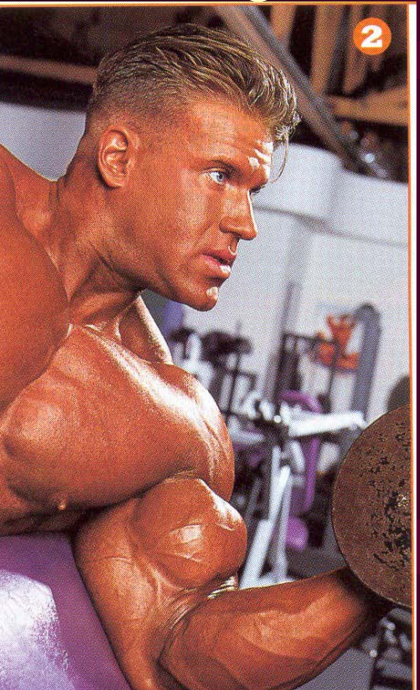


Fig 12.1

internal Muscular Force

- Vertical (“Rotary“) component is perpendicular to the lever (bone axis)
- Horizontal (nonrotary) component is parallel to the lever (bone axis)
- Most resting muscles have an angle of pull < 90˚



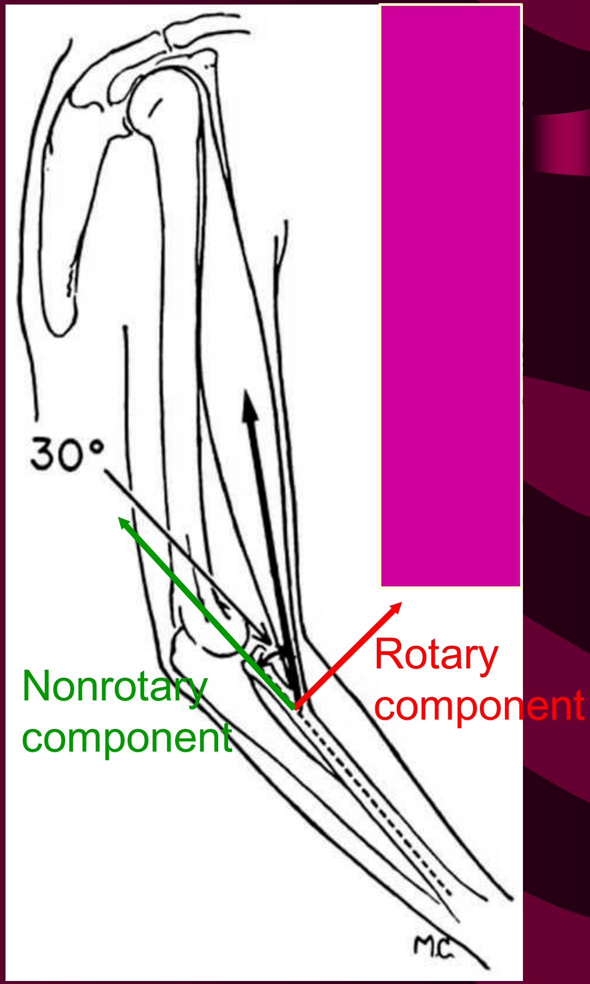
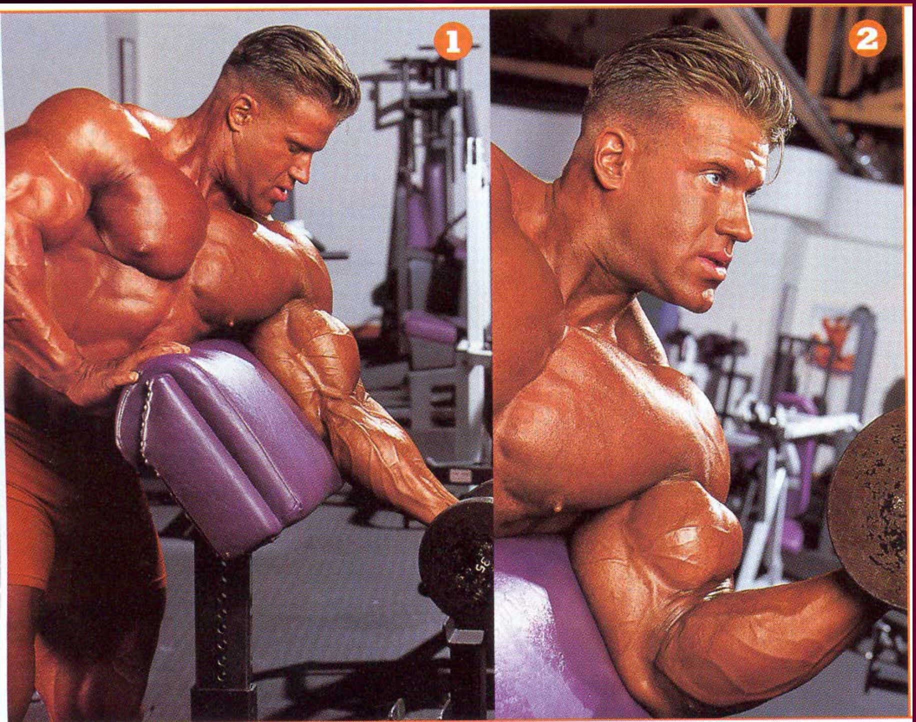


Fig 12.1a

Rotary vs. Nonrotary Components

Angle of pull < 90^0

- Nonrotary force directed toward fulcrum
- Helps maintain integrity of the joint (stabilizes)



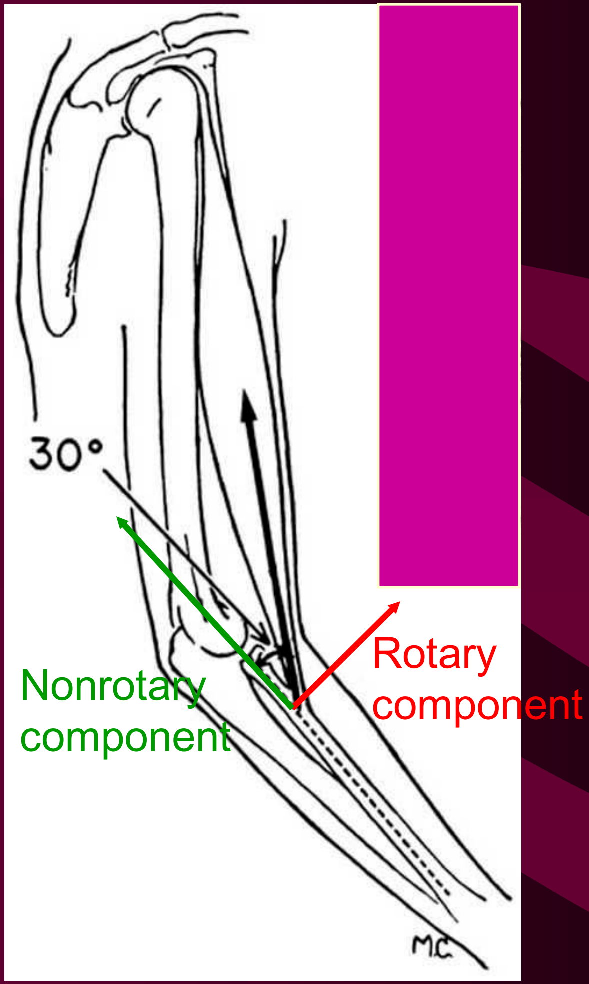
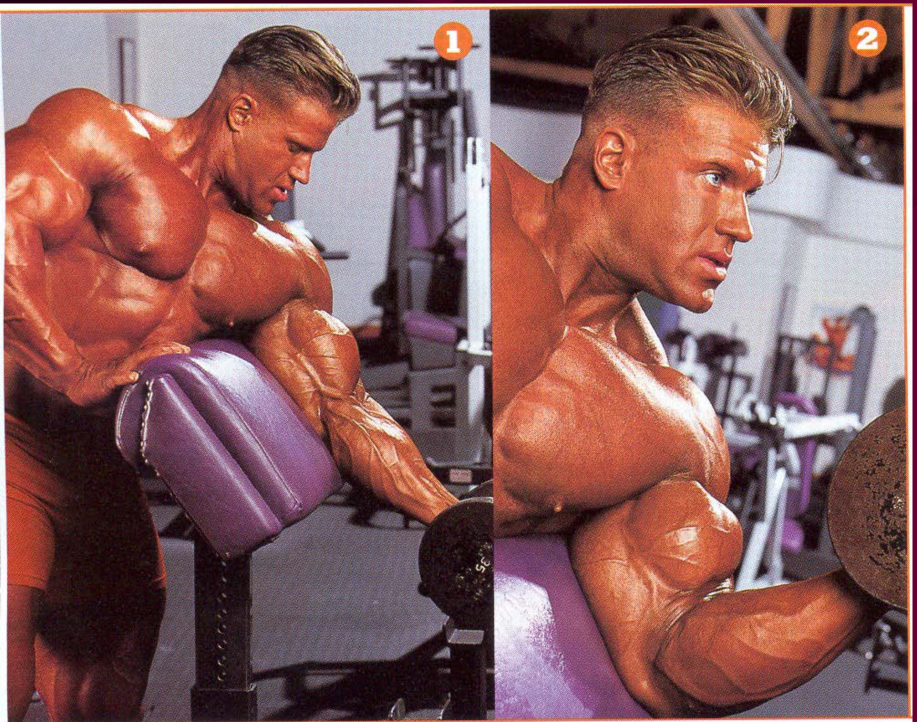


Fig 12.1a

Rotary vs. Nonrotary Components

Angle of pull > 90^0

- Dislocating force is directed away fulcrum
- Does not occur often
- Muscle is at limit of shortening range and not exerting much force



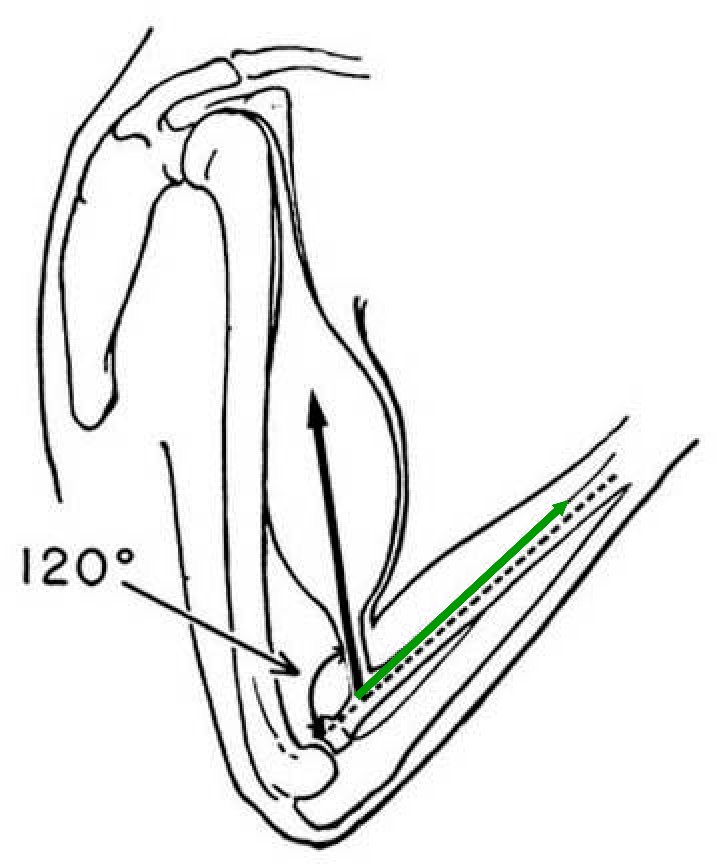


Fig 12.1c

Rotary vs. Nonrotary Components

Angle of pull = 90°

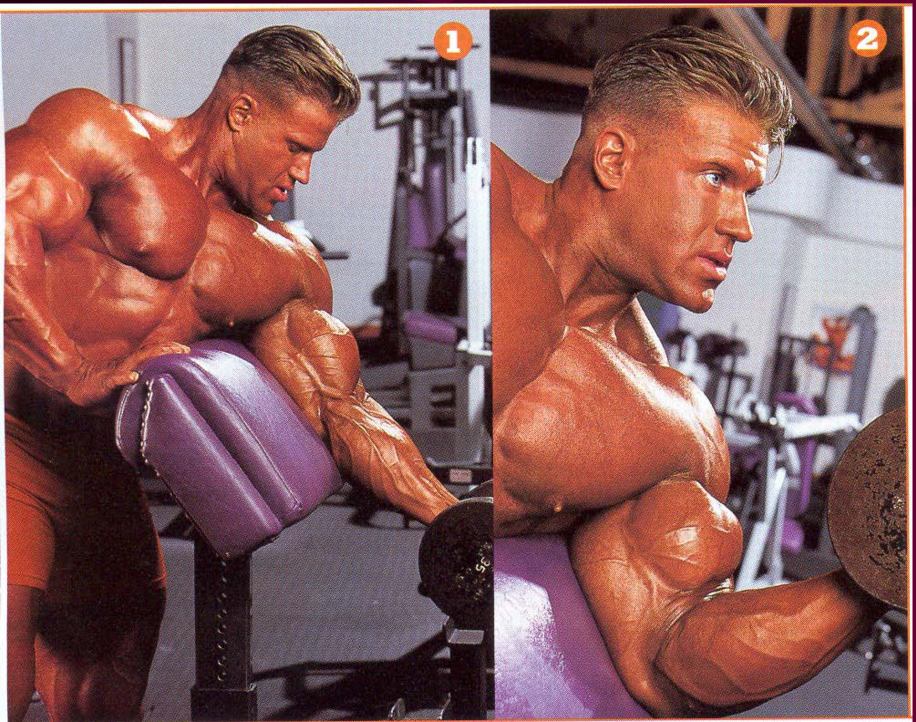
- Force is all rotary

Angle of pull = 45°

- Rotary & nonrotary components equal

Muscular force functions:

- Movement
- Stabilization



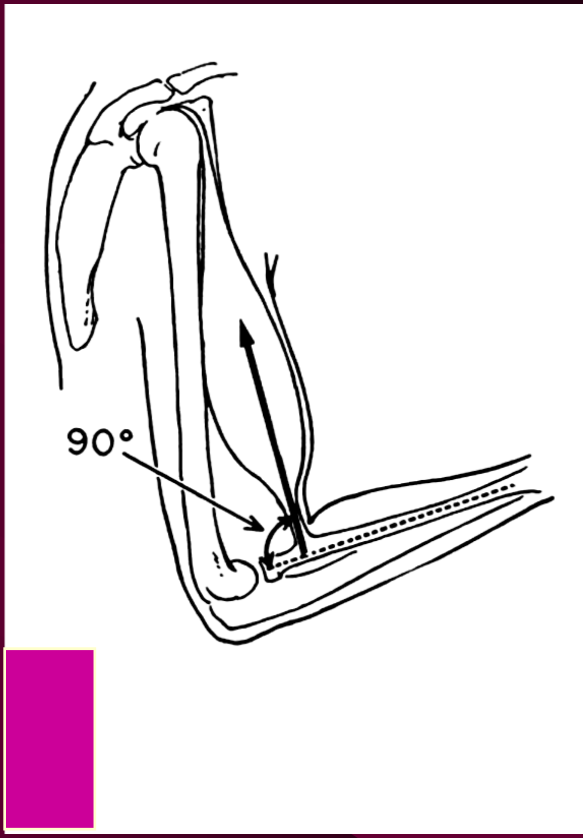
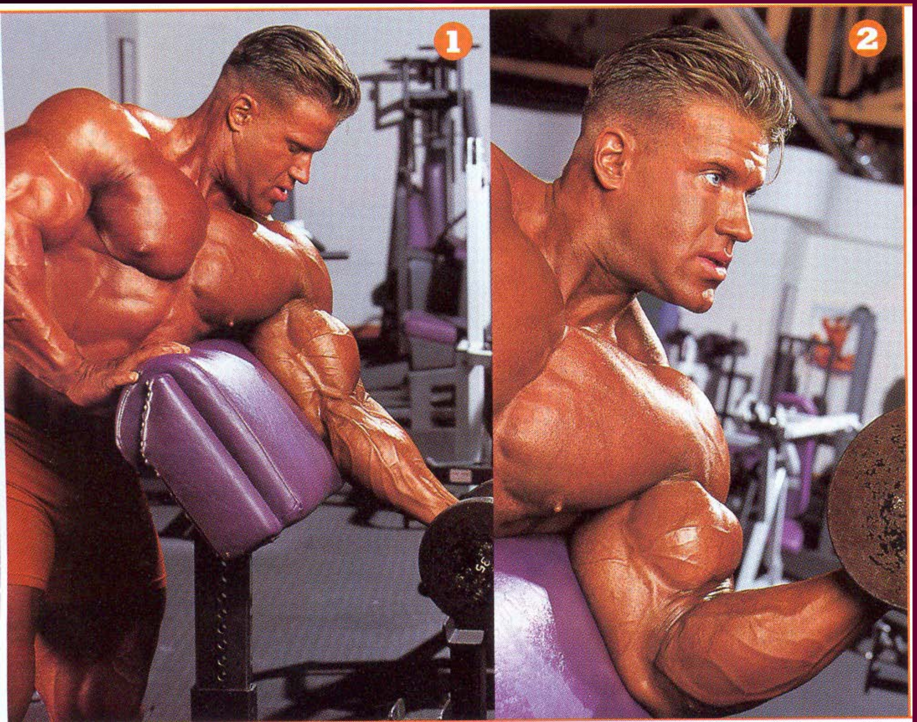


Fig 12.1b

Parallel Forces

- 10 N weight at 90°
- Gravity acts at points B & C
- A is force of biceps



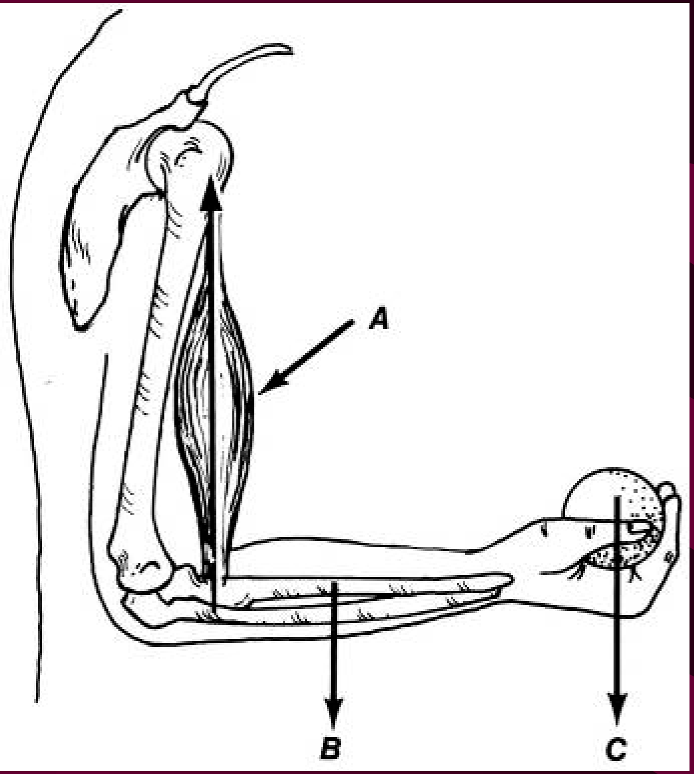
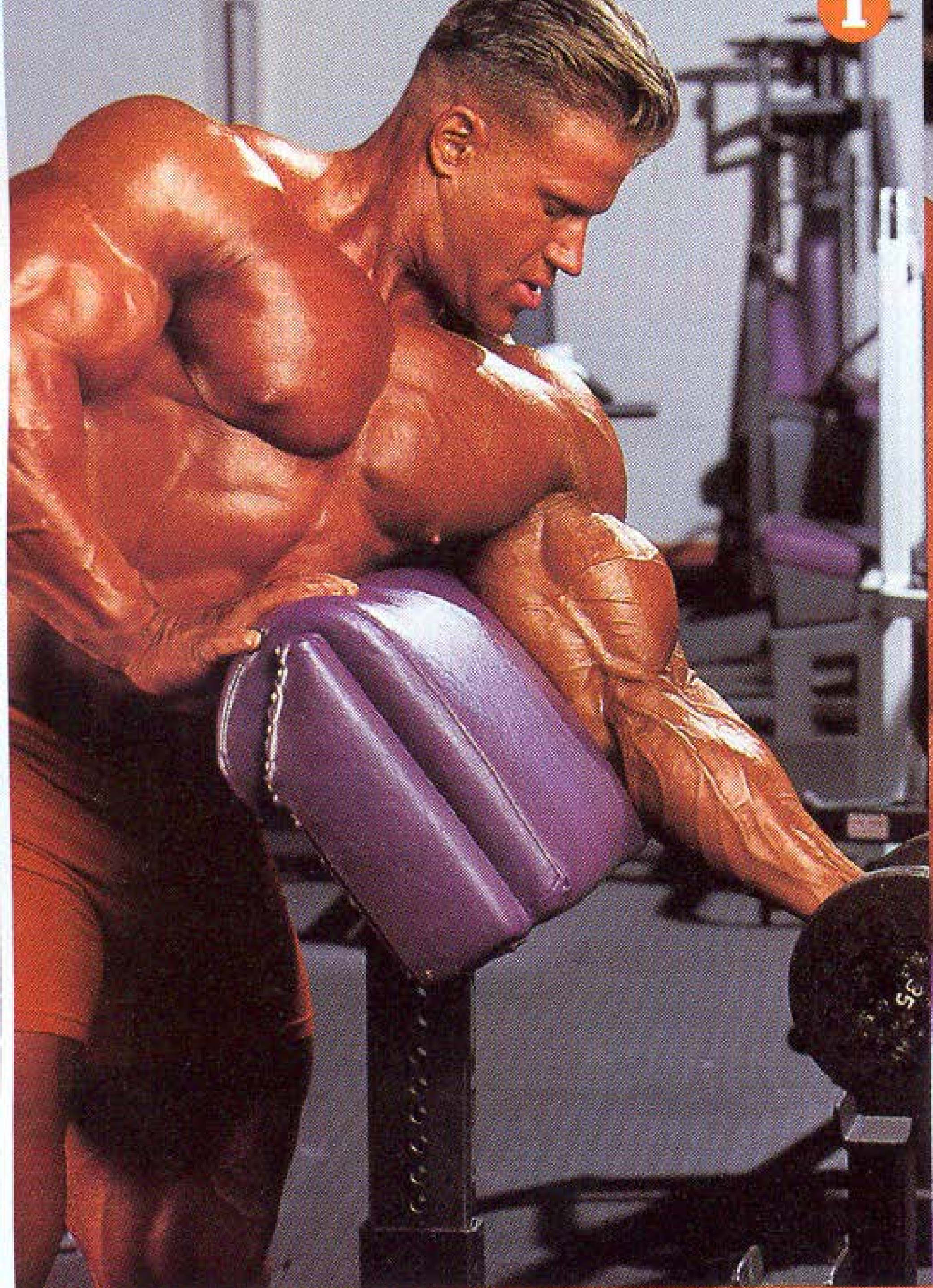


Fig 12.10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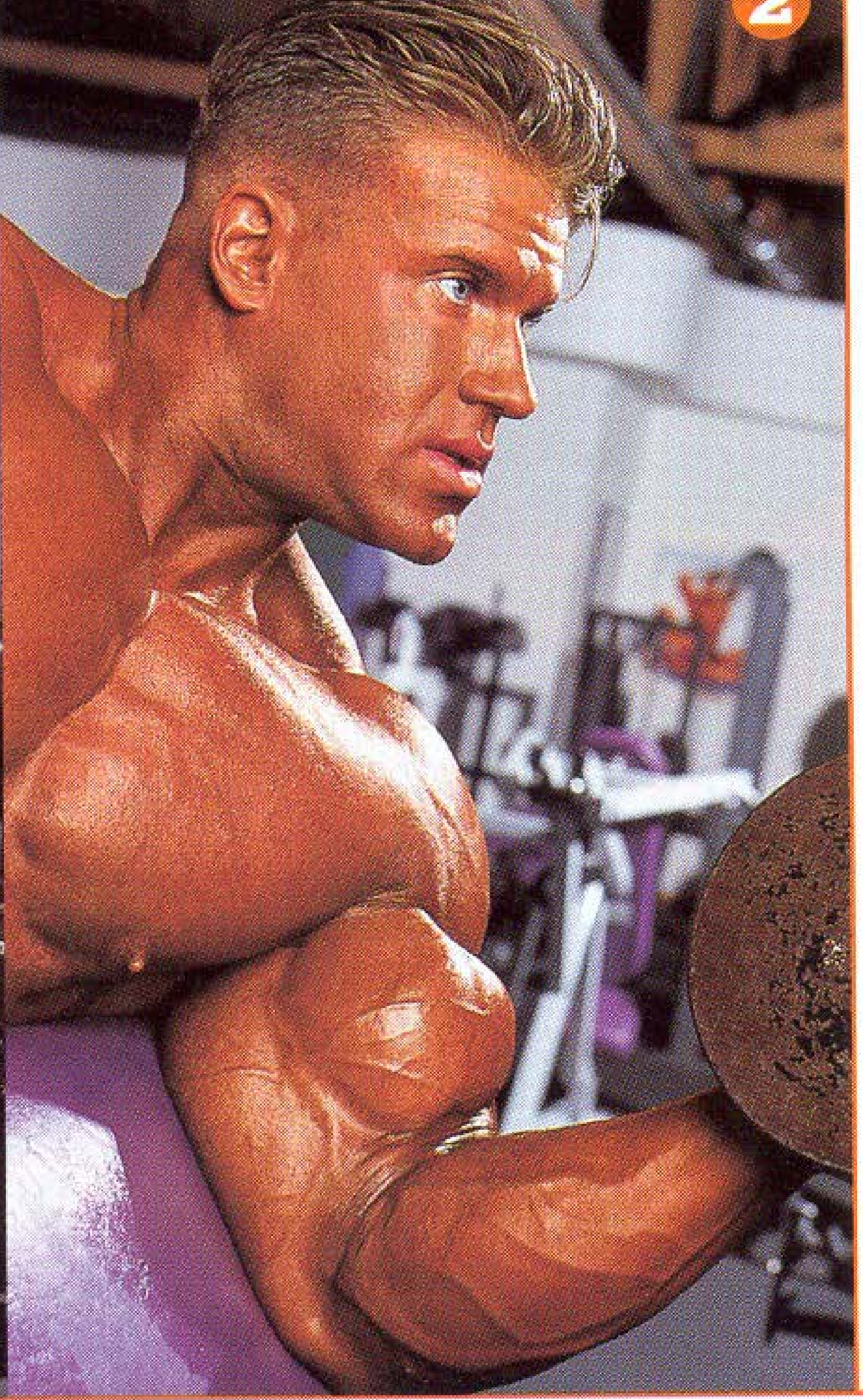
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Free Body Diagram for *Internal* FORCES

- Example human thigh isolated:
  - Weight of thigh (W)
  - Muscle force at Hip (M_H)
  - Reactive Forces
    - Hip (H_x & H_y)
    - Knee (K_x & K_y))

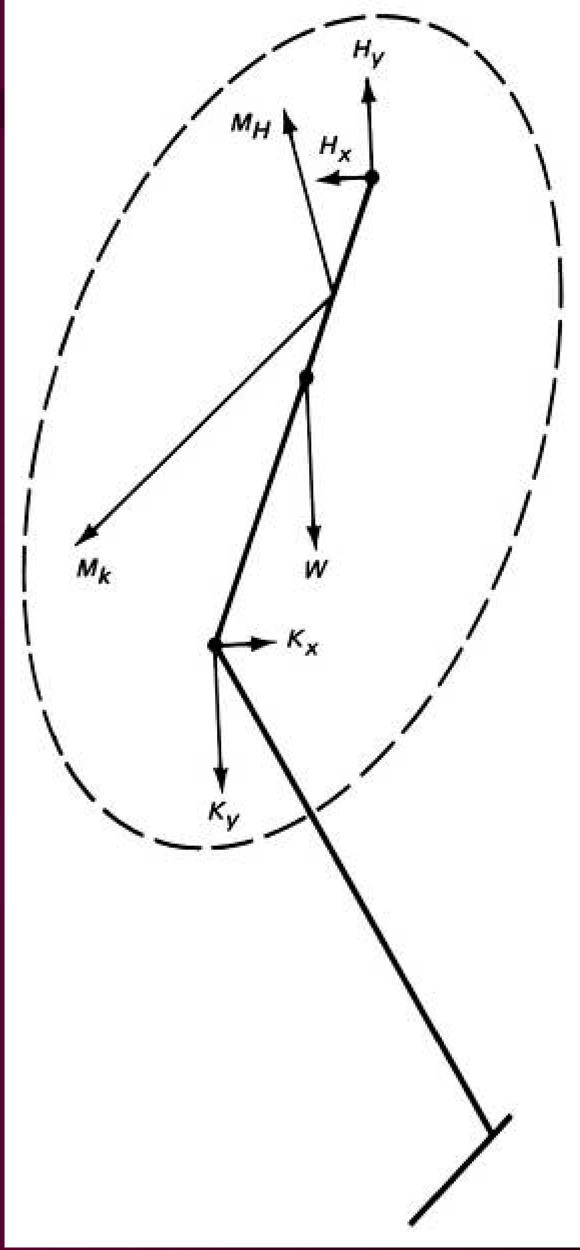
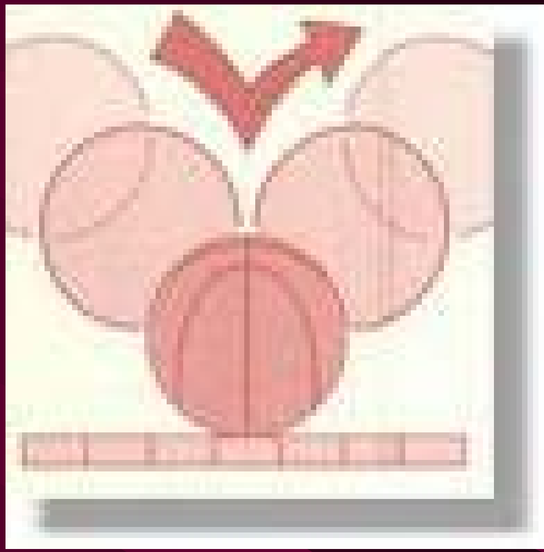


Fig 12.28

Elasticity and Rebound

- Rebound governed by:
  - Elasticity, Mass, Velocity of rebounding object
  - Friction between surfaces
  - Angle of contact

- <u>ELASTICITY</u> is ability to resist distorting influences and return to original size and shape



Elasticity and Rebound

- “STRESS” is the force (per unit area) that acts to distort, and takes the form of:
  - TENSION
  - COMPRESSION
  - BENDING
  - TORSION

- “STRAIN” is the distortion that occurs

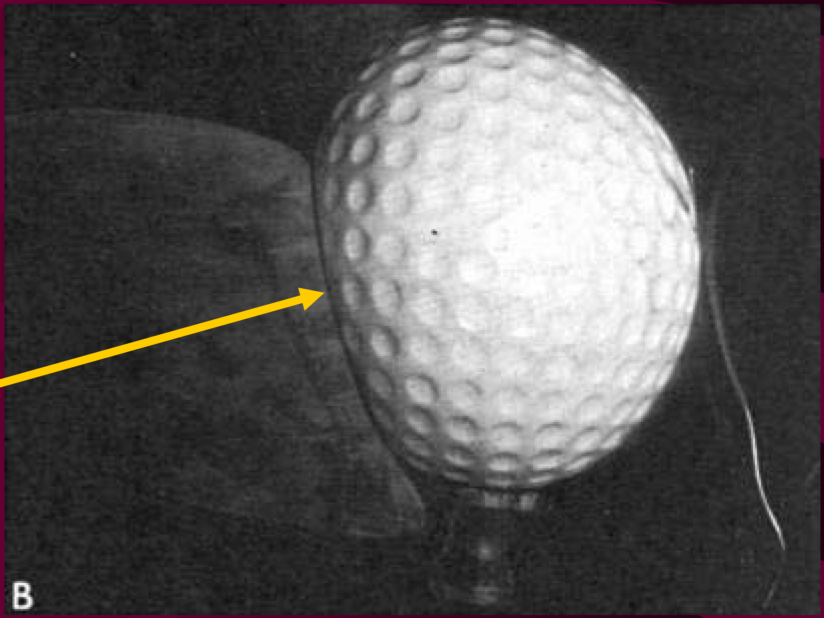
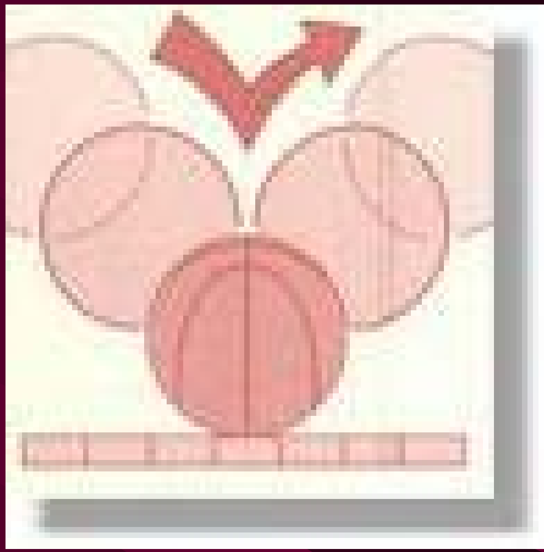


Fig 12.21b

Coefficient of Elasticity

- Defined as stress divided by strain
- Commonly determined in compression of balls by comparing drop height with bounce height:



$$e = \sqrt{\frac{\text{bounce height}}{\text{drop height}}}$$

- The closer to 1.0 the more perfect the elasticity

Angle of Rebound

- For a perfectly elastic object, the angle of incidence (striking) is equal to the angle of reflection (rebound)
- HOWEVER, as coefficient of elasticity varies variations will occur

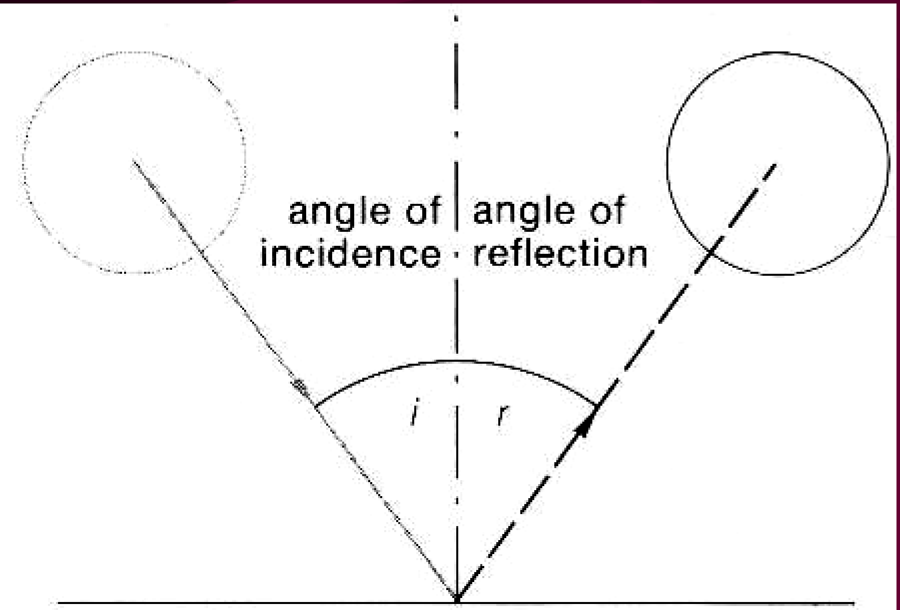


Fig 12.22