
Biomechanics – Chapter C: Muscle Structure & Function (Puzzle Scenarios)

Puzzle 1: The Failed Sit-Up

An intern observes a patient attempting sit-ups. The patient's hip flexors dominate, pulling the trunk without much abdominal contraction.

Question: Which biomechanical principle explains this?

Options:

1. Active insufficiency of rectus abdominis
2. Synergistic dominance of iliopsoas
3. Passive insufficiency of hamstrings
4. Concentric overload of spinal extensors

Answer & Reasoning:

👉 **Option 2.** When abs are weak, **hip flexors act as dominant synergists**, causing trunk pull instead of abdominal curling.

Puzzle 2: The Sprinter's Advantage

A physiotherapy student notes that sprinters have more type II muscle fibers compared to marathoners.

Question: Why is this biomechanically advantageous?

Options:

1. Type II fibers resist fatigue better
2. Type II fibers contract faster with greater force output

3. Type II fibers stabilize joints efficiently

4. Type II fibers optimize posture

Answer & Reasoning:

👉 **Option 2. Fast-twitch (Type II)** fibers allow explosive force and velocity, ideal for sprinting.

Puzzle 3: Limited Finger Flexion

A violinist tries to flex her fingers fully while keeping her wrist flexed. She struggles.

Question: Which biomechanical concept applies?

Options:

1. Active insufficiency of wrist flexors
2. Passive insufficiency of finger extensors
3. Active insufficiency of finger flexors
4. Passive insufficiency of wrist extensors

Answer & Reasoning:

👉 **Option 3.** With the wrist flexed, finger flexors shorten across both joints → **active insufficiency** reduces ability to generate force.

Puzzle 4: The Slow Lunge

A rehab patient performs a slow forward lunge. The physiotherapy intern wonders why eccentric quadriceps control is emphasized.

Options:

1. Eccentric control absorbs shock and decelerates descent
2. Concentric action improves joint stability
3. Isometric action prevents hip movement

4. Passive insufficiency increases quadriceps stretch

Answer & Reasoning:

👉 **Option 1.** Quadriceps contract **eccentrically to control knee flexion** against gravity, ensuring stability and safety.

Puzzle 5: Carrying Groceries

A student carries two heavy bags, arms straight at the sides. The deltoids fatigue faster than expected.

Question: Why?

Options:

1. Spurt action of deltoid in stabilizing shoulder
2. Shunt muscle action requiring endurance
3. Long lever arm of weight increases torque
4. Active insufficiency of rotator cuff muscles

Answer & Reasoning:

👉 **Option 3.** Bags act at the **end of a long lever arm**, increasing torque demand on shoulder stabilizers.

Puzzle 6: Isokinetic Training

In the lab, a student uses an isokinetic dynamometer. The speed is constant regardless of effort.

Question: What is being controlled here?

Options:

1. Muscle torque
2. Angular velocity of movement
3. Muscle length–tension ratio
4. Concentric vs eccentric load

Answer & Reasoning:

👉 **Option 2. Isokinetic exercise controls angular velocity** while allowing variable resistance to match effort.

Puzzle 7: Rising on Toes

A dancer rises on tiptoe repeatedly. The intern analyzes the gastrocnemius and soleus.

Question: Which principle explains their function here?

Options:

1. Gastrocnemius = spurt muscle, Soleus = shunt muscle
2. Soleus = phasic stabilizer, Gastrocnemius = tonic stabilizer
3. Both act concentrically with spurt action
4. Soleus stabilizes, gastrocnemius provides explosive push

Answer & Reasoning:

👉 **Option 4. Soleus (postural, endurance)** stabilizes, while **gastrocnemius (biarticular)** provides explosive propulsion.

Puzzle 8: Pull-Up Bar Strain

During pull-ups, a trainee notices fatigue in elbow flexors before full ROM is reached.

Question: Why does force generation drop in mid-range?

Options:

1. Reduced lever arm
2. Suboptimal length–tension relationship
3. Passive insufficiency of triceps
4. Joint capsule restriction

Answer & Reasoning:

👉 **Option 2.** Muscle force depends on **length–tension**: maximum at mid-range, weaker at extremes. If fatigued early, it indicates inefficiency at that length.