chapter

chapter

10

Biomechanics of Physical Activity

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WHAT IS BIOMECHANICS OF PHYSICAL ACTIVITY?

- Biomechanics applies the mechanical principles of physics and engineering to the motion, structure, and functioning of all living systems.
- Biomechanists ***in the field of physical activity*** study how these principles affect human movement and the structure and function of the human body.

USEFULNESS

- Improve movement techniques
  - Sport performance
  - Locomotion
  - Motor skill acquisition
- Improve equipment
- Prevent injury
- Guide rehabilitation and treatment

WHAT DOES A BIOMECHANIST DO?

- Researcher
- Clinical biomechanist
- Performance enhancement specialist
- Ergonomist (industrial task analysis specialist)
- Human factors engineer
- University professor

(continued)

WHAT DOES A BIOMECHANIST DO? *(CONTINUED)*

- Improve performance in sport and dance
- Reduce or prevent injuries at work, at home, and during exercise and sport tasks
- Improve the movements of people with pathological conditions (clinical settings)
- Increase performers' health with exercise or training regimens
- Assist with the design of equipment, artificial limbs, and orthoses for safety

GOALS OF BIOMECHANICS

- To understand how the basic laws of physics affect and shape the structure and function of the human body
- To apply this understanding to (a) improve the outcomes of our movements (i.e., performance effectiveness) or (b) increase or maintain the safety and health of our tissues

HISTORY OF BIOMECHANICS

Early beginnings:

- Aristotle, Leonardo da Vinci
- Biomechanics applications begin in late 1800s
- Posse and Skarstrom: First use of the term *kinesiology* in the United States
- 1920s and 1930s: Researchers such as Ruth Glassow, Thomas Cureton, and Charles McCloy
- World events shape biomechanics (WW I, WW II, polio, prosthetics, physical therapy)
- 1950s: Anthropometry, human factors design

(continued)

HISTORY OF BIOMECHANICS *(CONTINUED)*

Era of contemporary biomechanics

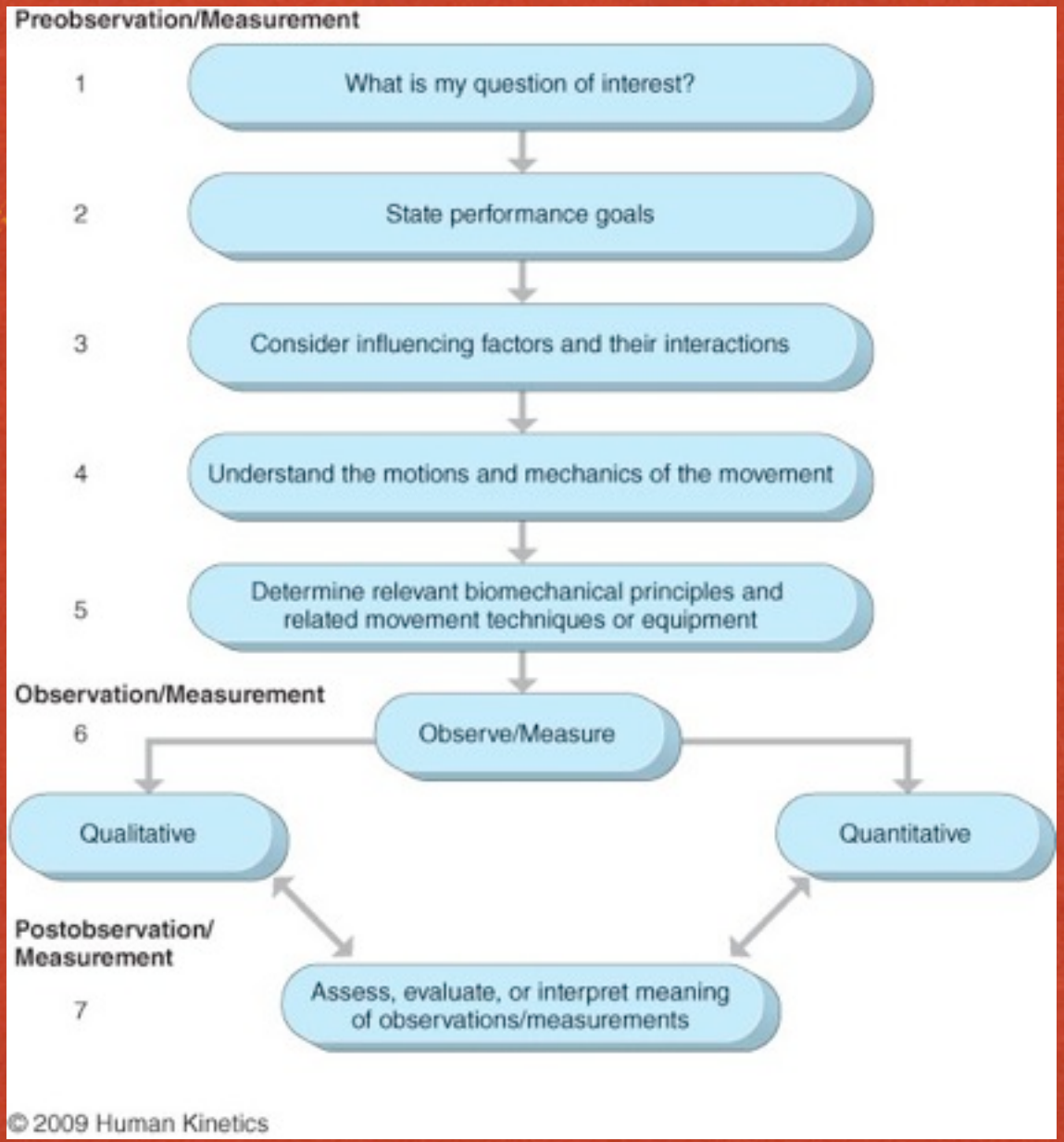
- 1960s: Conferences, organizations, graduate-level programs, Kinesiology Section (1965)
- 1970s: Rapid expansion, sports medicine, dance kinesiology (biomechanics)
- Late 20th century: Continued expansion of university programs and organizations, switch from the term *kinesiology* to *biomechanics* to identify this subdiscipline

RESEARCH METHODS IN BIOMECHANICS

Model of Analysis: Systematic Process

1. Identify the question.
2. State performance goals.
3. Consider influencing factors.
4. Understand motions and mechanics.
5. Determine relevant biomechanical principles and movement techniques.
6. Observe or measure.
7. What does it all mean? Assessment, evaluation, and interpretation: quantitative and qualitative.

FIGURE 10.2


Preobservation/Measurement
1
What is my question of interest?
2
State performance goals
3
Consider influencing factors and their interactions
4
Understand the motions and mechanics of the movement
5
Determine relevant biomechanical principles and related movement techniques or equipment
Observation/Measurement
6
Observe/Measure
Qualitative
Quantitative
Postobservation/ Measurement
7
Assess, evaluate, or interpret meaning of observations/measurements
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BIOMECHANICAL INSTRUMENTATION AND OTHER TOOLS

- **Stopwatches, metronomes, protractors, barbells, and free weights**
- **Computer simulations**
- **Motion measurement devices: video, light-emitting diodes (LED)**
- **Force measurement devices:**
  - Transducers, platforms
  - EMG

FIGURE 10.3

OVERVIEW OF KNOWLEDGE IN BIOMECHANICS OF PHYSICAL ACTIVITY

- How do external forces (gravity, ground reaction forces, friction, fluid resistance) act on performers?
- How do internal forces act on performers?
- How do biomechanical laws of nature shape our movements?
  - Law of inertia
  - Law of action–reaction
  - Torque or moment
  - Propulsive forces and fluid forces

(continued)

OVERVIEW OF KNOWLEDGE IN BIOMECHANICS OF PHYSICAL ACTIVITY *(CONTINUED)*

Assessment and evaluation of performers: biomechanical profiles

- Profiles and performance assessment in physical activities
- Profiles and clinical assessment

FIGURE 10.4

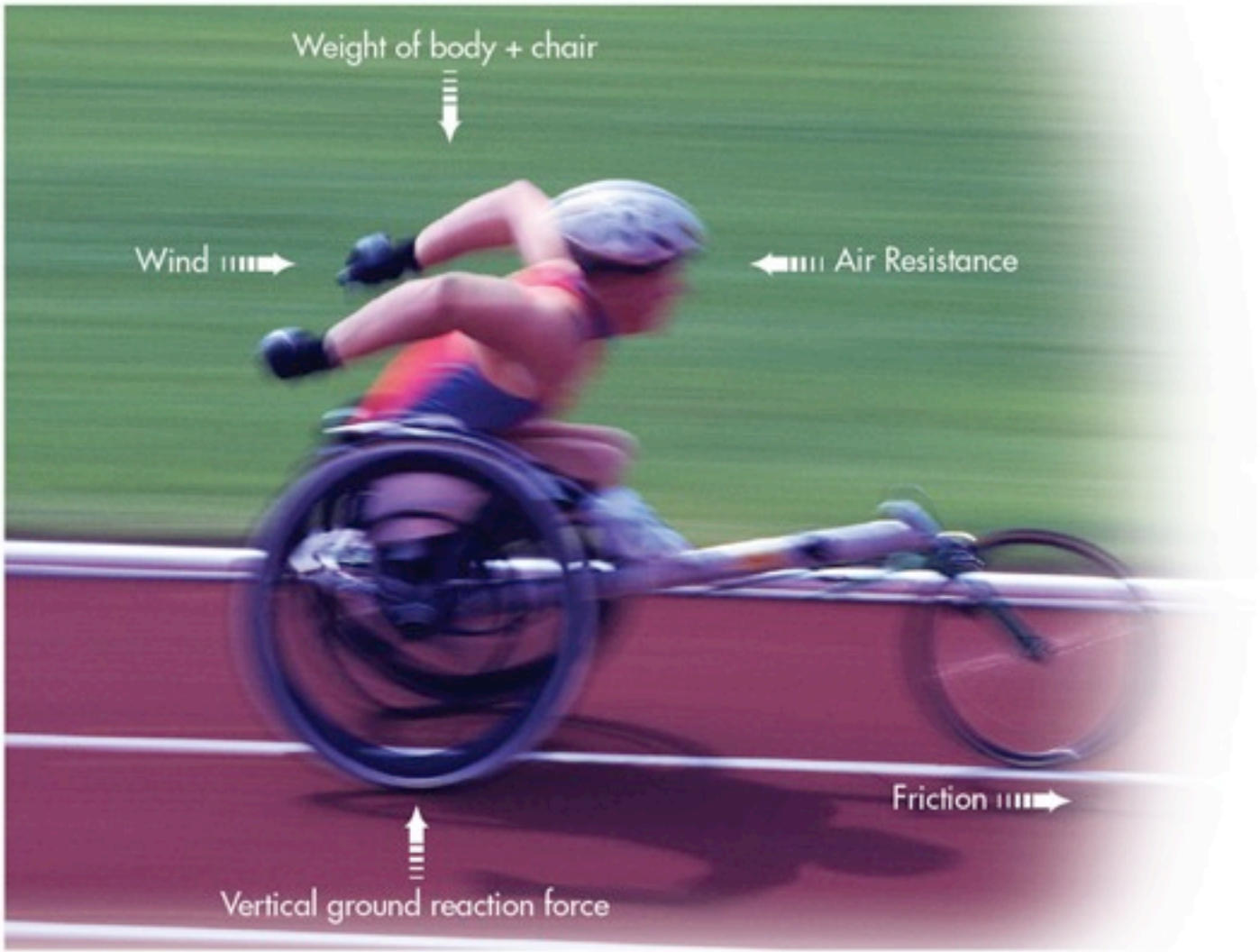


FIGURE 10.5

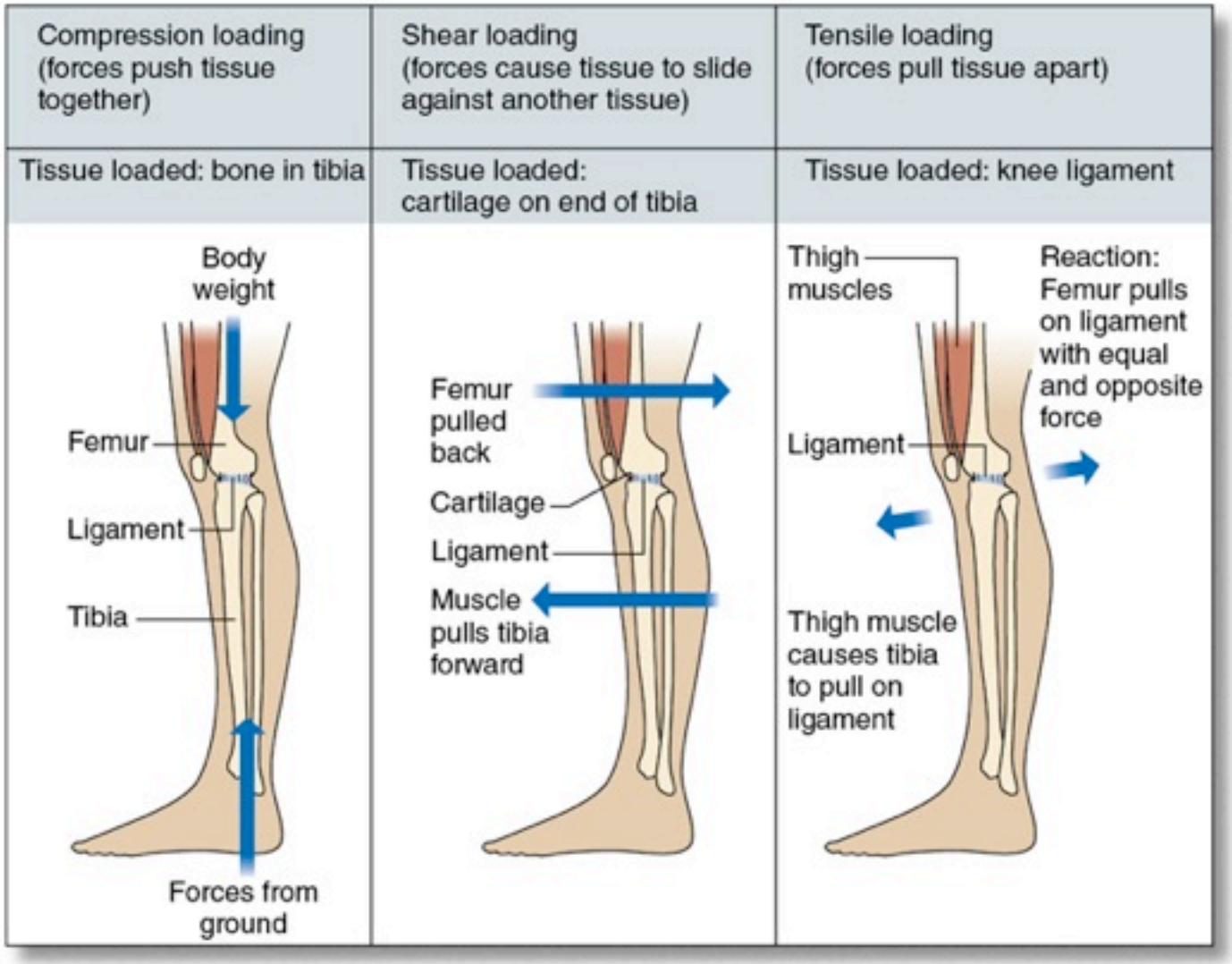


FIGURE 10.6

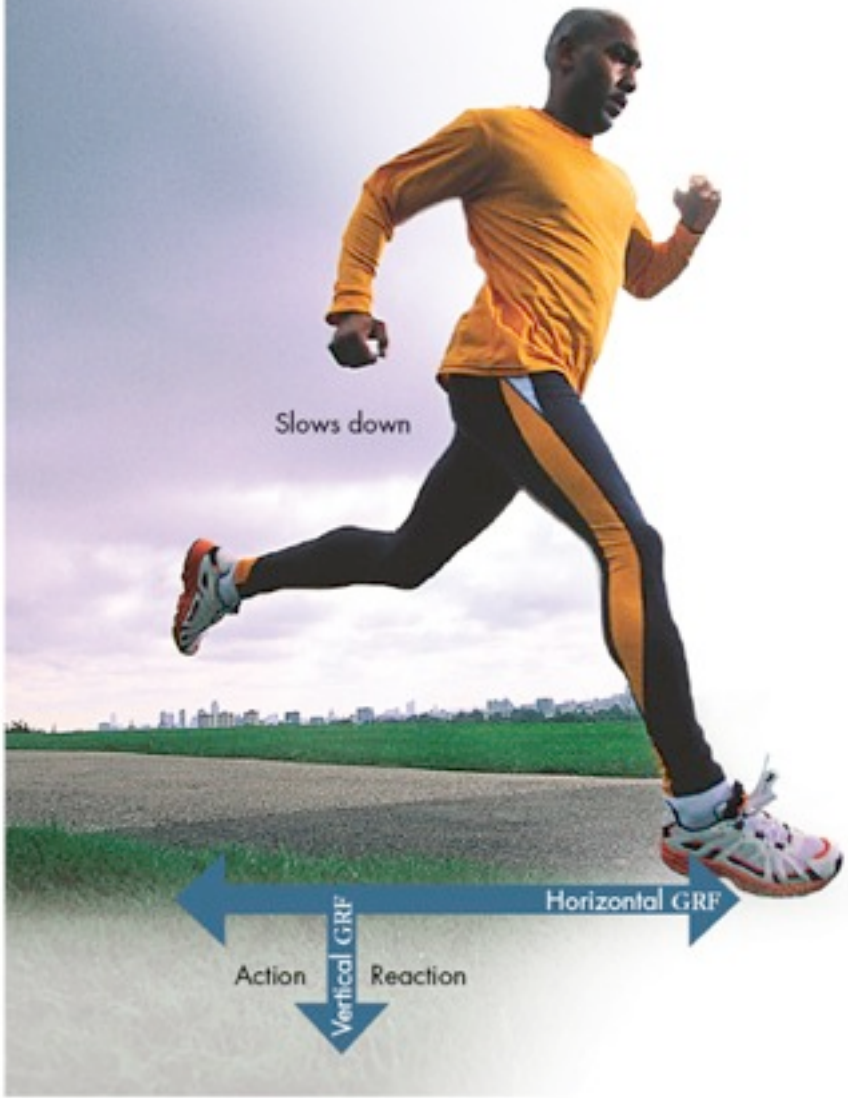
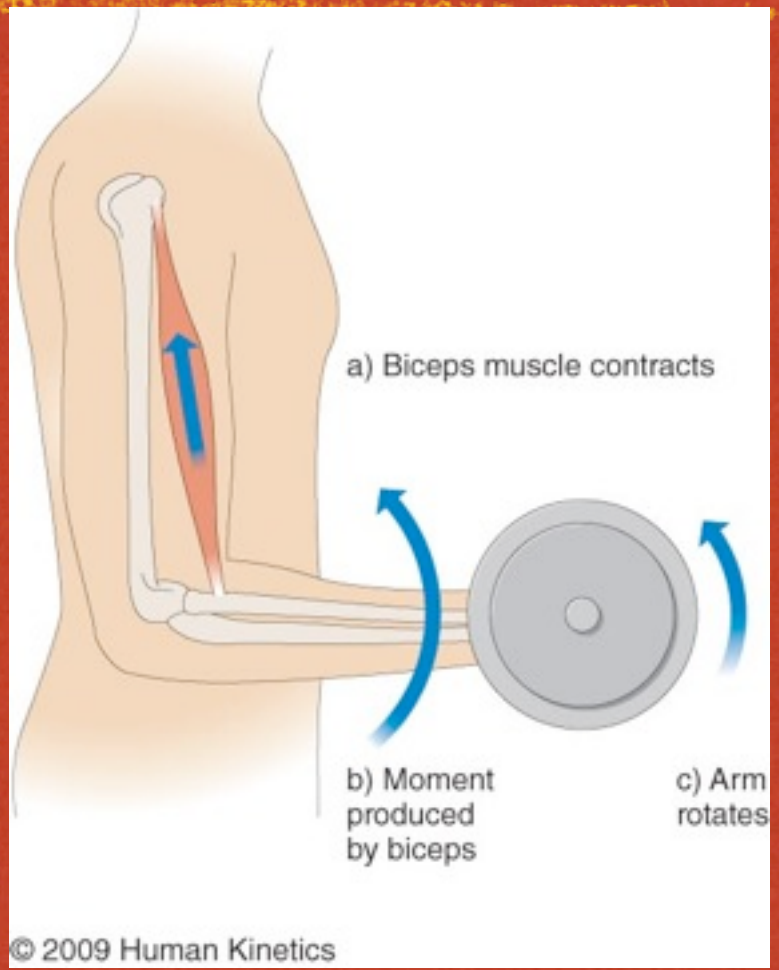


FIGURE 10.7


a) Biceps muscle contracts
b) Moment produced by biceps
c) Arm rotates
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ASSESSMENT AND EVALUATION OF PERFORMERS

- Biomechanical profiles
  - Performer-related characteristics
  - Group of individuals
  - Between groups
- Profiles and clinical assessment

ARE IMPACT FORCES BAD FOR YOU?

- Ground reaction forces (GRFs) contribute to injuries.
- Bone adaptations to GRFs
  - Occurs during dynamic (not static) loading
  - Only short duration needed
  - Routine loading unlikely to stimulate bone adaptations
- Footwear
- Training errors: type, duration, intensity

MECHANICAL PRINCIPLES

An important skill for a physical activity specialist, biomechanist, or allied health rehabilitative specialist is to be able to choose the relevant mechanical principles that apply to the movement of interest or to a phenomenon occurring inside the body.

BIOMECHANICS OF PHYSICAL ACTIVITY

- Related to laws of nature applied in sport and physical activity
- Closely related to mechanical physics; biology; mechanical, biological, and medical engineering; and other areas
- Important to all kinesiology professionals (physical educators for teaching motor skills, coaches for improving sport performance, physical therapists for guiding rehabilitation, fitness instructors for providing proper instruction and making equipment choices)

CONCLUSION

- Humans are not just objects that act passively when a force acts on them. Consequently, human movements are altered both consciously and subconsciously as a result of:
  - Sensory input, along with perceptions (for example, runners unconsciously hit the ground with less force when they perceive that the ground has become harder)
  - personal movement experiences; and
  - interactions among factors such as cultural expectations, socioeconomic class, gender, and anatomy.
- Biomechanics can help one predict what changes will or should be made to improve performance