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**ANSWERS FOR THE REVIEW QUESTIONS OF FUNDAMENTALS
OF BIOMECHANICS BOOK**

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CHAPTER ONE

1. REVIEW QUESTIONS

1. What is biomechanics and how is it different from the two common meanings of kinesiology?

Answer= Biomechanics is the study of how living things move using the science of mechanics. In the first half of the twentieth century this was synonymous with kinesiology, but now kinesiology is the academic discipline of the study of human movement

2. Biomechanical knowledge is useful for solving what kinds of problems?

Answer= Biomechanics knowledge solves human movement problems.

Specially in related to injury prevention and improving fitness

3. What are the advantages and disadvantages of a qualitative biomechanical analysis?

Answer= the advantages of qualitative biomechanical analysis is its ease of use and flexibility, but its weaknesses are related to subjectivity and reliability.

Quantitative biomechanical analysis may have greater precision and accuracy, but its weaknesses are the high cost in terms of equipment and time.

4. What are the advantages and disadvantages of a qualitative biomechanical analysis?

Answer= quantitative biomechanical analysis have greater precision and accuracy, but its weaknesses are the high cost in terms of equipment and time.

5. What kinds of journals publish biomechanics research?

Answer= A wide variety of journals publish biomechanics research. These journals include specialized biomechanics, engineering, biology, medicine, strength and conditioning, and sports-medicine journals.

6. What is the difference between knowledge and information?

Answer= Knowledge is contextual, theory-based, and data-supported ideas that make the best current explanation for reality.

Information is merely access to opinions or data, with no implied degree of accuracy.

The most important difference between information and knowledge is

- Information has a much higher chance of being incorrect than knowledge.
- Information is merely access to opinions or data, with no implied degree of accuracy.
- Information is also much easier to access in the age of the Internet and wireless communications.
- This distinction is clearer as you look at the hierarchy of the kinds of sources used for scholarly research and a simple strategy for the valuation of the quality of a source.

7. Why should biomechanical knowledge be integrated with other sport and exercise sciences in solving human movement problems?

Answer= Biomechanics must be integrated with other kinesiology sciences because people are not robots that move without regard to environmental factors. Psychological, physiological, and perceptual issues are all examples of factors that might be more important than biomechanical factors in some situations.

CHAPTER TWO

2. REVIEW QUESTIONS

1. What are major branches of mechanics, and which are most commonly used in performing biomechanical analyses of human movement?

Answer= Biomechanics has traditionally focused on rigid body and fluid mechanics. The majority of early biomechanical studies focused on the kinematics of movement, but there are still many studies on the causes (kinetics) of movement.

2. What are the specific foci of kinematic and kinetic analyses, and provide some examples?

Answer= Kinematics is motion description. In kinematics the motions of objects are usually measured in linear (meters, feet, etc.) or angular (radians, degrees, etc.) terms. Examples of the kinematics of running could be the speed of the athlete, the length of the stride, or the angular velocity of hip extension.

Kinetics is concerned with determining the causes of motion. Examples of kinetic variables in running are the forces between the feet and the ground or the forces of air resistance.

3. How are vector variables different from scalar variables?

Answer= Scalars only require knowledge of size and units.

Vector variables require knowledge of size, units, and direction.

4. How is a scientific principle different from a law?

Answer= Scientific principle is working tool of theory based of science event. It is also to mean the guiding tool of any science philosophy.

Whereas law is ultimate governing law proved through so many scientific experiment. Although the law is universal it works in specific condition.

5. The nine principles of biomechanics can be classified into which two areas of interest?

Answer= the nine principles of biomechanics can be subdivided into principles related to human movement and projectiles.

6. What are the nine principles of biomechanics?

Answer=

- a. force-motion
- b. force-time
- c. inertia
- d. range of motion
- e. segmental interaction principle
- f. coordination continuum principle
- g. balance
- h. optimal projectile motion



i. spin

7. What are some other factors that affect human movement and the application of the principles of biomechanics?

Answer= Many factors affect human movement along with the principles of biomechanics. Some factors might be performer characteristics (psychological, perceptual, or social), the physical environment, the goal of the movement, and the philosophical goals of the kinesiology professional.

8. List as many reasons as possible for the apparent theory-to-practice gap between scholars and practitioners.

Answer=

- some scholars might be concerned about receiving less recognition for applied scholarship
- some scholars are hesitant to propose application based on what is often less than conclusive data
- Practitioners refuse to recognize the theoretical nature of science, by not reading widely to compile the necessary evidence for practice

CHAPTER THREE

3. REVIEW QUESTIONS

1. What are the major anatomical terms used in kinesiology and medicine to describe the position and motion of the body?

Answer=

There are several anatomical terms employed to describe the location and mosuperiortion of body structures. Some examples include:

- Directions= (anterior/posterior, medial/lateral, superior/inferior, proximal/distal) and
- Joint movements =(flexion/extension, adduction/abduction, internal rotation/external rotation).

2. What structural and functional properties of muscle cells are different from other body cells?

Answer=

Structural difference of muscle

- a. Muscles differ in the arrangement of their myofilaments. The principal types of muscles are striated muscle, in which the filaments are organized in transverse bands as in
- b. Muscles differ in the stimuli required to activate them. In vertebrates, voluntary muscles require action potentials (electrical signals) in their nerves to initiate every contraction
- c. Muscles differ in the manner in which their forces are controlled. Most of the fibres in the voluntary muscles of mammals can only be switched on or off, and different degrees of force are obtained by activating different numbers of fibres.

Functional: muscle uses to movement using the contraction and relaxation principle.

- It also differ from other cell by which it manage its ATP energy.
- Uses for movement by relaxation and contraction

3. How do fiber properties and arrangement affect force and range-of-motion potential of a muscle?

Answer= Muscle fiber types and their architectural arrangement affect muscle force and range of motion. The rise and decay of muscle tension is greatest in fast-twitch fibers and decreases the greater the oxidative or slow-twitch characteristics of the fiber. Muscle fibers arranged in parallel have greater range of motion but create less force. Pennate fiber arrangements produce greater force but have less range of motion

4. Name and define the three kinds of muscle actions.

Answer=

- the three actions are based on the balance of the forces and torques present at any given instant
- **Isometric action-** results if the torque the activated muscles creates is exactly equal to the torque of the resistance.
- **concentric action-** occurs when the torque the muscle group makes is larger than the torque of a resistance, resulting in muscle shortening

- **eccentric action-** occurs when the torque the muscle group makes is smaller than the torque of a resistance, resulting in muscle lengthening

5. What are the two major sources of muscle tension, and where in the range of motion are they most influential?

Answer= Muscle tension has active and passive components. Passive tension does not appear to play a large role in the middle of the range of motion, but does tend to limit motion when the muscle is stretched near the end of the range of motion.

6. Explain the Hill three-component model of muscle and how the components relate to the sources of muscle tension.

Answer=

a. protein that is an important contributor to the contractile property of muscle and other cells. It exists in two forms: G-actin (monomeric globular actin) and F-actin (polymeric fibrous actin), the form involved in muscle contraction. In muscle, two long strands of beadlike actin molecules are twisted together to form a thin filament, bundles of which alternate and interdigitate with bundles of thick filaments formed of myosin, the most abundant protein found in muscle.,

b. The main constituent of the thick filaments is myosin. Each thick filament is composed of about 250 molecules of myosin. Myosin has two important roles: a structural one, as the building block for the thick filaments, and a functional one, as the catalyst of the breakdown of ATP during contraction and in its interaction with actin as part of the force generator of muscle.

c. tissue that attaches a muscle to other body parts, usually bones. Tendons are the connective tissues that transmit the mechanical force of muscle contraction to the bones; the tendon is firmly connected to muscle fibres at one end and to components of the bone at its other end.

7. What is an example of the Force– Motion Principle in human movement?

Answer= Examples of the force–motion principle can be seen anytime an object changes its state of motion. If a dumbbell reverses direction at the bottom of an arm curl exercise, we can conclude an unbalanced upward force was applied to the dumbbell.

8. Why is the mechanical method of muscle action analysis used in functional anatomy inadequate to determine the actions of muscles in human movement?

Answer=

- a. activation of individual muscles are not representative of all muscles in the same functional group
- descriptions of musculoskeletal anatomy often do not account for variations in muscle attachment sites across individuals
- the linked nature of the human body makes the isolated functional anatomical analysis incomplete
- modeling and simulation:

Modeling; is development of a mathematical representation of the biomechanical system

Simulation; uses biomechanical models to examine how changes in various techniques and parameters affect the movement or body

9. How does biomechanics help kinesiology professionals understand the causes and potential improvement of human movement?

Answer= Biomechanical principles and research help the kinesiology professional to understand how human movement occurs and how movement might be improved. The major areas of biomechanics research that are the most valuable in this area are EMG, studies of anatomical variation, linked segment interactions, and modeling and simulation.

10. What factors should a kinesiologist consider when defining the appropriate range of motion for a particular movement?

Answer= the number of joints, specific anatomical joint rotations, and amount of those rotations to tailor range of motion.

CHAPTER FOUR

4. REVIEW QUESTIONS

1. What are the major kinds of mechanical loads experienced by muscle, tendon, and bone?



Answer= the primary loads on body tissues are compression, tension, and shear. The combined loads are bending and torsion

2. What are the mechanical variables that can be determined from a load-deformation curve, and what do they tell us about the response of a material to loading?

Answer=

- **stress:** it is the measurement of the hardness of a load to change the shape of a material
- **Strain:** it is the measurement of the deformation of a material created by a load.
- **stiffness:** Stiffness or Young's modulus is defined as the ratio of stress to strain in the elastic region of
- the curve, but is often approximated by the ratio of load to deformation (ignoring the change in dimension of the material).

3. Compare and contrast the mechanical strength of muscle, tendon, ligaments and bone. How does this correspond to the incidence of various musculoskeletal injuries?

Answer= The tensile strengths of tendon and muscle are about 14,500 and 60 lb/in², respectively, while the tensile strength of bone is about 18,000 lb/in². These data are consistent with the higher incidence of muscle injuries compared to that for tendon or bone.

4. How does the passive behavior of the muscle tendon unit affect the prescription of stretching exercises?

Answer= the mechanical response of the MTU to passive stretching is viscoelastic, so the response of the tissue depends on the time or rate of stretch. At a high rate of passive stretch the MTU is stiffer than when it is slowly stretched. This is the primary reason why slow, static stretching exercises are Preferred over ballistic stretching techniques. A slow stretch results in less passive tension in the muscle for a given amount of elongation compared to a faster stretch. The load in an MTU during other movement conditions is even more complicated because the load can vary widely with activation, previous muscle action, and kind of muscle action.

5. What are the functional implications of the Force–Velocity Relationship of skeletal muscle for strength training?

Answer= The Force–Velocity Relationship has several implications for resistances and speed of movement in strength-training exercises. When training for muscular strength, large resistances should be moved slowly to train the muscle where it is strongest. Training for muscular power and endurance uses smaller resistances moved at faster speeds.

6. Use the Force–Length Relationship to describe how the active and passive components of muscle tension vary in the range of motion.

Answer=The active component of the Force–Length Relationship curve has a logical association with the potential numbers of cross-bridges between the actin and myosin filaments in the Sliding Filament Theory. Peak muscle force can be generated when there are the most cross-bridges. This happens at the resting length. Potential active muscle tension decreases for shorter or longer muscle lengths because fewer cross-bridges are available for binding. The passive tension increases very slowly near L0 but dramatically increases as the muscle is elongated. Passive muscle tension usually does not contribute to movements in the middle portion of the range of motion, but does contribute to motion when muscles are stretched or in various neuromuscular disorders .

7. Compare and contrast the Force–Time Relationship of muscle with the Force–Time Principle of biomechanics.

Answer= The Force–Time Relationship defines the delay between neuromuscular signaling for creation of muscle force and a rise in that force, while the force–time principle deals with duration of force application. While these two concepts are related, the force–time principle involves adapting the timing of the application of force by a person to the demands of the task while electromechanical delay is one of the factors that affects how force can be applied.

8. When might increasing the time of force application not benefit the development of movement speed and why?

Answer= in movements with high demands on timing accuracy (baseball batting or a tennis forehand), the athlete should not maximize the time of force application because extra speed is of lower importance than temporal accuracy.

9. How does the brain control muscle force and how is muscle fiber type related?

Answer= the brain creates muscle tension by recruitment of motor units and modifying their firing rate or rate coding. Motor units tend to have predominantly



one fiber type, so that the brain generally recruits motor units based on the size principle, from slow-twitch motor units to fast-twitch motor units.

9. What is the stretch-shortening cycle and in what kinds of movements is it most important?

Answer= stretch-shortening cycle is a countermovement away from the intended direction of motion that is slowed down (braked) with eccentric muscle action that is immediately followed by concentric action in the direction of interest.

This strategy is most beneficial in high-effort events and in submaximal movements.

11. What are the two major proprioceptors in muscle that monitor length and force?

Answer= Muscle spindles sense stretch and golgi tendon organs sense muscle tension.

12. How can range of motion in a movement be defined?

Answer= Range of Motion is the overall motion used in a movement and can be specified by linear or angular motion of the body segments

13. Explain how range of motion affects the speed, accuracy and force potential of movement. Give an example of when the Range of Motion Principle is mediated by other mechanical factors.

Answer= Large ranges of motion allow for greater production of speed and force, while smaller ranges of motion tend to allow for more accurate movement. The weight shifts in a golf swing and baseball batting are small because of the high accuracy demands of these skills. Maximizing range of motion in the countermovement in jumps is not usually effective because of timing limitations or biomechanically weak positions in deep knee flexion.

14. What biomechanical properties help contribute to the beneficial effect of continuous passive movement therapy (i.e., the slow, assisted motion of an injured limb) following surgery?

Answer= Stiffness, muscle strength, muscle reinforcement, muscle stretching

15. Write a complete description of a stretching or conditioning exercise. Identify the likely muscle actions and forces contributing to the movement.



Answer= A person doing a seated knee extension exercise uses concentric action of the quadriceps groups to extend the knee, and eccentric action of the quadriceps to flex the knee. The forces acting on the lower leg include muscle forces from the hamstrings, quadriceps, ankle muscles, and gravity. If the person were exercising on a machine there would be forces applied to the leg/ankle from the machine.

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