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BIOMECHANICS

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Biomechanics includes not only the structure of bones and muscles and the movement they can produce, but also the mechanics of blood circulation, renal function, and other body functions. The American Society of Biomechanics says that biomechanics represents the broad interplay between mechanics and biological systems. Biomechanics studies not only the human body but also animals and even extends to plants and the mechanical workings of cells. For example, the biomechanics of the squat includes consideration of the position and/or movement of the feet, hips, knees, back, and shoulders, and arms. Biological fluid mechanics, or biofluid mechanics, is the study of both gas and liquid fluid flows in or around biological organisms. An often studied liquid biofluid problem is that of blood flow in the human cardiovascular system. Under certain mathematical circumstances, blood flow can be modeled by the Navier–Stokes equations. In vivo whole blood is assumed to be an incompressible Newtonian fluid. However, this assumption fails when considering forward flow within arterioles. At the microscopic scale, the effects of individual red blood cells become significant, and whole blood can no longer be modeled as a continuum. When the diameter of the blood vessel is just slightly larger than the diameter of the red blood cell the Fahraeus–Lindquist effect occurs and there is a decrease in wall shear stress. However, as the diameter of the blood vessel decreases further, the red blood cells have to squeeze through the vessel and often can only pass in a single file. In this case, the inverse Fahraeus–Lindquist effect occurs and the wall shear stress increases.

The study of biomechanics ranges from the inner workings of a cell to the movement and development of limbs, to the mechanical properties of soft tissue and bones. Some simple examples of biomechanics research include the investigation of the forces that act on limbs, the aerodynamics of bird and insect flight, the hydrodynamics of swimming in fish, and locomotion in general across all forms of life, from individual cells to whole organisms. With growing understanding of the physiological behavior of living tissues, researchers are able to advance the field of tissue engineering, as well as develop improved treatments for a wide array of pathologies including cancer. Biomechanics is also applied to studying human musculoskeletal systems.

Such research utilizes force platforms to study human ground reaction forces and infrared videography to capture the trajectories of markers attached to the human body to study human 3D motion. Research also applies electromyography to study muscle activation, investigating muscle responses to external forces and perturbations.

The direction of motion can be described in terms of how the movement occurs along the plane and axis. A motion reduces joint angle in the sagittal plane it is called flexion and the "extension" motion increases the joint angle. Other common direction of motion in the sagittal plane are dorsiflexion and planter-flexion. Motion to the extremes of the range of motion is often referred to as "hyper," as is the case with hyperextension, and this also occurs in the sagittal plane. The motion of a segment away from the midline in the frontal plane is called “abduction,” while the movement back toward the midline is called “adduction”. Other direction of motion that is common in this plane includes eversion and inversion. Common motion along the transverse plane is internal rotation and external rotation, pronation and supination are also common motion along the transverse plane. There are other directional terms to help describe the position of the body segment relative to the anatomical position, this includes the superior and inferior, which describes body position towards the head and the feet, respectively. Also anterior and posterior can be used to describe objects related to the body as the front or back direction to the body, respectively. Parts or motion towards the midline of the body are said to be medial, while motion or position towards the sides of the body is lateral. Newton’s law of motion describes the effect of force and motion. The first Newton's law of motion also known as the law of inertia (inertia is the resistance of the body to change its state of motion), states that an object will remain at rest or uniform motion unless an unbalanced net force act on it. The concept in Newton’s law of inertia shows that the higher the mass of an object the higher the force to move it. For example, to wheel an endomorph man (someone with a high percentage of body fat) on a wheelchair will require a greater amount of force than to wheel an ectomorph (slender) man. Another area in which the first law of motion is applied is in the static analysis. Static analysis is an engineering method for the analysis of forces and moments produced when objects interact. This concept is applied in biomechanics for estimation of unknown forces of muscle and joint reaction in the musculoskeletal system.

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