

# Chapter 1

## A Systematic Survey of the Realm of Biomechanics: A Mechanical Engineer's Perspective

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### ABSTRACT

*The area of biomechanics is challenging and broad as it involves multidisciplinary concepts of engineering together with functional knowledge of biosciences. The area is rapidly evolving and new additions to it are being made daily. A survey that may help a beginner to have a general look on the broader aspects of the sub-domains of biomechanics is not available. The chapter aims to overview the realm of biomechanics and provide an introduction to various areas with mention to researches carried out. A broad survey of various areas of biomechanics from a mechanical engineer's perspective is reported in this chapter. Prominent areas like biomechanics of human motion; bone and joint biomechanics; biomechanics of spine; biomechanics of head, shoulder, and muscles; biomechanical analysis of heart and lungs; biomechanical analysis of arteries and veins; and MEMS in biomechanics are explored. Though it is difficult to include all the developments relevant to the above areas, the authors have focused primarily on a few prominent studies made in the last two decades in various domains.*

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## **INTRODUCTION**

Biomechanics involves the study of living organisms and processes relevant to human body with an engineer's perspective. This means the physical, anatomical and other functional characteristics of human body are studied under the umbrella of engineering concepts, for example-the concepts of engineering mechanics in the study of motion of human beings (especially for athletes), flow properties of blood using fluid dynamics and many more. Statics, dynamics, kinematics and kinetics of biological systems are used to study their response to mechanical forces. The studies relevant to biological systems has been an area of interest for researchers since medieval era but it has gained considerable attention in 20<sup>th</sup> century, and the specialist area of bio-medical engineering has evolved. Till the last decade of 20<sup>th</sup> century the studies of biomechanics were mainly focused on researches of simulations of cardiac, respiratory and/or skeletal systems as a whole; but with the rapid advancement in computational capabilities, the modeling of basic biological entities like tissues, cells etc. is possible in today's era; thus accuracy of prediction related to functioning of biological systems has improved considerably. The need for development of devices that work on micro- or nano- levels and compatible to biological processes is more pertinent.

The area of biomechanics is very challenging and broad as it involves multidisciplinary concepts of engineering sciences together with functional knowledge of biosciences, to provide necessary solutions. The non-linearity associated with biological systems make the problems too complex, further adding to the difficulties. In spite of the tremendous challenges, there is rapid advancement in the field of biomechanics research as a result of which a number of reports/ findings on the biomechanical processes are published as journal papers and textbooks of repute. Due to the large volume of literature relevant to various areas of biomechanics, it is very difficult to include or summarize all the developments, the present report highlights some of the prominent researches made in the last two decades. The contents are arranged such that the study is classified into seven sections; each section focuses primarily on a particular system- biomechanics of i) human motion, ii) bone, joint and muscle, iii) spine, iv) head, neck and shoulder, v) heart and lungs, vi) arteries and veins, vii) MEMS in biomechanics. As such the following report will greatly help a beginner to – a) know the basic terminologies associated, b) relate the biological processes with engineering concepts and c) the latest findings in the area.

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