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In this marvelously surprising, witty book, Steven Vogel compares these two mechanical worlds, introduces the reader to his field of biomechanics, and explains how the nexus of physical law, size, and convenience of construction determine the designs of both people and nature.

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**Cats Paws And Catapults Mechanical Worlds Of Nature And People**  
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Examines the workings of nature's mechanical designs and man's technology and compares the design similarities and differences of both human and natural technologies.

"Full of ideas and well-explained principles that will bring new understanding of everyday things to both scientists and non-scientists alike."R. McNeill Alexander, Nature Nature and humans build their devices with the same earthly materials and use them in the same air and water, pulled by the same gravity. Why, then, do their designs diverge so sharply? Humans, for instance, love right angles, while nature's angles are rarely right and usually rounded. Our technology goes around on wheels and on rotating pulleys, gears, shafts, and cams, yet in nature only the tiny propellers of bacteria spin as true wheels. Our hinges turn because hard parts slide around each other, whereas nature's hinges (a rabbit's ear, for example) more often swing by bending flexible materials. In this marvelously surprising, witty book, Steven Vogel compares these two mechanical worlds, introduces the reader to his field of biomechanics, and explains how the nexus of physical law, size, and convenience of construction determine the designs of both people and nature. "This elegant comparison of human and biological technology will forever change the way you look at each."Michael LaBarbera, American Scientist

The classic textbook on comparative biomechanics, revised and expanded Why do you switch from walking to running at a specific speed? Why do tall trees rarely blow over in high winds? And why does a spore ejected into air at seventy miles per hour travel only a fraction of an inch? Comparative Biomechanics is the first and only textbook that takes a comprehensive look at the mechanical aspects of life/covering animals and plants, structure and movement, and solids and fluids. An ideal entry point into the ways living creatures interact with their immediate physical world, this revised and updated edition examines how the forms and activities of animals and plants reflect the materials available to nature, considers rules for fluid flow and structural design, and explores how organisms contend with environmental forces. Drawing on physics and mechanical engineering, Steven Vogel looks at how animals swim and fly, modes of terrestrial locomotion, organism responses to winds and water currents, circulatory and suspension-feeding systems, and the relationship between size and mechanical design. He also investigates links between the properties of biological materials/such as spider silk, jellyfish jelly, and muscle/and their structural and functional roles. Early chapters and appendices introduce relevant physical variables for quantification, and problem sets are provided at the end of each chapter. Comparative Biomechanics is useful for physical scientists and engineers seeking a guide to state-of-the-art biomechanics. For a wider audience, the textbook establishes the basic biological context for applied areas/including ergonomics, orthopedics, mechanical prosthetics, kinesiology, sports medicine, and biomimetics/and provides materials for exhibit designers at science museums. Problem sets at the ends of chapters Appendices cover basic background information Updated and expanded documentation and materials Revised figures and text Increased coverage of friction, viscoelastic materials, surface tension, diverse modes of locomotion, and biomimetics

This entertaining and informative book describes how living things bump up against non-biological reality. "My immodest aim," says the author, "is to change how you view your immediate surroundings." He asks us to wonder about the design of plants and animals around us: why a fish swims more rapidly than a duck can paddle, why healthy trees more commonly uproot than break, how a shark manages with such a flimsy skeleton, or how a mouse can easily survive a fall onto any surface from any height. The book will not only fascinate the general reader but will also serve as an introductory survey of biomechanics. On one hand, organisms cannot alter the earth's gravity, the properties of water, the compressibility of air, or the behavior of diffusing molecules. On the other, such physical factors form both constraints with which the evolutionary process must contend and opportunities upon which it might capitalize. Life's Devices includes examples from every major group of animals and plants, with references to recent work, with illustrative problems, and with suggestions of experiments that need only common household materials.

This book is a fascinating, often witty, and highly original guide to the heart, vessels and blood, with side trips into the neighboring fields of physics, fluid mechanics, and chemistry.

The wave of the future has been around since the beginning of times: it's called Nature. Let inventor and entrepreneur Jay Harman introduce you to stunning solutions to some of the world's thorniest problems. Why does the bumblebee have better aerodynamics than a 747? How can copying a butterfly wing reduce the world's lighting energy bill by 80%? How will fleas' knees and bees' shoulders help scientists formulate a near-perfect rubber? Today an interdisciplinary and international group of scientists, inventors and engineers is turning to nature to innovate and find elegant solutions to human problems. The principle driving this transformation is called biomimicry, and Harman shares a wide range of examples of how we're borrowing from natural models to invent profitable, green solutions to pressing industrial challenges. Aimed at a business audience, aspiring entrepreneurs, environmentalists and general science readers, The Shark's Paintbrush reflects a force of change in the new global economy that does more than simply gratify human industrial ambition; it teaches us how to live in harmony with nature and opens bright opportunities for a better future.

There is no part of our bodies that fully rotates: be it a wrist or ankle or arm in a shoulder socket, we are made to twist only so far. And yet there is no more fundamental human invention than the wheel: a rotational mechanism that accomplishes what our physical form cannot. Throughout history, humans have developed technologies powered by human strength, complementing the physical abilities we have while overcoming our weaknesses. Providing a unique history of the wheel and other rotational devices/like cranks, cranes, carts, and capstans/Why the Wheel Is Round examines the contraptions and tricks we have devised in order to more efficiently move/and move through/the physical world. Steven Vogel combines his engineering expertise with his remarkable curiosity about how things work to explore how wheels and other mechanisms were, until very recently, powered by the push and pull of the muscles and skeletal systems of humans and other animals. Why the Wheel Is Round explores all manner of treadwheels, hand-spikes, gears, and more, as well as how these technologies diversified into such things as hand-held drills and hardy-gurdies. Surprisingly, a number of these devices can be built out of everyday components and materials, and Vogel's accessible and expansive book includes instructions and models so that inspired readers can even attempt to make their own muscle-powered technologies, like trebuchets and ballista. Appealing to anyone fascinated by the history of mechanics and technology as well as to hobbyists with home workshops, Why the Wheel Is Round offers a captivating exploration of our common technological heritage based on the simple concept of rotation. From our leg muscles powering the gears of a bicycle to our hands manipulating a mouse on a roller ball, it will be impossible to overlook the amazing feats of innovation behind our daily devices.

In its essence, science is a way of looking at and thinking about the world. In The Life of a Leaf, Steven Vogel illuminates this approach, using the humble leaf as a model. Whether plant or person, every organism must contend with its immediate physical environment, a world that both limits what organisms can do and offers innumerable opportunities for evolving fascinating ways of challenging those limits. Here, Vogel explains these interactions, examining through the example of the leaf the extraordinary designs that enable life to adapt to its physical world. In Vogel's account, the leaf serves as a biological everyman, an ordinary and ubiquitous living thing that nonetheless speaks volumes about our environment as well as its own. Thus in exploring the leaf's world, Vogel simultaneously explores our own. A companion website with demonstrations and teaching tools can be found here: <http://www.press.uchicago.edu/sites/vogel/index.html>

Reveals how recurring patterns in nature are accounted for by a single governing principle of physics, explaining how all designs in the world from biological life to inanimate systems evolve in a sequence of ever-improving designs that facilitate flow.

Nature's Machines: An Introduction to Organismal Biomechanics presents the fundamental principles of biomechanics in a concise, accessible way while maintaining necessary rigor. It covers the central principles of whole-organism biomechanics as they apply across the animal and plant kingdoms, featuring brief, tightly-focused coverage that does for biologists what H. M. Frost's 1967 Introduction to Biomechanics did for physicians. Frequently encountered, basic concepts such as stress and strain, Young's modulus, force coefficients, viscosity, and Reynolds number are introduced in early chapters in a self-contained format, making them quickly available for learning and as a refresher. More sophisticated, integrative concepts such as viscoelasticity or properties of hydrostats are covered in the later chapters, where they draw on information from multiple earlier sections of the book. Animal and plant biomechanics is now a common research area widely acknowledged by organismal biologists to have broad relevance. Most of the day-to-day activities of an animal involve mechanical processes, and to the extent that organisms are shaped by adaptive evolution, many of those adaptations are constrained and channelized by mechanical properties. The similarity in body shape of a porpoise and a tuna is no coincidence. Many may feel that they have an intuitive understanding of many of the mechanical processes that affect animals and plants, but careful biomechanical analyses often yield counterintuitive results: soft, squishy kelp may be better at withstanding pounding waves during storms than hard-shelled mollusks; really small swimmers might benefit from being spherical rather than streamlined; our bones can operate without breaking for decades, whereas steel surgical implants exhibit fatigue failures in a few months if not fully supported by bone. Offers organismal biologists and biologists in other areas a background in biomechanics to better understand the research literature and to explore the possibility of using biomechanics approaches in their own work Provides an introductory presentation of the everyday mechanical challenges faced by animals and plants Functions as recommended or required reading for advanced undergraduate biology majors taking courses in biomechanics, supplemental reading in a general organismal biology course, or background reading for a biomechanics seminar course

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