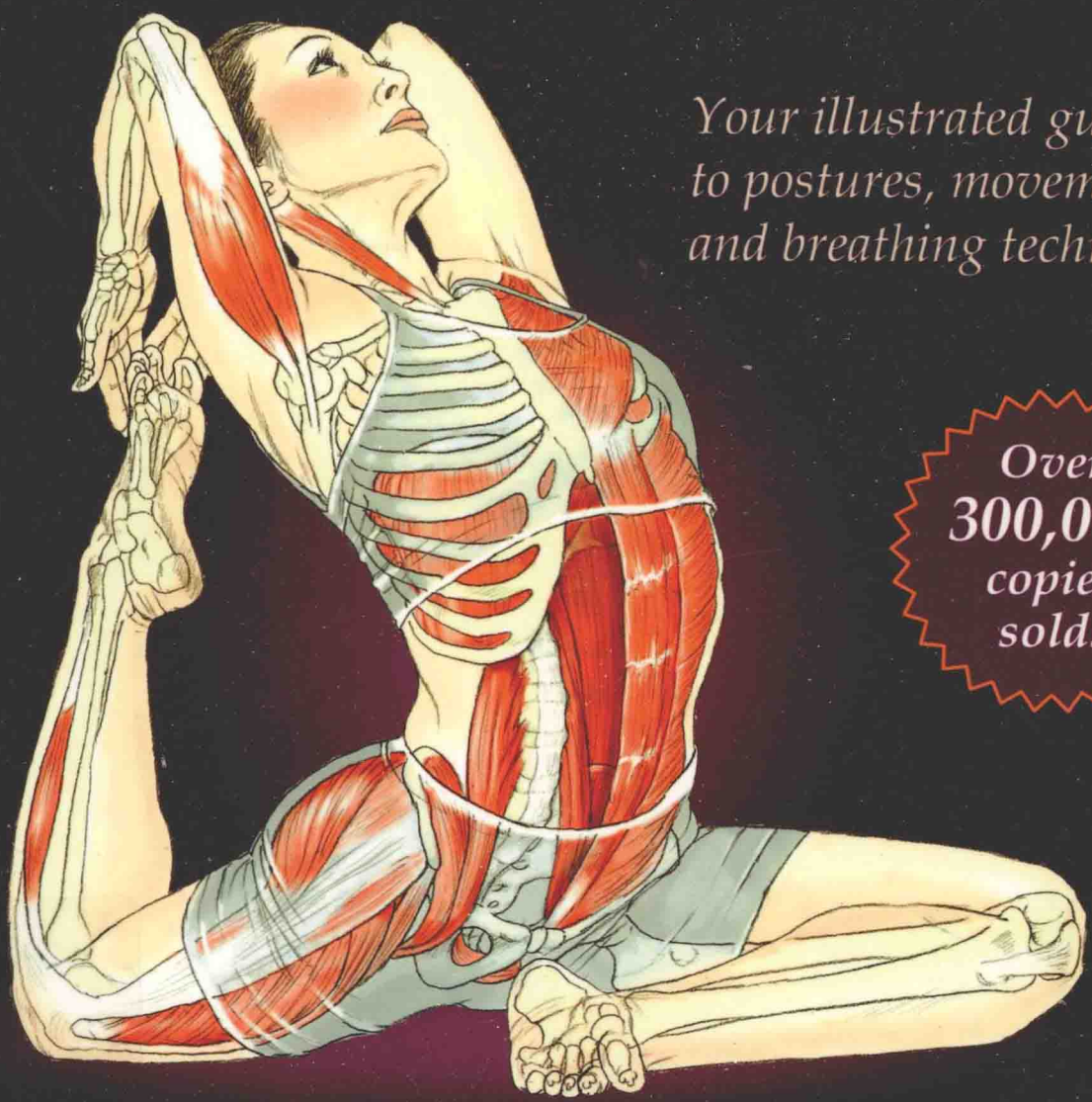
SECOND EDITION

YOGA Anatomy

LESLIE KAMINOFF
AMY MATTHEWS



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Leslie Kaminoff
Amy Matthews
Illustrated by
Sharon Ellis

Human Kinetics

Library of Congress Cataloging-in-Publication Data

Kaminoff, Leslie, 1958-
Yoga anatomy / Leslie Kaminoff, Amy Matthews ; Illustrated by Sharon Ellis. -- 2nd ed.
p. cm.
Includes bibliographical references and indexes.
ISBN-13: 978-1-4504-0024-4 (soft cover)
ISBN-10: 1-4504-0024-8 (soft cover)
1. Hatha yoga. 2. Human anatomy. I. Matthews, Amy. II. Title.
RA781.7.K356 2011
613.7'046--dc23

2011027333

ISBN-10: 1-4504-0024-8 (print)
ISBN-13: 978-1-4504-0024-4 (print)

The web addresses cited in this text were current as of August 2011, unless otherwise noted.

Managing Editor: Laura Podeschi; **Assistant Editors:** Claire Marty and Tyler Wolpert; **Copyeditor:** Joanna Hatzopoulos Portman; **Graphic Designer:** Joe Buck; **Graphic Artist:** Tara Welsch; **Original Cover Designer and Photographer (for illustration references):** Lydia Mann; **Photo Production Manager:** Jason Allen; **Art Manager:** Kelly Hendren; **Associate Art Manager:** Alan L. Wilborn; **Illustrations (cover and interior):** Sharon Ellis; **Printer:** United Graphics

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Printed in the United States of America 10 9 8 7 6 5 4 3 2 1

The paper in this book is certified under a sustainable forestry program.

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Website: www.HumanKinetics.com

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E5267

To my teacher, T.K.V. Desikachar, I offer this book in gratitude for his unwavering insistence that I find my own truth. My greatest hope is that this work can justify his confidence in me.

And to my philosophy teacher, Ron Pisaturo—the lessons will never end.

—Leslie Kaminoff

In gratitude to all the students and teachers who have gone before—especially Philip, my student, teacher, and friend.

—Amy Matthews

PREFACE

I am pleased to write this preface to an expanded, updated, and improved version of *Yoga Anatomy*. Most important, this new edition accurately reflects the true coauthorship of my collaborator and friend, Amy Matthews. In the first edition, I acknowledged working with Amy as one of the richest and most rewarding professional relationships I've ever had. At this point, a few years later in our collaboration, I remove the qualifier *one of*. When Amy and I work together, it is as if our complementary, individual knowledge and perspectives are specialized hemispheres that come together to act as a kind of superbrain. It is a truly joyous experience to work with someone who makes me exponentially smarter than when I'm alone. When we add the talent of Sharon Ellis, our extraordinary illustrator, as well as the support of our creative team at The Breathing Project, it makes for a potent mix.

Following the release of *Yoga Anatomy* in the summer of 2007, its success took everyone by surprise. As of this writing it has been translated into 19 languages, over 300,000 copies are in print, and it remains among the top-selling yoga books in the United States. We have received tremendous positive feedback from readers, many of whom are educators who now include *Yoga Anatomy* as a required text in their yoga teacher training courses. Practitioners as diverse as orthopedists, chiropractors, physical therapists, fitness trainers, and Pilates and Gyrotonic instructors are making good use of the book as well.

Some of the best feedback I've received revolves around the first two chapters centered on breath and spine. My intention in these chapters was to provide information I wish had been available to me 25 years ago when I was trying to figure out the anatomical basis of my teacher's distinctive approach to breathing in asana practice. I am especially pleased at how well received this information has been and am happy that this second edition provides the opportunity to add more illustrations, an expanded discussion of intrinsic equilibrium, the bandhas, and a brief history of the spine, deleted from the first edition due to space constraints.

Amy and I have also received critical feedback from readers, colleagues, and respected professionals in a variety of fields. The process of responding to this feedback has resulted in numerous improvements, the most significant of which are two new chapters by Amy on the skeletal system and the muscular system. These chapters feature a unique combination of sophistication and simplicity. The addition of these chapters makes *Yoga Anatomy* a more useful book that allows readers to better understand the specific anatomical terms used in the asana sections, especially joint actions and muscle actions.

Chapter 5 is a new jointly written chapter offering our analysis of the asanas and our approach to choosing what to analyze. You should read this chapter before reading any of the entries for the specific asanas, because it explains our unconventional and sometimes controversial perspectives on classification, breathing, and joint and muscle actions.

Amy has completely reviewed and revised the asana sections. She has eliminated arbitrary or confusing classifications, terms, and concepts and added information to clarify muscle actions and improve the overall consistency of presentation. Lydia Mann provided assistance in design by organizing the revised data as tables to offer ease of comprehension. Other improvements include additional asana variations and new indexes for illustrations of specific joints and muscles as well as corrections and relabeling of illustrations throughout.

Amy and I are confident that this new edition of *Yoga Anatomy* will continue to be a valuable resource for practitioners and teachers of yoga and all other forms of healthy movement. We hope you enjoy using it as much as we enjoyed putting it together. Please continue to let us know about your experiences in using the book.

Leslie Kaminoff
New York City
September 2011

ACKNOWLEDGMENTS

First and foremost, I express my gratitude to my family: Uma, Sasha, Jai, and Shaun. Their patience, understanding, love, and support have carried me through the lengthy process of conceiving, writing, editing, and revising this book. I wish also to thank my father and mother for supporting their son's unconventional interests and career for the past five decades. Allowing a child to find his own path in life is perhaps the greatest gift that a parent can give.

This has been a truly collaborative project that would never have happened without the ongoing support of a talented and dedicated team. Lydia Mann, whose most accurate title would be project and author wrangler, is a gifted designer, artist, and friend who guided me through every phase of this project: organizing, clarifying, and editing the structure of the book; shooting the majority of the photographs (including the author photos); and designing the covers. Without Lydia's partnership, this book would still be lingering somewhere in the space between my head and my hard drive.

Sharon Ellis has proven to be a skilled, perceptive, and flexible medical illustrator. When I first recruited her into this project after admiring her work online, she had no familiarity with yoga, but before long, she was slinging the Sanskrit terms and feeling her way through the postures like a seasoned yogi.

This book would never have existed had it not been originally conceived by the team at Human Kinetics. Martin Barnard's research led him to offer me the project. Leigh Keylock, Laura Podeschi, and Jason Muzinic's editorial guidance and encouragement kept the project on track. I can't thank them enough for their support and patience—mostly for their patience.

A very special thank-you goes to my literary agent and good friend, Bob Tabian, who has been a steady voice of reason and experience. He's the first person who saw me as an author, and he never lost faith that I could actually be one.

For education, inspiration, and coaching along the way, I thank Swami Vishnu Devananda, Lynda Huey, Leroy Perry Jr., Jack Scott, Larry Payne, Craig Nelson, Gary Kraftsow, Yan Dhyansky, Steve Schram, William LaSassier, David Gorman, Bonnie Bainbridge Cohen, Len Easter, Gil Hedley, and Tom Myers. I also thank all my students and clients past and present for being my most consistent and challenging teachers.

A big thank-you goes to all the models who posed for our images: Amy Matthews, Alana Kornfeld, Janet Aschkenasy, Mariko Hirakawa (our cover model), Steve Rooney (who also donated the studio at International Center of Photography for a major shoot), Eden Kellner, Elizabeth Luckett, Derek Newman, Carl Horowitz, J. Brown, Jyothi Larson, Nadiya Nottingham, Richard Freeman, Arjuna (Ronald Steiner), Eddie Stern, Shaun Kaminoff, and Uma McNeill. Thanks also to the Krishnamacharya Yoga Mandiram for permission to use the iconic photos of T. Krishnamacharya as reference for the Mahamudra and Mulabandhasana drawings.

Invaluable support for this project was provided by Jen Harris, Edya Kalev, Alana Kramer, Leandro Willaro, Rudi Bach, Jenna O'Brien, Sarah Barnaby, and all the teachers, staff, students, and supporters of The Breathing Project.

Leslie Kaminoff

I begin by thanking Leslie for his generosity of spirit. Since he initially invited me to be a part of The Breathing Project in 2003, he has unfailingly supported my approach to teaching, recommended my classes and workshops to his students, and invited me to be a part of the creation of this book.

Little did I know what would come when he approached me to help with a cool idea he had about a book on yoga anatomy! In the process of creating the initial book and this second edition, he and I have had many conversations in which we questioned and challenged and elaborated on each other's ideas in a way that has polished and refined what we both have to offer.

For me to be the educator that I now am, I first thank my family. My parents both encouraged me to question and to understand for myself. My father was always willing to explain something to me, and my mother encouraged me to go look it up and figure it out. From them, I learned I could do my own research and form my own ideas . . . and no detail was too small to consider!

Thanks to all the teachers who encouraged my curiosity and passion for understanding things: Alison West, for cultivating a spirit of exploration and inquiry in her yoga classes; Mark Whitwell, for constantly reminding me of what I already know about why I am a teacher; Irene Dowd, for her enthusiasm and precision; Gil Hedley, for his willingness to not know and still dive in and learn; and Bonnie Bainbridge Cohen, who models the passion and compassion for herself and her students that lets her be such a gift as a teacher.

Several people have been instrumental in the process of creating the new material in the second edition. Tremendous thanks to Chloe Chung Misner for reading every draft of the new chapters and reminding me to be in my bones. Michelle Gay also kept wanting to know more and asked incredibly useful questions. The students at The Breathing Project have continued to inspire me as a teacher. The staff at The Breathing Project, especially Alana, Edya, Alyson, and Alicia, have done an incredible job of keeping the space running when Leslie and I have been consumed by this process.

Sarah Barnaby has been an invaluable colleague in helping me refine the asana material in the second edition, brainstorming ideas for images, and in general reminding me of what I mean to say. She also prepared the material for the indexes and proofread at every step of the way.

I am grateful to all the people who helped me in the process of working on this book: my dearest friends Michelle and Aynsley; Karen, whose support sustained me in creating the first edition; our BMC summer kitchen table circle, Wendy, Elizabeth, and Tarina; Kidney and all the people I told to stop asking about the book; and the BMC students who welcomed me and gave me feedback, especially Moonshadow, Raven-Light, Michael, Rosemary, and Jesse. And a loving thank-you to Sarah, who continues to inspire me to be more expansive and creative about my life and my teaching than I had ever thought possible.

Amy Matthews

INTRODUCTION

This book is by no means an exhaustive study of human anatomy or the vast science of yoga. No single book could be. Both fields contain a potentially infinite number of details, both macro- and microscopic, all of which are endlessly fascinating and potentially useful depending on your interests. Our intention is to present the details of anatomy that are of most value to people involved in yoga whether as students or as teachers.

THE TRUE SELF IS AN EMBODIED SELF

Yoga speaks of getting at something deep inside of us—the true self. The goal of this quest is often stated in mystical terms, implying that our true selves exist on some nonmaterial plane. This book takes the opposing stand that in order to go deeply inside ourselves, we must journey within our physical bodies. Once there, we will not only understand our anatomy but also directly experience the reality that gives rise to the core concepts of yoga. This is a truly embodied experience of spirituality. We make a clear distinction between mystical (the claim to the perception of a supernatural reality experienced by some extrasensory means) and spiritual (from the Latin *spiritus,* meaning breath, the animating, sensitive, or vital principle of the individual).

The reason for this mutually illuminating relationship between yoga and anatomy is simple: The deepest principles of yoga are based on a subtle and profound appreciation of how the human system is constructed. The subject of yoga is the self, and the self is an attribute of a physical body.

PRACTICE, DISCERNMENT, AND SURRENDER

The ancient teachings we've inherited were developed through the enlightened observation of life in all its forms and expressions. The skillful observation of humans gave rise to the possibility of yoga practice (kriya yoga) classically formulated by Patañjali and restated by Reinhold Niebuhr in his famous serenity prayer.[1] Within this practice we orient our attitudes toward the discernment (swadhyaya) to distinguish the things we can change (tapah) from the things we cannot change (isvara pranidhana).

Isn't this a prime motivation to study anatomy in the context of yoga? We want to know what's inside of us so we can understand why some things are relatively easy to change and others seem so difficult. How much energy should we devote to working through our own resistance? When should we work on surrendering to something that's not likely to change? Both require effort. Surrender is an act of will. These are never-ending questions with answers that seem to change every day—precisely why we must never stop posing them.

A little anatomical knowledge goes a long way in this pursuit, especially when we include the subject of breathing in our inquiry. What makes the breath such a potent teacher of yoga? Breathing has the dual nature of being both voluntary and autonomic, which is why the breath illuminates the eternal inquiry about what we can control or change and what we cannot. We all face this personal yet universal inquiry at some point if we desire to evolve.

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[1] Karl Paul Reinhold Niebuhr (1892–1971), American theologian: "Grant to us the serenity of mind to accept that which cannot be changed, courage to change that which can be changed, and wisdom to know the one from the other."

WELCOME TO MY LABORATORY

The context that yoga provides for the study of anatomy is rooted in the exploration of how our life force expresses itself through the movements of the body, breath, and mind. The ancient metaphorical language of yoga has arisen from anatomical experimentations by millions of seekers over thousands of years. All these seekers shared a common laboratory—their human bodies. This book provides a guided tour of this lab, with descriptions on function of the equipment and the basic procedures that yield insights. Rather than offer a manual for the practice of a particular system of yoga, we offer a solid grounding in the principles of the physical practice of all systems of yoga.

Because yoga practice emphasizes the relationship of the breath and the spine, we pay particular attention to those systems. By viewing all other body structures in light of their relationship to the breath and spine, yoga becomes the integrating principle for the study of anatomy. Additionally, we honor the yogic perspective of dynamic interconnectedness by avoiding reductionist analysis of the poses and prescriptive listings of their benefits.

ALL WE NEED IS ALREADY PRESENT

The ancient yogis held the view that we actually have three bodies: physical, astral, and causal. From this perspective, yoga anatomy is the study of the subtle currents of energy that move through the layers, or sheaths, of those three bodies. The purpose of this work is to neither support nor refute this view. We simply offer the perspective that if you are reading this book, you have a mind and a body that are currently inhaling and exhaling in a gravitational field. Therefore, you can benefit immensely from a process that enables you to think more clearly, breathe more effortlessly, and move more efficiently. This is, in fact, our starting point and definition of yoga practice: the integration of mind, breath, and body.

Another ancient principle tells us that the main task of yoga practice is the removal of obstacles that impede the natural functioning of our systems. This sounds simple enough but runs counter to a common feeling that our problems are due to something that's lacking, or missing. What yoga can teach us is that everything essential we need for our health and happiness is already present in our systems. We merely need to identify and resolve some of the obstacles that obstruct those natural forces from operating, "like a farmer who cuts a dam to allow water to flow into the field where it is needed."[2] This is great news for anyone regardless of age, infirmity, or inflexibility; if there is breath and mind, then there can be yoga.

FROM THE CRADLE TO GRAVITY

Rather than see the body's musculature as a system of pulleys and fulcrums that needs to function as a counterforce to gravity, we see the body as a dynamically coupled series of spiraling tubes, channels, and chambers that support themselves from the inside.

Some of this support operates independently of the action of the musculature and its metabolic demands. We call this principle intrinsic equilibrium, and its workings are observable in the way the spine, rib cage, and pelvis are knit together under mechanical tension. The cavities contained by those structures exhibit a pressure differential that makes our organ systems gravitate upward toward the body's region of lowest pressure in the rib cage.

Why does it take practice to learn how to tap into these deep sources of internal support? Habitual tension accumulates over a lifetime of operating our muscular pulleys and

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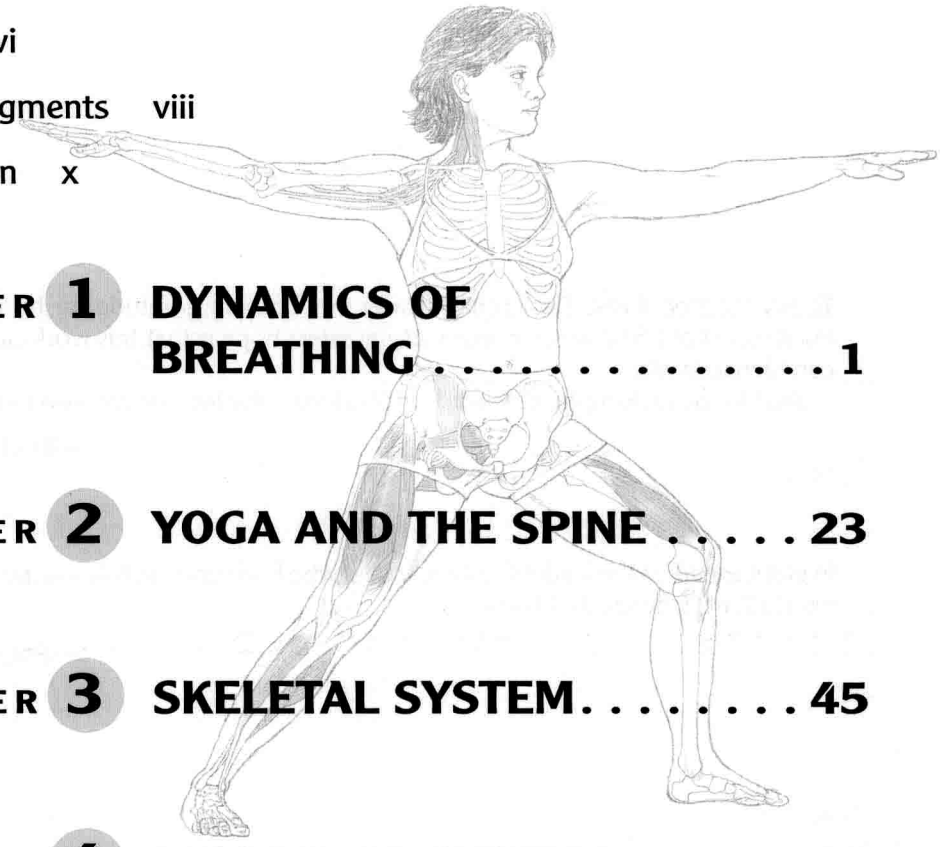
[2] From *Yoga Sutras* by Patañjali, chapter 4, sutra 3, in *The Heart of Yoga: Developing Personal Practice* by T.K.V. Desikachar (Inner Traditions International, 1995).

fulcrums against the constant pull of gravity, and the constant modulation of our breathing patterns is invoked as a way of regulating our internal emotional landscape. These postural and breath habits operate mostly unconsciously unless some intentional change (tapah) is introduced into the system by a practice like yoga. This is why we often refer to yoga as a controlled stress experience.

In this context, the practice of asana becomes a systematic exploration of unobstructing the deeper self-supporting forces of breath and posture. We offer suggestions for alignment, breathing, and awareness that can help in this exploration in the asana sections of this book.

Rather than view asana practice as a way of *imposing* order on the human system, we encourage you to use the poses as a way of *uncovering* the intrinsic order that nature put there. This doesn't mean we ignore issues of alignment, placement, and sequencing. We simply maintain that achieving proper alignment is a means to a greater end, not an end in itself. We don't live to do yoga; we do yoga so that we may *live*—more easily, joyously, and gracefully.

CONTENTS



CHAPTER 1

DYNAMICS OF BREATHING

This chapter explores breath anatomy from a yogic perspective, using the cell as a starting point. This most basic unit of life can teach us an enormous amount about yoga. In fact, we can derive the most essential yogic concepts from observing the cell's form and function. Furthermore, when we understand the basics of a single cell, we can understand the basics of anything made out of cells, such as the human body.

YOGA LESSONS FROM A CELL

Cells are the fundamental building blocks of life, from single-celled plants to multitrillion-celled animals. The human body, which is made up of roughly 100 trillion cells, begins as two newly created cells.

A cell consists of three parts: the cell membrane, the nucleus, and the cytoplasm. The membrane separates a cell's internal environment, which consists of the cytoplasm and nucleus, from its external environment, which contains the nutrients that the cell requires.

After nutrients have penetrated the membrane, they are metabolized and turned into energy that fuels a cell's life functions. An unavoidable by-product of all metabolic activity is waste, which must get back out through the same membrane. Any impairment to a cell's ability to let nutrients in or let waste out results in death by starvation or toxicity. The yogic concepts that relate to this functional activity of the cell are prana and apana. The concepts that relate to the structural properties of the membrane that support that function are sthira and sukha.

Prana and Apana

The Sanskrit term *prana* is derived from *pra-*, a prefix meaning before, and *an*, a verb meaning to breathe, to blow, and to live. *Prana* refers to what nourishes a living thing, but it has also come to mean the action that brings the nourishment in. Within this chapter, the term will refer to the functional life processes of a single entity. When capitalized, *Prana* is a more universal term that can be used to designate the manifestation of all creative life force.

All living systems require a balance of forces, and the yogic concept that complements prana is *apana*, which is derived from *apa*, meaning away, off, or down. Apana refers to the waste that's being eliminated as well as the action of elimination. These two fundamental yogic terms—*prana* and *apana*—encompass the essential functions of life on every level, from cell to organism.

Sthira and Sukha

If prana and apana are expressions of function, what of the structural conditions that have to exist in a cell in order for nutrition to enter and waste to exit? This is the function of the membrane—a structure that must be just permeable enough to allow material to pass in and out (see figure 1.1, page 2). If the membrane is too permeable, the cell loses integrity, causing it to either explode from pressures within or implode from pressures without.

In a cell, as in all living things, the principle that balances permeability is stability. The yogic terms that reflect these polarities are *sthira* and *sukha*. In Sanskrit, *sthira* can mean firm, hard, solid, compact, strong, unfluctuating, durable, lasting, or permanent. *Sukha* is composed of two roots: *su* meaning good and *kha* meaning space. It means easy, pleasant, agreeable, gentle, and mild. It also refers to a state of well-being, free of obstacles.

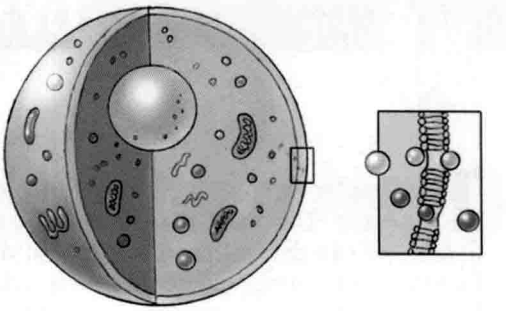


Figure 1.1 The cell's membrane must balance containment (stability) with permeability.

All successful living things must balance containment and permeability, rigidity and plasticity, persistence and adaptability, and space and boundaries. This is how life avoids destruction through starvation or toxicity and through implosion or explosion.

Successful man-made structures also exhibit a balance of sthira and sukha. For example, a suspension bridge is flexible enough to survive wind and earthquakes, but stable enough to support its load-bearing surfaces. This image also invokes the principles of tension and compression, which are discussed in chapter 2.

Sukha also means having a good axle hole, implying a space at the center that allows function. Like a wheel, a person needs to have good space at his or her center, or functional connections become impossible.

Human Pathways of Prana and Apana: Nutrition In, Waste Out

The body's pathways for nutrients and waste are not as simple as those of a cell, but not so complex that we can't easily describe them in terms of prana and apana.

Figure 1.2 shows a simplified version of our nutritional and waste pathways. It shows how the human system is open at the top and at the bottom. We take in prana—solid and liquid nourishment—at the top of the system. These solids and liquids enter the alimentary canal, move through the digestive process, and, after a lot of twists and turns, move down and out as waste matter. This is the only way waste can go, because the exits are at the bottom. It is clear that the force of apana, when acting on solid and liquid waste, must move down to get out.

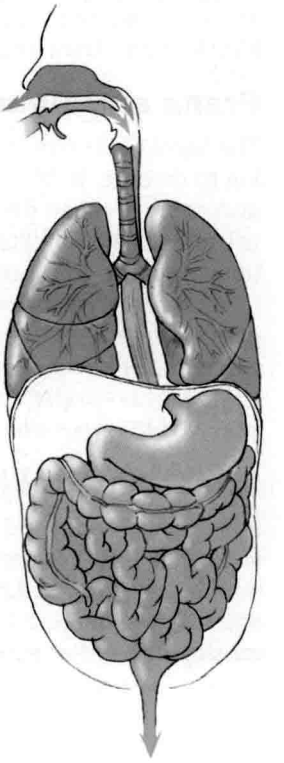


Figure 1.2 Solid and liquid nutrition (blue) enter at the top of the system and exit as waste at the bottom. Gaseous nutrition and waste (red) enter and exit at the top.

Prana also enters our bodies in gaseous form: the breath. Like solids and liquids, it enters at the top, where it remains above the diaphragm in the lungs (see figure 1.3), exchanging gases with the capillaries at the alveoli. The waste gas in the lungs needs to be expelled, but it gets out the same way it came in. The force of apana, when acting on respiratory waste gas, must move up to get out. Apana must be able to operate freely both upward and downward, depending on what type of waste it acts upon.

The ability to reverse apana's downward action is a basic and useful skill acquired through yoga practice, but not something most people are able to do without training. People are accustomed to pushing down to operate their apana. Many have learned that whenever something needs to be eliminated from the body, the body must squeeze in and push down. That is why, when most beginning students are asked to exhale completely, they activate their breathing muscles as if they are urinating or defecating.

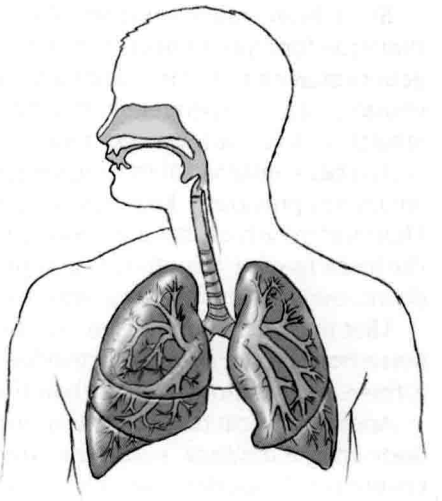


Figure 1.3 The pathway that air takes into and out of the body.

Sukha and Dukha

Prana and apana must have a healthy reciprocal relationship in the body; thus, the body's pathways must be clear of obstructing forces. In yogic terms, our breathing bodies must be in a state of *sukha*, translated literally as good space. Bad space is referred to as *dukha*, which is derived from *dus*, meaning bad, difficult, or hard, and *kha*, meaning space. It is generally translated as suffering, uneasy, uncomfortable, unpleasant, and difficult.

This model points to the fundamental methodology of all classical yoga practice, which seeks to uncover and resolve blockages or obstructions (kleshas[1]) to improve function. Essentially, when we make more good space our pranic forces flow freely and restore normal, healthy function.

The modern master of yoga therapy, T.K.V. Desikachar, has often said that yoga therapy is 90 percent waste removal.

Because exhalation is an action of removing waste from the system, another practical way of applying this insight is that if we take care of the exhalation, the inhalation takes care of itself. If we get rid of the unwanted, we make room for what is needed.

Being Born to Breath and Gravity

When a fetus is in utero, the mother does the breathing. Her lungs deliver oxygen to the uterus and placenta. From there it travels to the umbilical cord, which takes about half the oxygenated blood to the inferior vena cava while the other half enters the liver. The two sides of the heart are connected, bypassing the lungs, which remain dormant until the child is born. Needless to say, human fetal circulation is very different from ex-utero circulation.

[1] *Klestr* means that which causes pain or suffering.

Being born means being severed from the umbilical cord—the lifeline that has sustained the fetus for nine months. Suddenly, and for the first time, the infant needs to engage in actions that ensure continued survival. The very first of these actions declares physical and physiological independence. It is the first breath, and it is the most important and forceful inhalation a human will ever take.

The initial inflation of the lungs triggers enormous changes to the entire circulatory system, which has previously been geared toward receiving oxygenated blood from the placenta. That first breath causes a massive surge of blood into the lungs, the right and left sides of the heart to separate into two pumps, and the specialized vessels of fetal circulation to shut down, seal off, and become ligaments that support the abdominal organs.

That first inhalation must be so forceful because it needs to overcome the initial surface tension of the previously inactive lung tissue. The force required to overcome that tension is three or four times greater than that of a normal inhalation.[2]

Another radical reversal that occurs at the moment of birth is the sudden experience of body weight in space. Inside the womb, the fetus is in a cushioned, supportive, fluid-filled environment. Suddenly, the child's entire universe expands—the limbs and head can move freely, and the baby must be supported in gravity.

Because adults swaddle babies and move them around from place to place, stability and mobility may not seem to be so much of an issue early in life. In fact, infants begin to develop their posture immediately after taking their first breath, as soon as they begin to nurse. The complex, coordinated action of simultaneously breathing, sucking, and swallowing eventually provides them with the tonic strength to accomplish their first postural skill—supporting the weight of the head. This is no small feat for the infant, considering that an infant's head constitutes one fourth of its overall body length, compared to one eighth for an adult.

Head support involves the coordinated action of many muscles and, as with all weight-bearing skills, a balancing act between mobilization and stabilization. Postural development continues from the head downward until after about a year, when babies begin walking, culminating in the completion of the lumbar curve at about 10 years of age (see chapter 2).

Having a healthy life on Earth requires an integrated relationship between breath and posture, prana and apana, and sthira and sukha. If something goes wrong with one of these functions, by definition it will go wrong with the others. In this light, yoga practice can be viewed as a way of integrating the body's systems so we spend more time in a state of sukha than in dukha.

To summarize, from the moment of birth, humans are confronted by breath and gravity, two forces that were not present in utero. To thrive, we need to reconcile those forces as long as we draw breath on this planet.

BREATHING DEFINED: MOVEMENT IN TWO CAVITIES

Breathing is traditionally defined in medical texts as the process of taking air into and expelling it from the lungs. This process—the passage of air into and out of the lungs—is movement; specifically, it is movement in the body's cavities, which I will refer to as shape change. So, for the purposes of this exploration, here's our definition:

Breathing is the shape change of the body's cavities.

[2] The initial inflation of the lungs is assisted by the presence of surfactant, a substance that lowers the surface tension of the stiff, newborn lung tissue. Because surfactant is produced very late in intrauterine life, babies who are born prematurely (before 28 weeks of gestation) have a hard time breathing.