Tke Biology of Belief

Unleashing tke Power of Consciousness,
Matter and Miracles

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BRUCE H. LIPTON, PH.D.
www. brucelipton. com

Published by Mountain of
Love/Elite Books Santa Rosa,
CA 95404
www.BruceLipton.com

Library of Congress Cataloging-in-Publication Data:

Lipton, Bruce.

The biology of belief : unleashing the power of consciousness matter and miracles /by Bruce Lipton, Ph.D. —1st. Ed.

p. cm. Index

Includes bibliographical references.

ISBN 0-9759914-7-7

1. Life Sciences (Biology). 2. New Biology I. Title.

292.4-dc

Cover by Robert Mueller Interior design by Authors
Publishing Cooperative Typeset in Skia and Book Antigua
by Nan Sea Love Printed in USA First Edition

10 9 8 7 6 5 4 3 2

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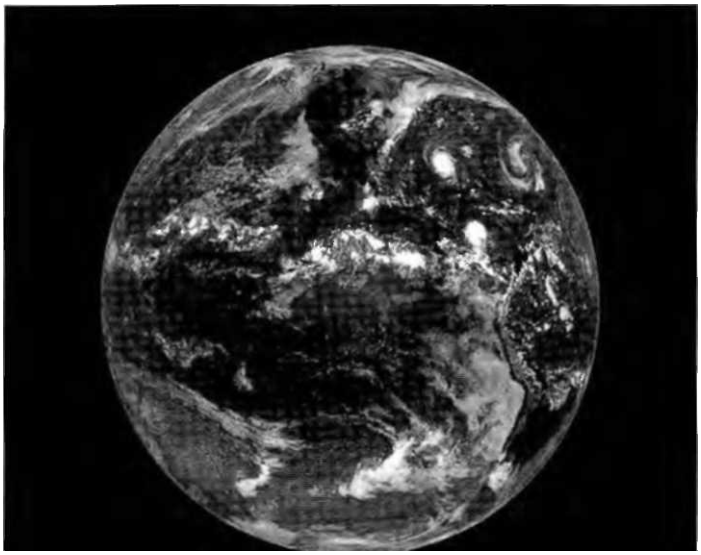
This book is dedicated



GAIA

The Mother of Us All

May She forgive us our trespasses. To my own mother, Gladys

who has continuously encouraged and supported me while being patient for the twenty years it took to get this book out.

To my daughters, Tanya and Jennifer

beautiful women of the world who have always been there for me ...no matter how weird things had become. And especially to my darling, Margaret Horton my best friend, my life partner, my love. May we continue on our joyous quest to live happily ever after!

ACKNOWLEDGMENTS

Much has transpired between my scientific inspiration and the creation of this book. During this time of great personal transformation, I was blessed and guided by both spiritual and incarnate muses —the inspiring spirits of the arts. I am particularly indebted to the following who have helped make this book a reality.

Vie Muses of Science: I am indebted to the *spirits* of science, for I am fully aware that *forces* outside of myself have guided me in bringing this message to the world. Special blessings to my heroes, Jean-Baptiste de Monet de Lamarck and Albert Einstein, for their world-changing spiritual and scientific contributions.

Vie Muses of Literature: The intention to write a book on the new biology was spawned in 1985, though it was not until Patricia A. King came into my life in 2003 that this book could come into reality. Patricia is a Bay Area freelance writer and former *Newsweek* reporter who worked for a decade as the magazine's San Francisco Bureau Chief. I will never forget our first meeting wherein I overwhelmed her with a lengthy new science tutorial and then burdened her with a truckload of aborted manuscripts, sheaves of innumerable articles I had written, boxes overflowing with video-taped lectures and stacks of scientific reprints.

Only as she was driving away, did I realize the monumental nature of the task I was asking of her. Without formal training in cell biology and physics, Patricia accomplished miracles in downloading and understanding the new science. In a very short time, she not only learned the new biology, she was even able to expand on its topics. Her amazing skills at integrating, editing and synthesizing information are responsible for the clarity of this book.

Patricia works on book projects, newspaper and magazine stories that focus on health issues, especially mind-body medicine and the role stress plays in disease. Her work has appeared in publications such as the *Los Angeles Times,* Southwest Airline's *Spirit* magazine and

Common Ground magazine. A native of Boston, King lives in Marin with her husband, Harold and their daughter, Anna. I am in deep appreciation and gratitude to Patricia for her efforts and look forward to the opportunity of writing another book with her in the future.

T)w Muses of the Arts: In 1980 I left academia and went "on the road" presenting a touring light show called *The Laser Symphony.* The heart and brains of our spectacular laser production was Robert Mueller, a visionary artist and computer graphics genius. Wise beyond his teenage years, Bob drank in the new science I was working on, first

as a student and later as my "spiritual son." Years ago he offered, and I accepted, his bid to create a cover for the book whenever it would appear.

Bob Mueller is cofounder and creative director of LightSpeed Design, Bellevue, Washington. He and his company have produced award winning 3-D light and sound shows for science museums and planetariums around the world. Their edutainment show on the fragile ecology of our oceans was an honored presentation, seen by 16,000 viewers daily at the World's Expo held in Lisbon, Portugal (1998). Bob's creative endeavors can be sampled at www.lightspeeddesign.com.

Bob's work, inspired by science and the Light, is beautiful and profound. I am honored to have his contribution as the cover art, the image that will introduce this new awareness to the public.

Muses of Music: From the conception of this new science to the submission of the book, I have been continuously encouraged and energized by the music of Yes and especially the lyrics of their vocalist Jon Anderson. Their music and message reveal an inner knowing and understanding of the new science. The music of Yes speaks to the fact that we are all connected to the Light. Their songs emphasize how our experiences, our beliefs and our dreams shape our lives and influence those of our children. What takes me pages of text to explain, Yes can say in a few powerful and poignant lines. You guys are great!

Regarding the physical production of this book, I sincerely want to thank the New York publishers who turned down the book proposal. Without you, I was able to create my *own* book—just like I wanted to

The classroom was deadly silent for the first ten minutes of the testing period. Then nervous fidgeting felled the students one by one, faster than the spread of the deadly Ebola virus. By the time the twenty minutes allotted for the quiz were over, wide-eyed panic had gripped the class. When I said, "Stop/' the pent-up nervous anxiety erupted into the din of a hundred excited conversations. I quieted the class down and began to read them the answers. The first five or six answers were met with subdued sighs. After I reached the tenth question, each subsequent answer was followed by agonizing groans. The highest score in the class was ten correct answers, followed by several students who answered seven correctly; with guesswork, most of the rest scored at least one or two correct answers.

When I looked up at the class, I was greeted with frozen, shell-shocked faces. The "strivers" found themselves behind the big eight ball. With more than half a semester behind them, they had to start the course all over again. A dark gloom overcame the students, most of whom were already treading water in their other, very demanding medical school courses. Within moments, their gloom had turned into quiet despair. In profound silence, I looked out over the students and they looked back at me. I experienced an internal ache —the class collectively resembled one of those Greenpeace pictures of wide-eyed baby seals just before heartless fur traders club them to death.

My heart welled. Perhaps the salt air and sweet scents had already made me more magnanimous. In any case, unexpectedly, I found myself announcing that I would make it my personal commitment to see that every student was fully prepared for the final exam, if they would commit to providing matching efforts. When they realized I was truly committed to their success, I could see the lights flash on in their previously panicked eyes.

Feeling like an embattled coach revving up the team for the Big Game, I told them I thought they were every bit as intelligent as the students I taught in the States. I told them I believed their State-side peers were simply more proficient at rote memorization, the quality that enabled them to score better in the medical college admissions tests. I also tried very hard to convince them that histology and cell biology are not intellectually difficult courses. I explained that in all of its elegance, nature employs very simple operating principles. Rather than just memorizing facts and figures, I promised they were going to gain an understanding of cells because I would present simple principles on top of simple principles. I offered to provide additional night lectures, which would tax their stamina after their already long lecture and lab-packed days. The students were pumped up after my ten-minute pep talk. When the period ended, they bolted from that classroom snorting fire, determined they would not be beaten by the system.

After the students left, the enormity of the commitment I had made sank in. I started having doubts. I knew that a significant number of the students were truly unqualified to be attending medical school. Many others were capable students whose backgrounds had not prepared them for the challenge. I was afraid that my island idyll would

degenerate into a frenetic, time-consuming academic scrimmage that would end in failure for my students and for me as their teacher. I started thinking about my job at Wisconsin, and suddenly it was beginning to look easy. At Wisconsin, I gave only eight lectures out of the approximately fifty that made up the histology/cell biology course. There were five members of the Anatomy Department who shared the lecturing load. Of course I was responsible for the material in all of the lectures because I was involved in their accompanying laboratory sessions. I was supposed to be available to answer all course-related questions asked by the students. But knowing the material and presenting lectures on the material are not the same thing!

I had a three-day weekend to wrestle with the situation I had created for myself. Had I faced a crisis such as this back home, my type A personality would have had me swinging from the proverbial chandeliers. Interestingly, as I sat by the pool, watching the sun set into the Caribbean, the potential angst simply morphed into an exciting adventure. I began to get excited about the fact that for the first time in my teaching career, I was solely responsible for this major course and free from having to conform to the style and content restrictions of team-taught programs.

Cells As Miniature Humans

As it turned out, that histology course was the most exhilarating and intellectually profound period of my academic career. Free to teach the course the way I wanted to teach it, I ventured into a new way of covering the material, an approach that had been roiling in my brain for several years. I had been fascinated by the idea that considering cells as "miniature humans" would make it easier to understand their physiology and behavior. As I contemplated a new structure for the course, I got excited. The idea of overlapping cell and human biology rekindled the inspiration for science I had felt as a child. I still experienced that enthusiasm in my research laboratory, though not when I was mired in the administrative details of being a tenured faculty member, including endless meetings and what for me were tortuous faculty parties.

I was prone to thinking of cells as human-like because, after years behind a microscope, I had become humbled by the complexity and

power of what at first appear to be anatomically simple, moving blobs in a Petri dish. In school you may have learned the basic components of a cell: the nucleus that contains genetic material, the energy-producing mitochondria, the protective membrane at the outside rim, and the cytoplasm in between. But within these anatomically simple-looking cells is a complex world; these smart cells employ technologies that scientists have yet to fully fathom.

The notion of cells as miniature humans that I was mulling over would be considered heresy by most biologists. Trying to explain the nature of anything not human by relating it to human behavior is called anthropomorphism. "True" scientists consider anthropomorphism to be something of a mortal sin and ostracize scientists who knowingly employ it in their work.

However, I believed though that I was breaking out of orthodoxy for a good reason. Biologists try to gain scientific understanding by observing nature and conjuring up a hypothesis of how things work. Then they design experiments to test their ideas. By necessity, deriving the hypothesis and designing the experiments require the scientist to "think" how a cell or another living organism carries out its life. Applying these "human" solutions, i.e. a human view of resolving biology's mysteries, automatically makes these scientists guilty of anthropomorphizing. No matter how you cut it, biological science is based to some degree on humanizing the subject matter.

Actually, I believe that the unwritten ban on anthropomorphism is an outmoded remnant of the Dark Ages when religious authorities denied any direct relationship existed between humans and any of God's other creations. While I can see the value of the concept when people try to anthropomorphize a light bulb, a radio or a pocketknife, I do not see it as a valid criticism when it is applied to living organisms. Human beings are multicellular organisms — we must inherently share basic behavioral patterns with our own cells.

However, I know that it takes a shift in perception to acknowledge that parallel. Historically, our Judeo-Christian beliefs have led us to think that *we* are the intelligent creatures who were created in a separate and distinct process from all other plants and animals. This view has us looking down our noses at lesser creatures as non-intelligent life

forms, especially those organisms on the lower evolutionary rungs of life.

Nothing could be farther from the truth. When we observe other humans as individual entities or see ourselves in the mirror as an individual organism, in one sense, we are correct, at least from the perspective of our level of observation. However, if I brought you down to the size of an individual cell so you could see your body from that perspective, it would offer a whole new view of the world. When you looked back at yourself from that perspective you would not see yourself as a single entity. You would see yourself as a bustling community of more than 50 trillion individual cells.

As I toyed with these ideas for my Histology class, the picture that kept recurring in my mind was a chart from an encyclopedia I had used as a child. Under the section on humans, there was an illustration with seven transparent plastic pages, each printed with an identical, overlapping outline of the human body. On the first page the outline was filled in with an image of a naked man. Turning the first page was like peeling off his skin and revealing his musculature, the image within the outline on the second page. When I turned the second page, the overlapping images of the remaming pages revealed a vivid dissection of the body. Flipping through the pages I could see in turn, the skeleton, the brain and nerves, blood vessels and organ systems.

For my Caribbean course, I mentally updated those transparencies with several additional, overlapping pages, each illustrated with cellular structures. Most of the cell's structures are referred to as organelles, which are its "rniniature organs" suspended within a jelly-like cytoplasm. Organelles are the functional equivalents of the tissues and organs of our own bodies. They include the nucleus, which is the largest organelle, the mitochondria, the Golgi body and vacuoles. The traditional way of teaching the course is to deal first with these cellular structures, then move on to the tissues and organs of the human body. Instead, I integrated the two parts of the course to reflect the overlapping nature of humans and cells.

I taught my students that the biochemical mechanisms employed by cellular organelle systems are essentially the same mechanisms employed by our human organ systems. Even though humans are made up of trillions of cells, I stressed that there is not one "new" func-

tion in our bodies that is not already expressed in the single cell. Each eukaryote (nucleus-containing cell) possesses the functional equivalent of our nervous system, digestive system, respiratory system, excretory system, endocrine system, muscle and skeletal systems, circulatory system, integument (skin), reproductive system and even a primitive immune system, which utilizes a family of antibody-like "ubiquitin" proteins.

I also made it clear to my students that each cell is an intelligent being that can survive on its own, as scientists demonstrate when they remove individual cells from the body and grow them in a culture. As I knew intuitively when I was a child, these smart cells are imbued with intent and purpose; they actively seek environments that support their survival while simultaneously avoiding toxic or hostile ones. Like humans, single cells analyze thousands of stimuli from the microenvironment they inhabit. Through the analysis of this data, cells select appropriate behavioral responses to ensure their survival.

Single cells are also capable of learning through these environmental experiences and are able to create cellular memories, which they pass on to their offspring. For example, when a measles virus infects a child, an immature immune cell is called in to create a protective protein antibody against that virus. In the process, the cell must create a new gene to serve as a blueprint in manufacturing the measles antibody protein.

The first step in generating a specific measles antibody gene occurs in the nuclei of immature immune cells. Among their genes are a very large number of DNA segments that encode uniquely shaped snippets of proteins. By randomly assembling and recombining these DNA segments, immune cells create a vast array of different genes, each one providing for a uniquely shaped antibody protein. When an immature immune cell produces an antibody protein that is a "close" physical complement to the invading measles virus, that cell will be activated.

Activated cells employ an amazing mechanism called *affinity maturation* that enables the cell to perfectly "adjust" the final shape of its antibody protein, so that it will become a perfect complement to the invading measles virus. [Li, et al, 2003; Adams, et al, 2003] Using a process called *somatic hi/permutation,* activated immune cells makes hundreds of copies of their original antibody gene. However, each new

version of the gene is slightly mutated so that it will encode a slightly different shaped antibody protein. The cell selects the variant gene that makes the best fitting antibody. This selected version of the gene also goes through repeated rounds of somatic hypermutation to further sculpt the shape of the antibody to become a "perfect" physical complement of the measles virus. [Wu, et al, 2003; Blanden and Steele 1998; Diaz and Casaii 2002; Gearhart 2002]

When the sculptured antibody locks on to the virus, it inactivates the invader and marks it for destruction, thus protecting the child from the ravages of measles. The cells retain the genetic "memory" of this antibody, so that in the future if the individual is again exposed to measles, the cells can immediately launch a protective immune response. The new antibody gene can also be passed on to all the cell's progeny when it divides. In this process, not only did the cell "learn" about the measles virus, it also created a "memory" that will be inherited and propagated by its daughter cells. This amazing feat of genetic engineering is profoundly important because it represents an inherent "intelligence" mechanism by which cells evolve. [Steele, et al, 1998]

The Origins of Life: Smart Cells Get Smarter

It shouldn't be surprising that cells are so smart. Single-celled organisms were the first life forms on this planet. Fossil evidence reveals they were here within 600 million years after the Earth was first formed. For the next 2.75 billion years of the Earth's history, only free-living, single-celled organisms — bacteria, algae and amoeba-like protozoans, populated the world.

Around 750 million years ago, these smart cells figured out how to get smarter when the first multicellular organisms (plants and animals) appeared. Multicellular life forms were initially loose communities or "colonies" of single-celled organisms. At first, cellular communities consisted of tens and hundreds of cells. But the evolutionary advantage of living in a community soon led to organizations comprised of millions, billions and even trillions of socially interactive single cells. Though each individual cell is of microscopic dimensions, the size of multicellular communities may range from the barely visible to the monolithic. Biologists have classified these organized communities

based on their structure as observed by the human eye. While the cellular communities appear as single entities to the naked eye —a mouse, a dog, a human —they are, in fact, highly organized associations of millions and trillions of cells.

The evolutionary push for ever-bigger communities is simply a reflection of the biological imperative to survive. The more awareness an organism has of its environment, the better its chances for survival. When cells band together they increase their awareness exponentially. If each cell were to be arbitrarily assigned an awareness value of X, then each colonial organism would collectively have a potential awareness value of at least X times the number of cells in the colony.

In order to survive at such high densities, the cells created structured environments. These sophisticated communities subdivided the workload with more precision and effectiveness than the ever-changing organizational charts that are a fact of life in big corporations. It proved more efficient for the community to have individual cells assigned to specialized tasks. In the development of animals and plants, cells begin to acquire these specialized functions in the embryo. A process of cytological specialization enables the cells to form the specific tissues and organs of the body. Over time, this pattern of *differentiation,* i.e. the distribution of the workload among the members of the community, became embedded in the genes of every cell in the community, significantly increasing the organism's efficiency and its ability to survive.

In larger organisms, for example, only a small percentage of cells are concerned with reading and responding to environmental stimuli. That is the role of groups of specialized cells that form the tissues and organs of the nervous system. The function of the nervous system is to perceive the environment and coordinate the behavior of all the other cells in the vast cellular community.

Division of labor among the cells in the community offered an additional survival advantage. The efficiency it offered enabled more cells to live on less. Consider the old adage, "Two can live as cheaply as one." Or consider the construction costs of building a two-bedroom, single home versus the cost of building a two-bedroom apartment in a hundred-apartment complex. To survive, each cell is required to expend a certain amount of energy. The amount of energy conserved

by individuals living in a community contributes to both an increased survival advantage and a better quality of life.

In American capitalism, Henry Ford saw the tactical advantage in the differentiated form of communal effort and employed it in creating his assembly line system of manufacturing cars. Before Ford, a small team of multi-skilled workers would require a week or two to build a single automobile. Ford organized his shop so that every worker was responsible for only one specialized job. He stationed a large number of these differentiated workers along a single row, the assembly line, and passed the developing car from one specialist to the next. The efficiency of job specialization enabled Ford to produce a new automobile in 90 minutes rather than weeks.

Unfortunately, we conveniently "forgot" about the cooperation necessary for evolution when Charles Darwin emphasized a radically different theory about the emergence of life. He concluded 150 years ago that living organisms are perpetually embroiled in a "struggle for existence." For Darwin, struggle and violence are not only a part of animal (human) nature, but the principal "forces" behind evolutionary advancement. In the final chapter of *The Origin of Species: By Means of Natural Selection, Or, The Preservation Of Favoured Races In TJte Struggle For Life,* Darwin wrote of an inevitable "struggle for life" and that evolution was driven by "the war of nature, from famine and death." Couple that with Darwin's notion that evolution is random and you have a world, as poetically described by Tennyson that can be characterized as "red in tooth and claw," a series of meaningless, bloody battles for survival.

Evolution Without the Bloody Claws

Though Darwin is by far the most famous evolutionist, the first scientist to establish evolution as a scientific fact was the distinguished French biologist Jean-Baptiste de Lamarck. [Lamarck 1809,1914,1963] Even Ernst Mayr, the leading architect of "neo Darwinism," a modernization of Darwin's theory that incorporates twentieth-century molecular genetics, concedes that Lamarck was the pioneer. In his classic 1970 book *Evolution and the Diversity of Life,* [Mayr 1976, page 227] Mayr wrote: "It seems to me Lamarck has a much better claim to be designated the 'founder of the theory of evolution/ as indeed he has by

several French historians...he was the first author to devote an entire book primarily to the presentation of a theory of organic evolution. He was the first to present the entire system of animals as a product of evolution."

Not only did Lamarck present his theory fifty years before Darwin, he offered a much less harsh theory of the mechanisms of evolution. Lamarck's theory suggested that evolution was based on an "instructive," cooperative interaction among organisms and their environment that enables life forms to survive and evolve in a dynamic world. His notion was that organisms acquire and pass on adaptations necessary for their survival in a changing environment. Interestingly, Lamarck's hypothesis about the mechanisms of evolution conform to modern cell biologists' understanding of how immune systems adapt to their environment as described above.

Lamarck's theory was an early target of the Church. The notion that humans evolved from lower life forms was denounced as heresy. Lamarck was also scorned by his fellow scientists who, as creationists, ridiculed his theories. A German developmental biologist, August Weismann, helped propel Lamarck into obscurity when he tried to test Lamarck's theory that organisms pass on survival-oriented traits acquired through their interaction with the environment. In one of Weismann's experiments, he cut off the tails of male and female mice and mated them. Weismann argued that if Lamarck's theory were correct, the parents should pass on their tail-less state to future generations. The first generation of mice was born with tails. Weismann repeated the experiment for 21 more generations, but not one tail-less mouse was born, leading Weismann to conclude that Lamarck's notion of inheritance was wrong.

But Weismann's experiment was not a true test of Lamarck's theory. Lamarck suggested that such evolutionary changes could take "immense periods of time," according to biographer L. J. Jordanova. In 1984, Jordanova wrote that Lamarck's theory "rested on" a number of "propositions" including: "...the laws governing living things have produced increasingly complex forms over immense periods of time." [Jordanova 1984, page 71] Weismann's five-year experiment was clearly not long enough to test the theory. An even more fundamental flaw in his experiment is that Lamarck never argued that every change an

organism experienced would take hold. Lamarck said organisms hang on to traits (like tails) when they need them to survive. Although Weismann didn't think the mice needed their tails, no one asked the mice if they thought their tails were necessary for survival!

Despite its obvious flaws, the study of the tail-less mice helped destroy Lamarck's reputation. In fact, Lamarck has been mostly ignored or vilified. Cornell University evolutionist C.H. Waddington, wrote in *TIte Evolution of An Evolutionist* [Waddington 1975, page 38]: "Lamarck is the only major figure in the history of biology whose name has become to all intents and purposes, a term of abuse. Most scientists' contributions are fated to be outgrown, but very few authors have written works, which, two centuries later, are still rejected with indignation so intense that the skeptic may suspect something akin to an uneasy conscience. In point of fact, Lamarck has, I think, been somewhat unfairly judged."

Waddington wrote those prescient words thirty years ago. Today Lamarck's theories are being reevaluated under the weight of a body of new science that suggests that the oft-denounced biologist was not entirely wrong and the oft-lauded Darwin not entirely correct. The title of an article in the prestigious journal *Science* in 2000 was one sign of glasnost: "Was Lamarck Just a Little Bit Right?" [Baiter 2000]

One reason some scientists are taking another look at Lamarck is that evolutionists are reminding us of the invaluable role cooperation plays in sustaining life in the biosphere. Scientists have long noted symbiotic relationships in nature. In *Danvin's Blind Spot* [Ryan 2002, page 16], British physician Frank Ryan chronicles a number of such relationships, including a yellow shrimp that gathers food while its partner gobi fish protects it from predators, and a species of hermit crab that carries a pink anemone on top of its shell. "Fish and octopuses like to feed on hermit crabs, but when they approach this species, the anemone shoots out its brilliantly colored tentacles, with their microscopic batteries of poisoned darts, and sting the potential predator, encouraging it to look elsewhere for its meal." The warrior anemone gets something out of the relationship as well because it eats the crab's leftover food.

But today's understanding of cooperation in nature goes much deeper than the easily observable ones. "Biologists are becoming

increasingly aware that animals have coevolved, and continue to coexist, with diverse assemblages of microorganisms that are required for normal health and development," according to a recent article in *Science* called "We Get By With A Little Help From Our (Little) Friends." [Ruby, et al, 2004] The study of these relationships is now a rapidly growing held called "Systems Biology."

Ironically, in recent decades, we have been taught to wage war against microorganisms with everything from anti-bacterial soap to antibiotics. But that simplistic message ignores the fact that many bacteria are essential to our health. The classic example of how humans get help from microorganisms is the bacteria in our digestive system, which are essential to our survival. The bacteria in our stomach and intestinal tract help digest food and also enable the absorption of life-sustaining vitamins. This microbe-human cooperation is the reason that the rampant use of antibiotics is detrimental to our survival. Antibiotics are indiscriminate killers; they kill bacteria that are required for our survival as efficiently as they kill harmful bacteria.

Recent advances in genome science have revealed an additional mechanism of cooperation among species. Living organisms, it turns out, actually integrate their cellular communities by sharing their genes. It had been thought that genes are passed on only to the progeny of an individual organism through reproduction. Now scientists realize that genes are shared not only among the individual members of a species, but also among members of different species. The sharing of genetic information via *gene transfer* speeds up evolution since organisms can acquire "learned" experiences from other organisms. [Nitz, et al, 2004; Pennisi 2004; Boucher, et al, 2003; Dutta and Pan, 2002; Gogarten 2003] Given this sharing of genes, organisms can no longer be seen as disconnected entities; there is no wall between species. Daniel Drell, manager of the Department of Energy's microbial genome program told *Science* in (2001 294:1634): "...we can no longer comfortably say what is a species anymore." [Pennisi 2001]

This sharing of information is not an accident. It is nature's method of enhancing the survival of the biosphere. As discussed earlier, genes are physical memories of an organism's learned experiences. The recently recognized exchange of genes among individuals disperses those memories, thereby influencing the survival of all organisms that

make up the community of life. Now that we are aware of this inter- and intra-species gene transfer mechanism, the dangers of genetic engineering become apparent. For example, tinkering with the genes of a tomato may not stop at that tomato, but could alter the entire biosphere in ways that we cannot foresee. Already there is a study that shows that when humans digest genetically modified foods, the artificially created genes transfer into and alter the character of the beneficial bacteria in the intestine. [Heritage 2004; Netherwood, et al, 2004] Similarly, gene transfer among genetically engineered agricultural crops and surrounding native species has given rise to highly resistant species deemed superweeds. [Milius 2003; Haygood, et al, 2003; Desplanque, et al, 2002; Spencer and Snow 2001] Genetic engineers have never taken the reality of gene transfer into consideration when they have introduced genetically modified organisms into the environment. We are now beginning to experience the dire consequences of this oversight as their engineered genes are spreading among, and altering other organisms in the environment. [Watrud, et al, 2004]

Genetic evolutionists warn that if we fail to apply the lessons of our shared genetic destiny, which should be teaching us the importance of cooperation among all species, we threaten human existence. We need to move beyond Darwinian theory, which stresses the importance of *individuals,* to one that stresses the importance of the *community,* British scientist Timothy Lenton provides evidence that evolution is more dependent on the interaction among species than it is on the interaction of individuals within a species. Evolution becomes a matter of the survival of the fittest *groups* rather than the survival of the fittest individuals. In a 1998 article in *Nature,* Lenton wrote that rather than focusing on individuals and their role in evolution, "...We must consider the totality of organisms and their material environment to fully understand which traits come to persist and dominate." [Lenton 1998]

Lenton subscribes to James Lovelock's Gaia hypothesis that holds that the Earth and all of its species constitute one interactive, living organism. Those who endorse the hypothesis argue that tampering with the balance of that super-organism called Gaia, whether it be by destroying the rainforest, depleting the ozone layer or altering organ-

isms through genetic engineering, can threaten its survival and consequently ours.

Recent studies funded by Britain's Natural Environment Research Council provide support for those concerns. [Thomas, et al, 2004; Stevens, et al, 2004] While there have been five mass extinctions in the history of our planet, they are all presumed to have been caused by extraterrestrial events, such as a comet smashing to earth. One of the new studies concludes that the "natural world is experiencing the sixth, major extinction event in its history." [Lovell 2004] This time though, the cause of the extinctions is not extraterrestrial. According to one of the study's authors, Jeremy Thomas: "As far as we can tell this one is caused by one animal organism —man."

Walking the Talk of Cells

In my years of teaching in medical school, I had come to realize that medical students in an academic setting are more competitive and backbiting than a truckload of lawyers. They live out the Darwinian struggle in their quest to be one of the "fittest" who stagger to graduation after four grueling years in medical school. The single-minded pursuit of stellar medical school grades, without regard for the students surrounding you, no doubt follows a Darwinian model, but it always seemed to me an ironic pursuit for those who are striving to become compassionate healers.

But my stereotypes about medical students toppled during my stay on the island. After my call to arms, my class of misfits stopped acting like conventional medical students; they dropped their survival of the fittest mentality and amalgamated into a single force, a team that helped them survive the semester. The stronger students helped the weaker and in so doing, all became stronger. Their harmony was both surprising and beautiful to observe.

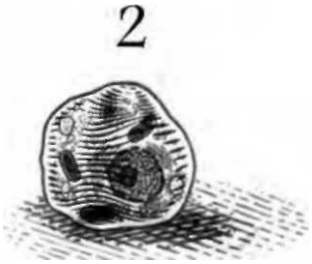
In the end, there was a bonus: a happy Hollywood ending. For their final exam, I gave my students exactly the same test the students in Wisconsin had to pass. There was virtually no difference in the performance of these "rejects" and their "elitist" counterparts in the States. Many students later reported that when they went home and met with their peers who attended American medical schools, they proudly

found themselves more proficient in their understanding of the principles governing the life of cells and organisms.

I was of course thrilled that my students had pulled off an academic miracle. But it was years before I understood *how* they were able to do it. At the time, I thought the format of the course was key, and I still believe that overlapping human and cell biology is a better way to present the course material. But now that I've ventured into what I told you would be considered by some as wacky Dr. Dolittle territory, I think a good part of the reason for my students' success was that they eschewed the behavior of their counterparts in the United States. Instead of mirroring smart American medical students, they mirrored the behavior of smart cells, banding together to become even smarter. I didn't tell my students to pattern their lives after the lives of the cells, because I was still steeped in traditional, scientific training. But I like to think that they went in that direction intuitively, after listening to my praise of cells' ability to group together cooperatively to form more complex and highly successful organisms.

I didn't know it at the time, but I now believe that another reason for my students' success was that I did not stop at praising cells. I praised the students as well. They needed to hear they were first-rate students in order to believe that they could perform as first-rate students. As I will detail in future chapters, so many of us are leading limited lives not because we have to, but because we *think* we have to. But I'm getting ahead of myself. Suffice it to say that after four months in paradise, teaching in a way that clarified my thinking about cells and the lessons they provide to humans, I was well on my way to an understanding of the New Biology, which leaves in the dust the defeatism of genetic and parental programming as well as survival-of-the-fittest Darwinism.

Chapter 2



IT'S THE ENVIRONMENT, STUPID

I will never forget a piece of wisdom I received in 1967, on the first day I learned to clone stem cells in graduate school. It took me decades to realize how profound this seemingly simple piece of wisdom was for my work and my life. My professor, mentor and consummate scientist, Irv Konigsberg was one of the first cell biologists to master the art of cloning stem cells. He told me that when the cultured cells you are studying are ailing, you look first to the cell's environment, not to the cell itself for the cause.

My professor wasn't as blunt as Bill Clinton's campaign manager James Carville, who decreed, "It's the economy, stupid," to be the mantra for the 1992 presidential election. But cell biologists would have done well to post, "It's the environment, stupid," over our desks, just as the "It's the economy, stupid" sign was posted at Clinton headquarters. Though it wasn't apparent at the time, I eventually realized that this advice was a key insight into understanding the nature of life. Over and over I learned the wisdom of Irv's advice. When I provided a healthy environment for my cells they thrived; when the environ

ment was less than optimal, the cells faltered. When I adjusted the environment, these "sick" cells revitalized.

But most cell biologists knew nothing of this wisdom of tissue culture techniques. And scientists moved sharply away from considering environmental influences after Watson and Crick's revelation of DNA's genetic code. Even Charles Darwin conceded, near the end of his life, that his evolutionary theory had shortchanged the role of the environment. In an 1876 letter to Moritz Wagner he wrote: [Darwin, F 1888]

"In my opinion, the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environments, i.e. food, climate, etc., independently of natural selection...When I wrote the "Origin," and for some years afterwards, I could find little good evidence of the direct action of the environment; now there is a large body of evidence."

Scientists who follow Darwin continue to make the same error. The problem with this underemphasis on the environment is that it led to an overemphasis on "nature" in the form of genetic determinism— the belief that genes "control" biology. This belief has not only led to a misallocation of research dollars, as I will argue in a later chapter, but more importantly, it has changed the way we think about our lives. When you are convinced that genes control your life and you know that you had no say in which genes you were saddled with at conception, you have a good excuse to consider yourself a victim of heredity. "Don't blame me for my work habits —it's not my fault that I've been procrastinating on my deadline...It's genetic!"

Since the dawning of the Age of Genetics, we have been programmed to accept that we are subservient to the power of our genes. The world is filled with people who live in constant fear that, on some unsuspecting day, their genes are going to turn on them. Consider the masses of people who think they are ticking time bombs; they wait for cancer to explode in their lives as it exploded in the life of their mother or brother or sister or aunt or uncle. Millions of others attribute their failing health not to a combination of mental, physical, emotional and spiritual causes, but simply to the inadequacies of their body's biochemical mechanics. Are your kids unruly? Increasingly the first choice is to medicate these children to correct their "chemical imbalances," rather than fully grappling with what is going on in their bodies, minds and spirits.

Of course there is no doubt that some diseases, like Huntington's chorea, beta thalassemia and cystic fibrosis, can be blamed entirely on one faulty gene. But single-gene disorders affect less than two percent of

the population; the vast majority of people come into this world with genes that should enable them to live a happy and healthy life. The diseases that are today's scourges — diabetes, heart disease and cancer —short circuit a happy and healthy life. These diseases, however, are not the result of a single gene, but of complex interactions among multiple genes and environmental factors.

What about all those headlines trumpeting the discovery of a gene for everything from depression to schizophrenia? Read those articles closely and you'll see that behind the breathless headlines is a more sober truth. Scientists have linked lots of genes to lots of different diseases and traits, but scientists have rarely found that *one* gene causes a trait or a disease.

The confusion occurs when the media repeatedly distort the meaning of two words: correlation and causation. It's one thing to be linked to a disease; it's quite another to cause a disease, which implies a directing, controlling action. If I show you my keys and say that a particular key "controls" my car, you at first might think that makes sense because you know you need that key to turn on the ignition. But does the key actually "control" the car? If it did, you couldn't leave the key in the car alone because it might just borrow your car for a joy ride when you are not paying attention. In truth, the key is "correlated" with the control of the car; the person who turns the key actually controls the car. Specific genes are correlated with an organism's behavior and characteristics. But these genes are not activated until something triggers them.

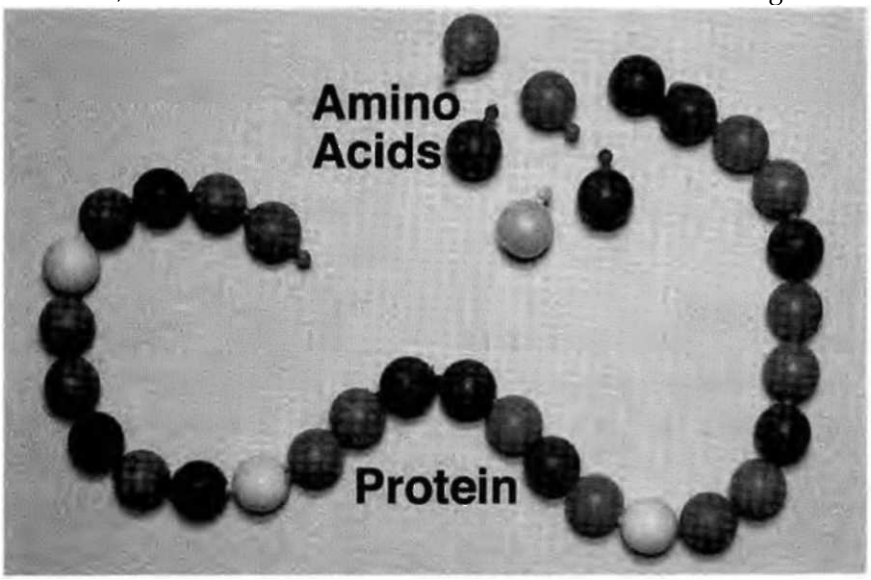
What activates genes? The answer was elegantly spelled out in 1990 in a paper entitled "Metaphors and the Role of Genes and Development" by H. F. Nijhout. [Nijhout 1990] Nijhout presents evidence that the notion that genes control biology has been so frequently repeated for such a long period of time that scientists have forgotten it is a hypothesis, not a truth. In reality, the idea that genes control biology is a supposition, which has never been proven and in fact has been undermined by the latest scientific research. Genetic control, argues Nijhout, has become a metaphor in our society. We want to believe that genetic engineers are the new medical magicians who can cure diseases and while they're at it create more Einsteins and Mozarts as well. But metaphor does not equate with scientific truth. Nijhout summarizes the truth: "When a gene product is needed, a signal from its environment, not an emergent property of the gene itself, activates expression of that gene." In other words, when it comes to genetic control, "It's the environment, stupid."

Protein: The Stuff of Life

It is easy to understand how genetic control became a metaphor as scientists with ever-greater excitement zeroed in on the mechanisms of DNA. Organic chemists discovered that cells are made up of four types of very large molecules: polysaccharides (complex sugars), lipids (fats), nucleic acids (DNA/RNA) and proteins. Though the cell requires each of the four molecular types, proteins are the most important single component for living organisms. Our cells are, in the main, an assembly of protein-building blocks. So one way of looking at our trillion-celled bodies is that they are protein machines, although, as you know, I think we are more than machines! It sounds simple, but it isn't. For one thing, it takes over 100,000 different types of proteins to run our bodies.

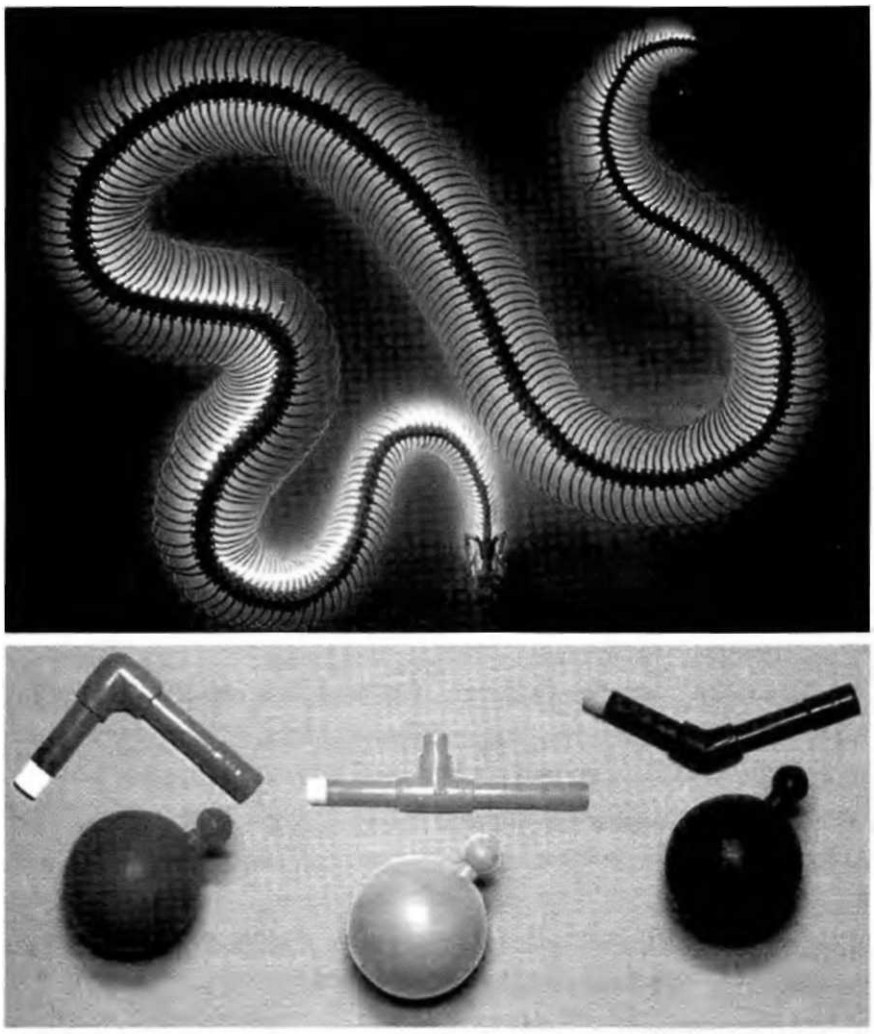
Let's take a closer look at how our cells' 100,000 plus proteins are assembled. Each protein is a linear string of linked amino acid molecules, comparable to a child's pop bead necklace as illustrated on the following page.

Each bead represents one of the twenty amino acid molecules used by cells. Though I like the pop bead analogy because everyone is familiar with it, it is not an exact one because each amino acid has a slightly different shape. So to be completely accurate, you should think of a pop bead necklace that got mangled a bit in the factory.



And to be even more accurate, you should know that the amino acid necklace, which forms the "backbone" of the cells' proteins, is far more malleable than a pop bead necklace, which falls apart when you bend it too much. The structure and behavior of the linked amino acids in protein backbones better resemble that of a snake's backbone. The spine of a snake, made up of a large number of linked subunits, the vertebrae, is capable of coiling the snake into a wide variety of shapes, ranging from a straight rod to a knotted "ball."

The flexible links *(peptide bonds)* between amino acids in a protein backbone enables each protein to adopt a variety of shapes. Through the rotation and flexion of their amino acid "vertebrae," protein molecules resemble nano-snakes in their ability to writhe and squirm. There are two primary factors that determine the contour of a protein's backbone, and therefore its shape. One factor is the physical pattern defined by the sequence of differently shaped amino acids comprising the pop bead-

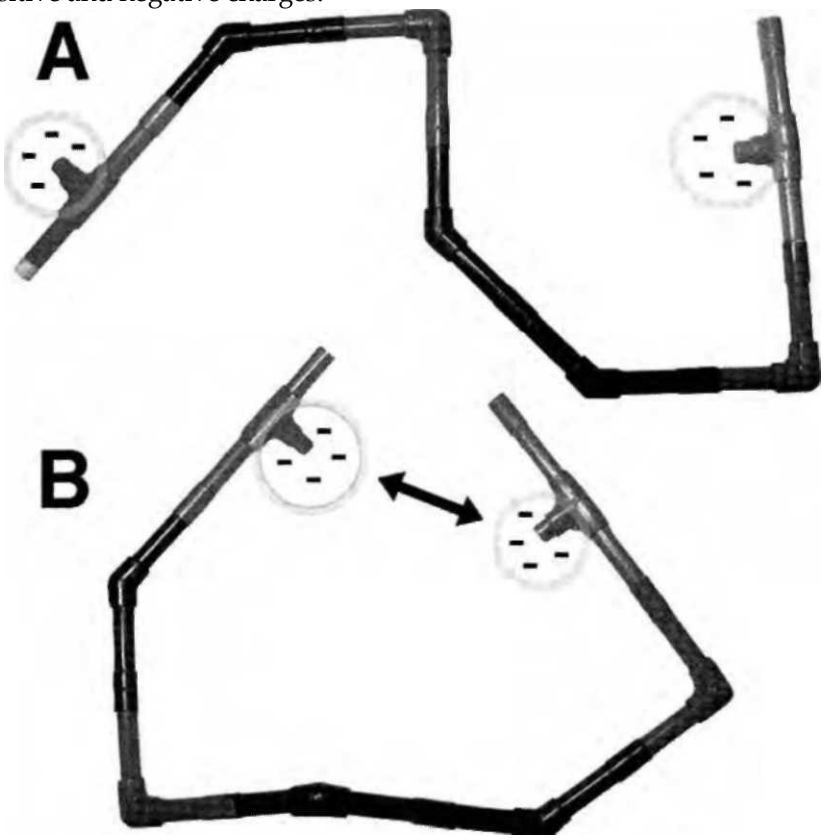


Unlike uniform-shaped pop beads, each of the twenty amino acids comprising protein backbones has a unique conformation. Consider the differences between the character of a "backbone" made from identically shaped pop beads and one assembled from the differently shaped pipe fittings illustrated above.

like backbone.

The second factor concerns the interaction of electromagnetic charges among the linked amino acids. Most amino acids have posi five or negative charges, which act like magnets: *like* charges cause the molecules to repel one another, while *opposite* charges cause the mole-

cules to attract each other. As shown above, a protein's flexible backbone spontaneously folds into a preferred shape when its amino acid subunits rotate and flex their bonds to balance the forces generated by their positive and negative charges.



The protein backbones shown in A and B have the exact same amino acid (pipe fitting) sequence but reveal radically different shapes (conformations). Variations in the backbone's shape result from differential rotations at the junctions between adjacent fittings. Like pipe fittings, the protein's differently shaped amino acids also rotate around their junctions (peptide bonds), allowing the backbone to wriggle like a snake. Proteins shape-shift though they will generally prefer two or three specific conformations. Which of the two conformations, A or B, would our hypothetical protein prefer? The answer is related to the fact that the two terminal amino acids (pipe fittings) have regions of negative charges. Since like-charges repel each other, the farther apart they are, the more stable the conformation. Conformation A would be preferred because the negative charges are farther apart than they are in B.

The backbones of some protein molecules are so long that they require the assistance of special "helper" proteins called chaperones to aid in the folding process. Improperly folded proteins, like people with spinal defects, are unable to function optimally. Such aberrant proteins are marked for destruction by the cell; their backbone amino acids are disassembled and recycled in the synthesis of new proteins.

How Proteins Create Life

Living organisms are distinguished from non-living entities by the fact that they move; they are *animated.* The energy driving their move-

ments is harnessed to do the "work" that characterizes living systems, such as respiration, digestion, and muscle contraction. To understand the nature of life one must first understand how protein "machines" are empowered to move.

The final shape, or *confoiTnation* (the technical term used by biologists), of a protein molecule reflects a balanced state among its electromagnetic charges. However, if the protein's positive and negative charges are altered, the protein backbone will dynamically twist and adjust itself to accommodate the new distribution of charges. The distribution of electromagnetic charge within a protein can be selectively altered by a number of processes including: the binding of other molecules or chemical groups such as hormones; the enzymatic removal or addition of charged ions; or interference from electromagnetic fields such as those emanating from cell phones. [Tsong 1989]

The shape-shifting proteins exemplify an even more impressive engineering feat because their precise, three-dimensional shapes also

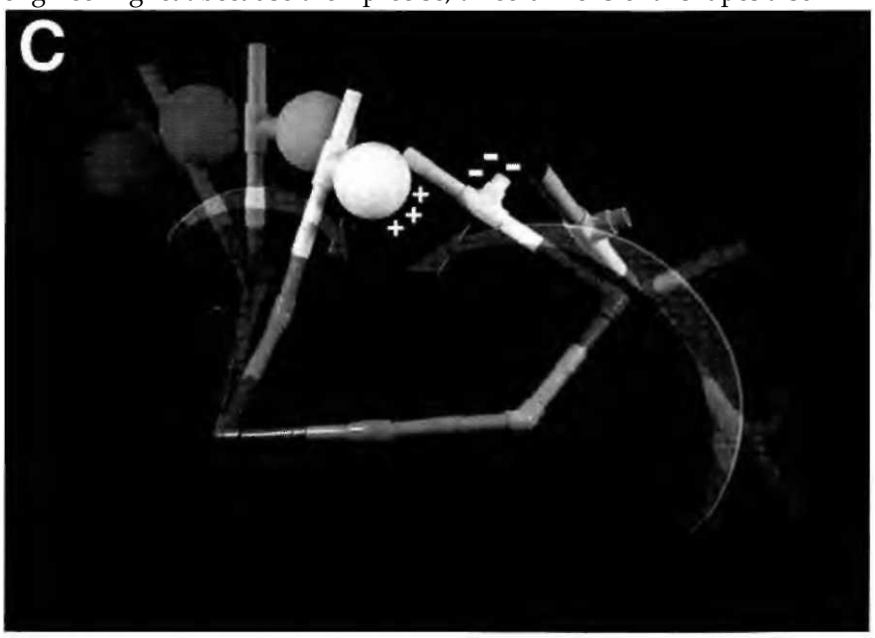
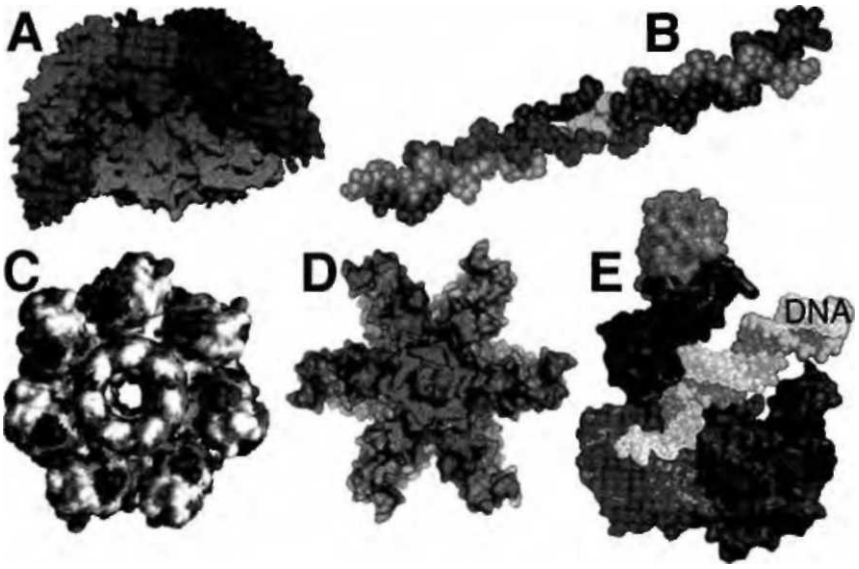


Figure A shows the preferred conformation of our hypothetical protein backbone. The repelling forces between the two negatively charged terminal amino acids (arrows) causes the backbone to extend so that the negative amino acids are as far apart as possible. Figure B shows a close-up of an end amino acid. A *signal,* in this case a molecule with a very positive electric charge (white sphere), is attracted to, and binds with, the negative site on the protein's terminal amino acid. In our particular scenario, the signal is *more* positive in charge than the amino acid is negative in charge. After the signal couples with the protein, there is now an excess positive charge at this end of the backbone. Since positive and negative charges attract one another, the backbone's amino acids will rotate around their bonds so that positive and negative terminals will come closer together. Figure C shows the protein changing from conformation A to conformation B. Changing conformations generates movement and the movement is harnessed to do work, providing for such functions as digestion, respiration and muscle contraction. When the signal detaches, the protein returns to its preferred extended conformation. This is how signal-generated protein movements provide for life.

give them the ability to link up with other proteins. When a protein encounters a molecule that is a physical and energetic complement, the two bind together like human-made products with interlocking gears, say an eggbeater or an old-fashioned watch.

Examine the following two illustrations. The first shows five uniquely shaped proteins, examples of the molecular "gears" found in cells. These organic "gears" have softer edges than machine-shop-manufactured gears, but you can see that their precise, three-dimensional shapes would enable them to securely engage with other complementary proteins.



Protein Menagerie. Illustrated above are five different examples of protein molecules. Each protein possesses a precise three-dimensional conformation that is the same for each copy of itself in every cell. A) Enzyme that digests hydrogen atoms; B) Woven filament of collagen protein; C) Channel, a membrane-bound protein with hollow central pore; D) Protein subunit of "capsule" that encloses a virus; E) DNA-synthesizing enzyme with attached helical DNA molecule

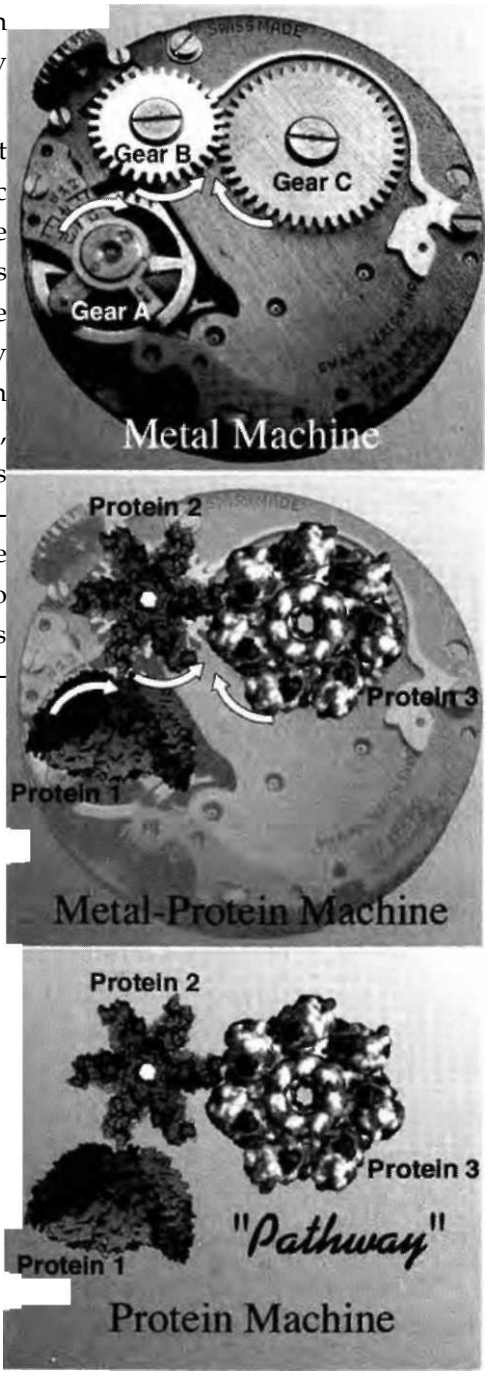
In the second illustration (p.59), I chose a wind-up watch to represent the workings of the cell. The first picture shows a metal machine, revealing the gears, springs, jewels and case of the watch model. When Gear A turns it causes Gear B to turn. When B moves it causes Gear C to turn, etc. In the next image, I overlay the human-made machined gears with softer-edged organic proteins (magnified millions of times in proportion to the watch) so that it becomes visually conceivable that proteins could be like the watch's mechanism. In this metal-protein "machine," one can imagine Protein A rotating and causing Protein B to revolve, which in turn causes Protein C to move. Once you see that

possibility, you can look to the third figure in which the human-made parts are removed. Voila! We are left with a protein "machine," one of

the thousands of similar protein assemblies that collectively comprise the cell!

Cytoplasmic proteins that cooperate in creating specific physiologic functions are grouped into specific assemblies known as *pathways.* These assemblies are identified by functions such as respiration pathways, digestion pathways, muscle contraction pathways and the infamous, energy-generating Krebs cycle, the bane of many a science student, who has to memorize every one of its protein components and complex chemical reactions.

Can you imagine how excited cell biologists were when they figured out how the protein assembly machines work? Cells exploit the movements of these protein-assembly machines to empower specific metabolic and behavioral functions. The constant, shape-shifting movements of proteins—which can occur thousands of times in a single second—are the movements that propel life.



The Primacy of DNA

You'll notice that in the above section I didn't discuss DNA at all. That's because it is the changing of the proteins' electromagnetic charges that is responsible for their behavior-generating movement, not DNA. How did we get to the widespread and often-cited notion that genes "control" biology? In the *Origin of Species,* Darwin suggested that "hereditary" factors were passed on from generation to generation, controlling the traits of the offspring. Darwin's influence was so great

that scientists myopically focused on identifying that hereditary material which, they thought, controlled life.

In 1910, intensive microscopic analyses revealed that the hereditary information passed on generation after generation was contained in chromosomes, thread-like structures that become visible in the cell just before it divides into two "daughter" cells. Chromosomes are incorporated into the daughter cell's largest organelle, the nucleus. When scientists isolated the nucleus, they dissected the chromosomes and found that the hereditary elements were essentially comprised of only two kinds of molecules, protein and DNA. Somehow the protein machinery of life was entangled in the structure and function of these chromosome molecules.

The understanding of the chromosome's functions was further refined in 1944 when scientists determined that it was DNA that actually contained hereditary information. [Avery, et al, 1944; Lederberg 1994] The experiments that singled out DNA were elegant. These scientists isolated pure DNA from one species of bacteria —let's call it Species A— and added the pure DNA to cultures containing only Species B bacteria. Within a short time, Species B bacteria began to show hereditary traits that were formerly seen only in Species A. Once it was known that you needed nothing other than DNA to pass on traits, the DNA molecule became a scientific superstar.

It was now left to Watson and Crick to unravel the structure and function of that superstar molecule. DNA molecules are long and threadlike. They are made from four nitrogen-containing chemicals called bases (adenine, thymine, cytosine, and guanine or A, T, C and G). Watson and Crick's discovery of DNA's structure led to the fact that the sequence of the A, T, C and G bases in DNA spells out the sequence of amino acids along a protein's backbone [Watson and Crick 1953]. Those long strings of DNA molecules can be subdivided into single genes, segments that provide the blueprint for specific proteins. The code for recreating the protein machinery of the cell had been cracked!

Watson and Crick also explained why DNA is the perfect hereditary molecule. Each DNA strand is normally intertwined with a second strand of DNA, a loosely wrapped configuration known as the "double helix." The genius of this system is that the sequences of DNA bases on both strands are mirror images of each other. When the two strands of DNA unwind, each single strand contains the information to make an exact, complementary copy of itself. So through a process of separating the strands of a double helix, DNA molecules become self-replicating.

This observation led to the assumption that DNA "controlled" its own replication...it was its own "boss."

The "suggestion" that DNA controlled its own replication *and* also served as the blueprint for the body's proteins led Francis Crick to create biology's Central Dogma, the belief that DNA rules. The dogma is so fundamental to modern biology it is essentially written in stone, the equivalent of science's Ten Commandments. The dogma, also referred to as "The Primacy of DNA," is a fixture of every scientific text.

In the dogma's scheme of how life unfolds, DNA perches loftily on top, followed by RNA. RNA is the short-lived Xerox™ copy of the DNA. As such, it is the physical template encoding the amino acid sequence that makes up a protein's backbone. The Primacy of DNA diagram provides the logic for the Age of Genetic Determinism. Because the character of a living organism is defined by the nature of its proteins, and its proteins are encoded in the DNA, then by logic, DNA would represent the "first cause" or primary determinant of an organism's traits.

The Human Genome Project

After DNA achieved superstar status, the remaining challenge was to create a catalogue of all the genetic stars in the human firmament. Enter the Human Genome Project, a global, scientific effort begun in the late 1980s to create a catalogue of all the genes present in humans.

From the outset, the Human Genome Project was a massively ambitious one. Conventional thought held that the body needed one gene to provide the blueprint for each of the 100,000 plus different proteins that make up our bodies. Add to that at least 20,000 regulatory genes, which orchestrate the activity of the protein-encoding genes. Scientists concluded that the human genome would contain a minimum of 120,000 genes located within the twenty-three pairs of human chromosomes.

But that wasn't the whole story. A cosmic joke was unfolding, one of those jokes that periodically unsettle scientists convinced they have discovered the secrets of the Universe. Consider the impact of Nicolaus Copernicus' discovery published in 1543 that the Earth was not the center of the Universe as was thought by the scientist-theologians of the day. The fact that the Earth actually revolved around the sun, and that the sun itself was not the center of the universe, undermined the teachings of the Church. Copernicus' paradigm-busting discoveries launched the modern, scientific revolution by challenging the presumed "infallibility" of the Church. Science eventually displaced the Church as

Western civilization's source of wisdom for understanding the mysteries of the Universe.

Geneticists experienced a comparable shock when, contrary to their expectations of over 120,000 genes, they found that the entire human genome consists of approximately 25,000 genes. [Pennisi 2003a and 2003b; Pearson 2003; Goodman 2003] More than eighty percent of the presumed and *required* DNA does not exist! The missing genes are proving to be more troublesome than the missing eighteen minutes of the Nixon tapes. The one-gene, one-protein concept was a fundamental tenet of genetic determinism. Now that the Human Genome Project has toppled the one-gene for one-protein concept, our current theories

The Central Dogma. The dogma, also referred to as the *Primacy of DNA,* defines the flow of information in biological organisms. As indicated by the arrows, the flow is *only* in one direction, from DNA to RNA and then to Protein. The DNA represents the cell's long-term memory, passed from generation to generation. RNA, an unstable copy of the DNA molecule, is the *active* memory that is used by the cell as a physical template in synthesizing proteins. Proteins are the molecular building blocks that provide for the cell's structure and behavior. DNA is implicated as the 'source" that controls the character of the cell's proteins, hence the concept of DNA's *primacy* that literally means "first cause."

of how life works have to be scrapped. No longer is it possible to believe that genetic engineers can with relative ease fix all our biological dilemmas. There are simply not enough genes to account for the complexity of human life or of human disease.

I may sound like Chicken Little shouting that the genetics sky is falling. However, you don't have to take my word for it. Chicken Big is saying the same thing. In a commentary on the surprising results of the

Human Genome Project, David Baltimore, one of the world's pre-eminent geneticists and a Nobel Prize winner, addressed the issue of human complexity: [Baltimore 2001]

"But unless the human genome contains a lot of genes that are opaque to our computers, it is clear that we do not gain our undoubted complexity over worms and plants by using more genes.

"Understanding what does give us our complexity — our enormous behavioral repertoire, ability to produce conscious action, remarkable physical coordination, precisely tuned alterations in response to external variations of the environments, learning, memory, need I go on? — remains a challenge for the future."

As Baltimore states, the results of the Human Genome Project force us to consider other ideas about how life is controlled. "Understanding what does give us our complexity...remains a challenge for the future." The sky *is* falling.

In addition, the results of the Human Genome Project are forcing us to reconsider our genetic relationship with other organisms in the biosphere. We can no longer use genes to explain why humans are at the top of the evolutionary ladder. It turns out there is not much difference in the total number of genes found in humans and those found in primitive organisms. Let's take a look at three of the most studied animal models in genetic research, a microscopic nematode roundworm known as *Caenorhabditis elegans,* the fruit fly and the laboratory mouse.

The primitive *Caenorhabditis* worm serves as a perfect model for studying the role of genes in development and behavior. This rapidly growing and reproducing organism has a precisely patterned body comprised of exactly 969 cells and a simple brain of about 302 cells. Nonetheless it has a unique repertoire of behaviors and most importantly, it is amenable to genetic experimentation. The *Caenorhabditis* genome consists of approximately 24,000 genes. [Blaxter 2003] The human body, comprised of over fifty trillion cells, contains only 1,500 more genes than the lowly, spineless, thousand-celled microscopic worm.

The fruit fly, another favored research subject, has 15,000 genes. [Blaxter 2003; Celniker, et al, 2002] So the profoundly more complicated fruit fly has 9,000 fewer genes than the more primitive

Caenorhabditis worm. And when it comes to the question of mice and men, we might have to think more highly of them, or less of ourselves; the results of parallel genome projects reveal that humans and rodents have roughly the same number of genes!

Cell Biology 101

In retrospect, scientists should have known that genes couldn't provide the *control* of our lives. By definition, the brain is the organ responsible for controlling and coordinating the physiology and behavior of an organism. But is the nucleus truly the cell's brain? If our assumption that the nucleus and its DNA-containing material is the "brain" of the cell, then removing the cell's nucleus, a procedure called enucleation, should result in the immediate death of the cell.

And now, for the big experiment...(Maestro, a drum roll if you please).

The scientist drags our unwilling cell into the microscopic operating arena and straps it down. Using a micromanipulator, the scientist guides a needle-like micropipette into position above the cell. With a deft thrust of the manipulator, our investigator plunges the pipette deep into the cell's cytoplasmic interior. By applying a little suction, the nucleus is drawn up into the pipette and the pipette is withdrawn from the cell. Below the nucleus-engorged pipette lies our sacrificial cell - its "brain" torn out.

But *wait!* It's still moving! My God...the cell is still *alive!*

The wound has closed and like a recovering surgical patient, the cell begins to slowly stagger about. Soon the cell is back on its feet (OK, its pseudopods), fleeing the microscope's field with the hope that it will never see a doctor again.

Following enucleation, many cells can survive for up to two or more months without genes. Viable enucleated cells do not lie about like brain-dead lumps of cytoplasm on life-support systems. These cells actively ingest and metabolize food, maintain coordinated operation of their physiologic systems (respiration, digestion, excretion, motility, etc.), retain an ability to communicate with other cells, and are able to engage in appropriate responses to growth and protection-requiring environmental stimuli.

Unsurprisingly, enucleation is not without side effects. Without their genes, cells are not able to divide, nor are they able to reproduce any protein parts they lose through the normal wear and tear of the cytoplasm. The inability to replace defective cytoplasmic proteins contributes to mechanical dysfunctions that ultimately result in the death of the cell.

Our experiment was designed to test the idea that the nucleus is the "brain" of the cell. If the cell had died immediately following enucleation, the observations would have at least supported that belief.

However, the results are unambiguous: enucleated cells still exhibit complex, coordinated, life-sustaining behaviors, which imply that the cell's "brain" is still intact and functioning.

The fact that enucleated cells retain their biological functions in the absence of genes is by no means a new discovery. Over a hundred years ago, classical embryologists routinely removed the nuclei from dividing egg cells and showed that a single, enucleated egg cell was able to develop as far as the blastula, an embryonic stage consisting of forty or more cells. Today, enucleated cells are used for industrial purposes as living "feeder" layers in cell cultures designed for virus vaccine production.

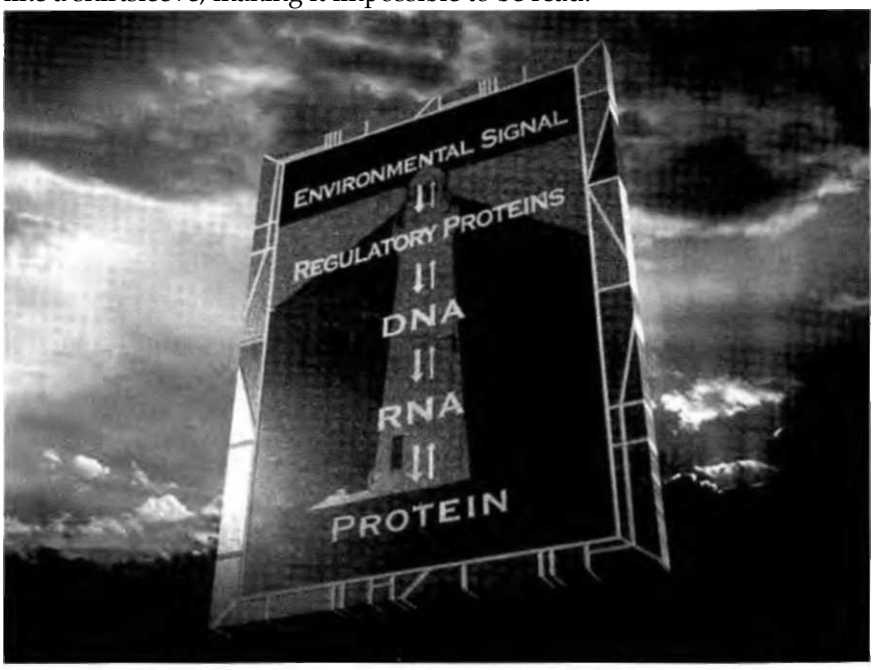
If the nucleus and its genes are not the cell's brain, then what exactly is DNA's contribution to cellular life? Enucleated cells die, not because they have lost their brain but because they have lost their reproductive capabilities. Without the ability to reproduce their parts, enucleated cells cannot replace failed protein building blocks, nor replicate themselves. So the nucleus is not the brain of the cell —the nucleus is the cell's gonad! Confusing the gonad with the brain is an understandable error because science has always been and still is a patriarchal endeavor. Males have often been accused of thinking with their gonads, so it's not entirely surprising that science has inadvertently confused the nucleus with the cell's brain!

Epiqenetics: The New Science of Self-Empowerment

Genes-as-destiny theorists have obviously ignored hundred-year-old science about enucleated cells, but they cannot ignore new research that undermines their belief in genetic determinism. While the Human Genome Project was making headlines, a group of scientists were inaugurating a new, revolutionary field in biology called *epi-genetics.* The science of epigenetics, which literally means "control above genetics," profoundly changes our understanding of how life is controlled. [Pray 2004; Silverman 2004] In the last decade, epigenetic research has established that DNA blueprints passed down through genes are not set in concrete at birth. Genes are not destiny! Environmental influences, including nutrition, stress and emotions, can modify those genes, without changing their basic blueprint. And those modifications, epigeneticists have discovered, can be passed on to future generations as surely as DNA blueprints are passed on via the Double Helix. [Reik and Walter 2001; Surani 2001]

There is no doubt that epigenetic discoveries have lagged behind genetic discoveries. Since the late 1940s, biologists have been isolating DNA from the cell's nucleus in order to study genetic mechanisms. In the process they extract the nucleus from the cell, break open its enveloping membrane and remove the chromosomal contents, half of which is made up of DNA and half of which is made up of regulatory proteins. In their zeal to study DNA, most scientists threw away the proteins, which we now know is the equivalent of throwing the baby out with the bathwater. Epigeneticists are bringing back the baby, by studying the chromosome's proteins, and those proteins are turning out to play as crucial a role in heredity as DNA.

In the chromosome, the DNA forms the core, and the proteins cover the DNA like a sleeve. When the genes are covered, their information cannot be "read." Imagine your bare arm as a piece of DNA representing the gene that codes for blue eyes. In the nucleus, this stretch of DNA is covered by bound regulatory proteins, which cover your blue-eye gene like a shirtsleeve, making it impossible to be read.



PrimacyofEnvironment. The new science reveals that the information that *controls* biology starts with Environmental Signals that in turn, control the binding of Regulatory Proteins to the DNA. Regulatory Proteins direct the activity of genes. The DNA, RN A, and Protein functions are the same as described in the Primacy of DNA chart. Note: the flow of information is no longer unidirectional. In the 1960s, Howard Temin's challenged the Central Dogma with experiments that revealed RNA could go against the predicted flow of information and rewrite the DNA. Originally ridiculed for his "heresy," Temin later won a Nobel Prize for describing *reverse transcriptase,* the molecular mechanism by which RNA can rewrite the genetic code. Reverse transcriptase is now notorious, for it is used by the AIDS virus' RNA to commandeer the infected cell's DNA. It is also now known that changes in the DNA molecule, such as adding or removing methyl chemical groups, influences the binding of regulatory

proteins. Proteins must also be able to buck the predicted flow of information, since protein antibodies in immune cells are involved with changing the DNA in the cells that synthesize them. The size of the arrows indicating information flow are not the same. There are tight restrictions on the reverse flow of information, a design that would prevent radical changes to the cell's genome.

How do you get that sleeve off? You need an environmental signal to spur the "sleeve" protein to change shape, i.e. detach from the DNA's double helix, allowing the gene to be read. Once the DNA is uncovered, the cell makes a copy of the exposed gene. As a result, the activity of the gene is "controlled" by the presence or absence of the ensleeving proteins, which are in turn controlled by environmental signals.

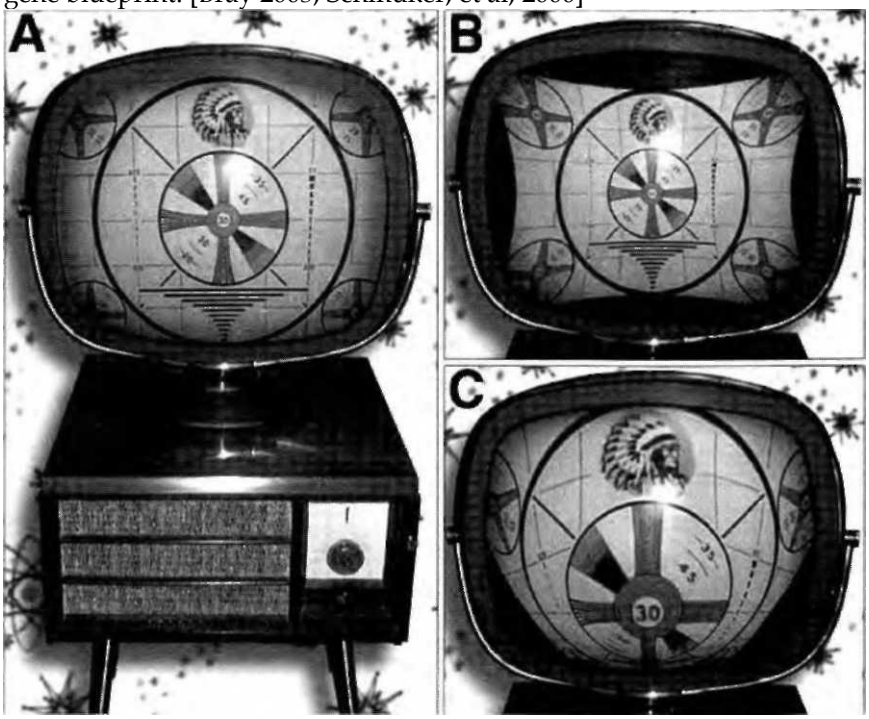
The story of epigenetic control is the story of how environmental signals control the activity of genes. It is now clear that the Primacy of DNA chart described earlier is outmoded. The revised scheme of information flow should now be called the "Primacy of the Environment." The new, more sophisticated flow of information in biology starts with an environmental signal, then goes to a regulatory protein and only then goes to DNA, RNA, and the end result, a protein.

The science of epigenetics has also made it clear that there are two mechanisms by which organisms pass on hereditary information. Those two mechanisms provide a way for scientists to study both the contribution of nature (genes) and the contribution of nurture (epigenetic mechanisms) in human behavior. If you only focus on the blueprints, as scientists have been doing for decades, the influence of the environment is impossible to fathom. [Dennis 2003; Chakravarti and Little 2003]

Let's present an analogy, which hopefully will make the relationship between epigenetic and genetic mechanisms clearer. Are you old enough to remember the days when television programming stopped after midnight? After the normal programming signed off, a "test pattern" would appear on the screen. Most test patterns looked like a dartboard with a bull's eye in the middle, similar to the one pictured on the following page.

Think of the pattern of the test screen as the pattern encoded by a given gene, say the one for brown eyes. The dials and switches of the TV fine-tune the test screen by allowing you to turn it on and off and modulate a number of characteristics, including color, hue, contrast, brightness, vertical and horizontal holds. By adjusting the dials, you can alter the appearance of the pattern on the screen, while not actually changing the original broadcast pattern. This is precisely the role of regulatory proteins. Studies of protein synthesis reveal that epigenetic

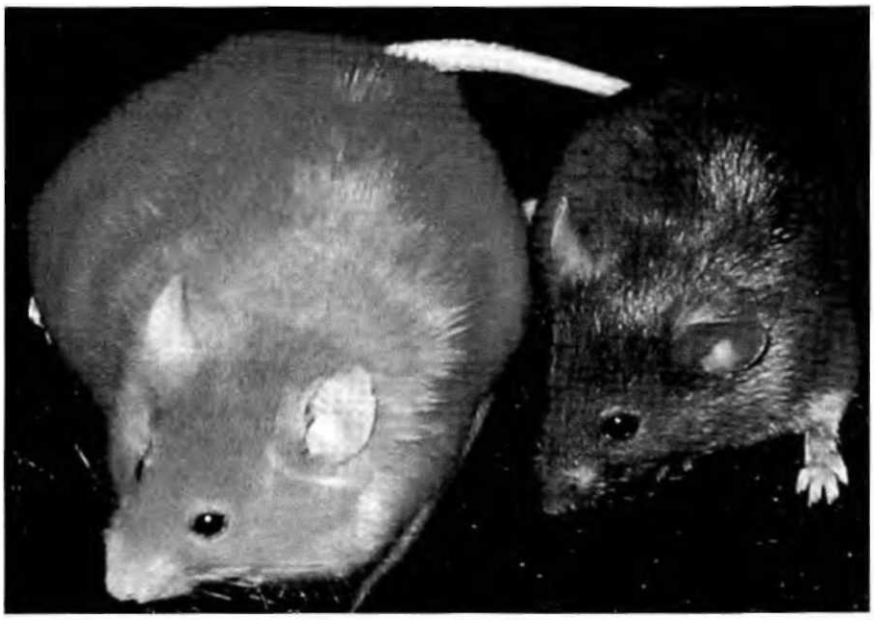
"dials" can create 2,000 or more variations of proteins from the same gene blueprint. [Bray 2003; Schmuker, et al, 2000]



In this epigenetic analogy, the test pattern on the screen represents the protein backbone pattern encoded by a gene. While the TV's controls can change the appearance of the pattern (B and C), they do not change the original pattern of the broadcast (i.e., the gene). Epigenetic control modifies the read-out of a gene without changing the DNA code.

Parental Life Experiences Shape Their Children's Genetic Character

We now know that the environmentally influenced fine-tuning described above can be passed from generation to generation. A landmark Duke University study published in the August 1, 2003 issue of *Molecular and Cellular Biology* found that an enriched environment can even override genetic mutations in mice. [Waterland and Jirtle 2003] In the study, scientists looked at the effect of dietary supplements on pregnant mice with the abnormal "agouti" gene. Agouti mice have yellow coats and are extremely obese, which predisposes them to cardiovascular disease, diabetes and cancer.



Agouti Sisters: One year old female genetically identical agouti mice. Maternal methyl donor supplementation shifts coat color of the offspring from yellow to brown, and reduces the incidence of obesity, diabetes and cancer. (Photo courtesy of Jirtle and Watcrland ©)

In the experiment, one group of yellow, obese, agouti mothers received methyl-group-rich supplements available in health food stores: folic acid, vitamin B12, betaine and choline. Methyl-rich supplements were chosen because a number of studies have shown that the methyl chemical group is involved with epigenetic modifications. When methyl groups attach to a gene's DNA, it changes the binding characteristics of regulatory chromosomal proteins. If the proteins bind too tightly to the gene, the protein sleeve cannot be removed and the gene cannot be read. Methylating DNA can silence or modify gene activity.

This time the headlines "Diet Trumps Genes" were accurate. The mothers who got the methyl group supplements produced standard, lean, brown mice, even though their offspring had the same agouti gene as their mothers. The agouti mothers who didn't get the supplements produced yellow pups, which ate much more than the brown pups. The yellow pups wound up weighing almost twice as much as their lean, "pseudo-agouti" counterparts.

The University's photo on the previous page is striking. Though the two mice are genetically identical, they are radically different in appearance: one mouse is lean and brown and the other mouse is obese and yellow. What you can't see in the picture is that the obese mouse is diabetic while its genetically identical counterpart is healthy.

Other studies have found epigenetic mechanisms to be a factor in a variety of diseases, including cancer, cardiovascular disease and diabetes. In fact, only 5% of cancer and cardiovascular patients can attribute their disease to heredity. [Willett 2002] While the media made a big hoopla over the discovery of the BRCA1 and BRCA2 breast cancer genes, they failed to emphasize that ninety-five percent of breast cancers are not due to inherited genes. The malignancies in a significant number of cancer patients are derived from environmentally-induced epigenetic alterations and not defective genes. [Kling 2003; Jones 2001; Seppa 2000; Baylin 1997]

The epigenetic evidence has become so compelling that some brave scientists are even invoking the "L" word for Jean Baptiste de Lamarck, the much-scorned evolutionist, who believed that traits acquired as a result of environmental influence could be passed on. Philosopher Eva Jablonka and biologist Marion Lamb wrote in their 1995 book *Epigenetic Inheritance and Evolution - The Lamarckian Dimension:* "In recent years, molecular biology has shown that the genome is far more fluid and responsive to the environment than previously supposed. It has also shown that information can be transmitted to descendants in ways other than through the base sequence of DNA." [Jablonka and Lamb 1995]

We're back to where we started in this chapter, the environment. In my own work in the laboratory, I saw over and over the impact a changed environment had on the cells I was studying. But it was only at the end of my research career, at Stanford, that the message fully sank in. I saw that endothelial cells, which are the blood vessel-lining cells I was studying, changed their structure and function depending on their environment. When, for example, I added inflammatory chemicals to the tissue culture, the cells rapidly became the equivalent of macrophages, the scavengers of the immune system. What was also exciting to me was that the cells transformed even when I destroyed their DNA with gamma rays. These endothelial cells were "functionally enucleated," yet they completely changed their biological behavior in response to inflammatory agents, just as they had when their nuclei were intact. These cells were clearly showing some "intelligent" control in the absence of their genes. [Lipton 1991]

Twenty years after my mentor Irv Konigsberg's advice to first consider the environment when your cells are ailing, I finally got it. DNA does not control biology and the nucleus itself is not the brain of the cell. Just like you and me, cells are shaped by where they live. In other words, it's the environment, stupid.

Chapter 3

THE MAGICAL MEMBRANE

Now that we've looked at the protein assembly machinery of the cell, debunked the notion that the nucleus is the brain of the cellular operation, and recognized the crucial role the environment plays in the operation of the cell, we're on to the good stuff— the stuff that can make sense of your life and give you insight into ways of changing it.

This chapter puts forth my nominee for the true brain that controls cellular life — the membrane. I believe that when you understand how the chemical and physical structure of the cell's membrane works, you'll start calling it, as I do, the magical membrane. Or alternatively, capitalizing on the fact that part of the word is a homophone for brain, I refer to it in my lectures as the magical mem-Brain. And when you couple your understanding of the magical membrane with an understanding of the exciting world of quantum physics that I'll present in the next chapter, you will also understand how wrong the tabloids were in 1953. The true secret of life does not lie in the famed double

helix. The true secret of life lies in understanding the elegantly simple biological mechanisms of the magical membrane — the mechanisms by which your body translates environmental signals into behavior.

When I started studying cell biology in the 1960s, the idea that the membrane was the cell's brain would have been considered laughable. And I have to concede that the membrane in those days was a sorry-looking Mensa candidate. The membrane seemed to be just a simple, semi-permeable, three-layered skin that held the contents of the cytoplasm together. Think Saran™ wrap with holes.

One reason scientists misjudged the membrane is that it is so thin. Membranes are only seven millionths of a millimeter thick. In fact, they are so thin that they can only be seen with an electron microscope, which was developed after the Second World War. So it wasn't until the 1950s that biologists could even confirm that cell membranes exist. Up until that time, many biologists thought the cell's cytoplasm held together because it had a Jello™-like consistency. With the aid of microscopes, biologists learned that *all* living cells have membranes and that all cell membranes share the same, basic, three-layered structure. However, the simplicity of that structure belies its functional complexity.

Cell biologists gained insight into the amazing abilities of the cell membrane by studying the most primitive organisms on this planet, the prokaryotes. Prokaryotes, which include bacteria and other microbes, consist only of a cell membrane that envelops a droplet of soupy cytoplasm. Though prokaryotes represent life in its most primitive form, they have purpose. A bacterium does not bounce around in its world like a ball in a pinball machine. A bacterium carries out the basic physiologic processes of life like more complicated cells. A bacterium eats, digests, breathes, excretes waste matter and even exhibits "neurological" processing. They can sense where there is food and propel themselves to that spot. Similarly, they can recognize toxins and predators and purposely employ escape maneuvers to save their lives. In other words, prokaryotes display intelligence!

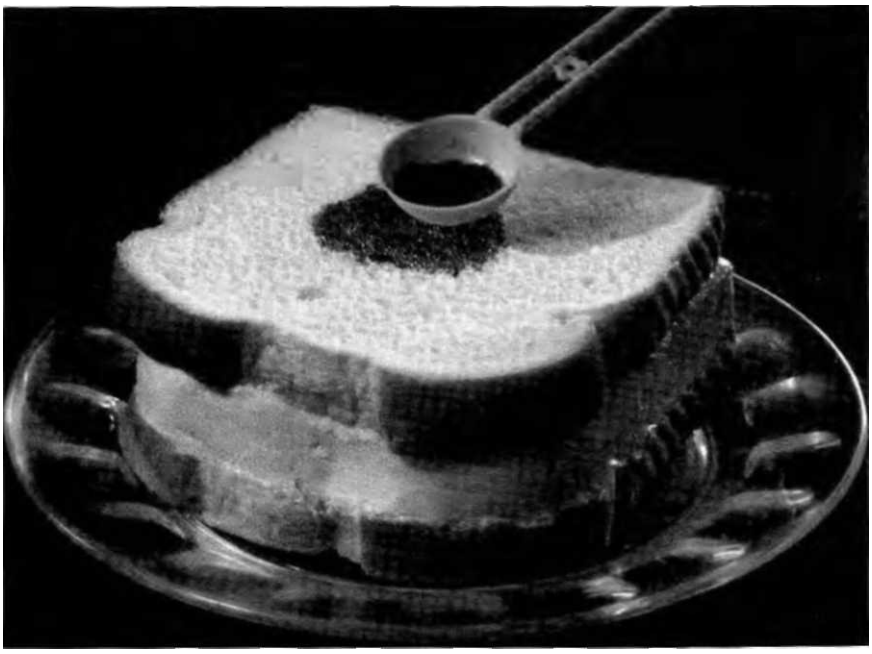
So what structure in the prokaryotic cell provides its "intelligence"? The prokaryotes' cytoplasm has no evident organelles that are found in more advanced, eukaryotic cells, such as the nucleus and mitochondria. The only organized cellular structure that can be considered a candidate for the prokaryote's brain is its cell membrane.

Bread, Butter, Olives and Pimentos

As I came to the realization that membranes were characteristic of all intelligent life, I focused my attention on understanding their structure

and function. I came up with a gastronomic treat (just kidding) to illustrate the basic structure of the membrane. The treat consists of a bread and butter sandwich. To further refine the analogy, I added olives. Actually my instructive sandwich features two kinds of olives, ones stuffed with pimentos, the others pimento-free. Gourmands, don't groan. When I've left this sandwich out of my lectures, repeat members of the audience have asked me where it went!

Here's an easy experiment to show you how the "sandwich" membrane works. Make a bread and butter sandwich (at the moment free



of olives). This sandwich represents a section of the cell membrane. Now pour a teaspoon of colored dye on top of the sandwich.

As illustration below, the dye seeps through the bread, but stops when it gets to the butter, because the oily substance in the middle of the sandwich provides an effective barrier.

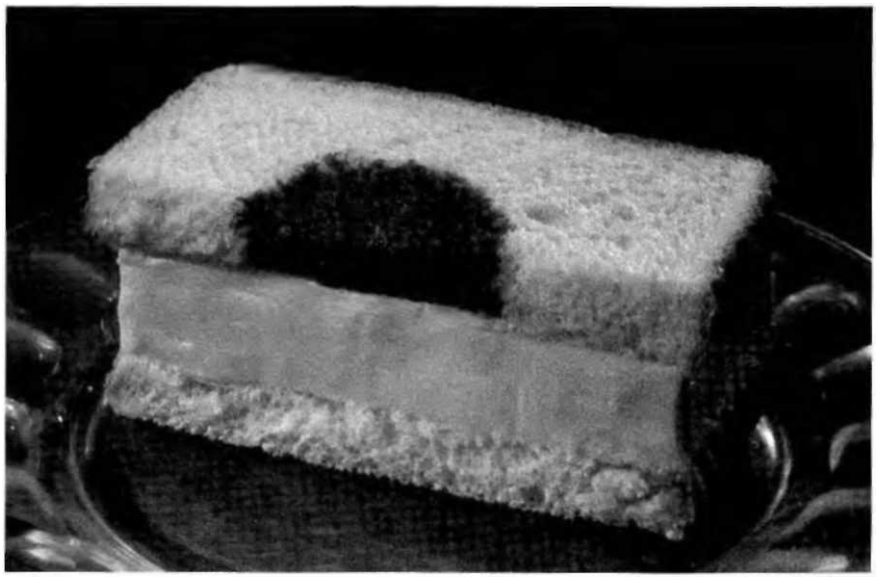
Now let's make a bread and butter sandwich with stuffed and unstuffed olives.

Now when we add the dye to the bread and slice the sandwich, we see a different result. When the dye hits a pimento-stuffed olive, it stops as surely as it stopped when it hit butter. But when the dye reaches an olive without a pimento, the pitted olive provides a channel through which the dye can flow freely across the middle of the sandwich, then through the bread to the plate.

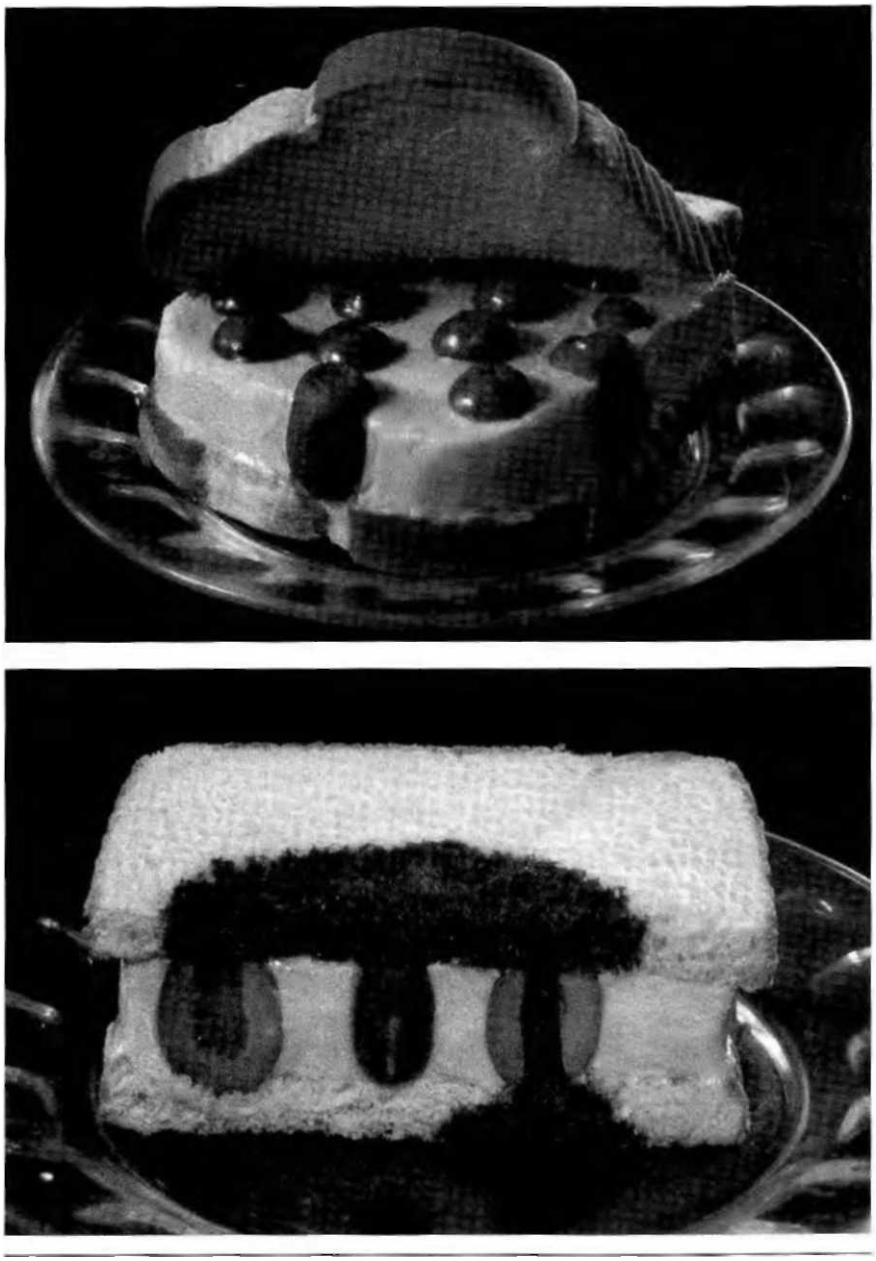
The plate in this analogy represents the cell's cytoplasm. By passing through the pimento-free olive, the dye penetrates the buttery layer to

reach the other side of the "membrane" sandwich. The dye has successfully navigated the formidable, fatty, membrane barrier!

It is important for the cell to allow molecules to break through the barrier because in my sandwich analogy, the dye is life-sustaining food. If the membrane were simply a bread and butter sandwich, it



would provide a fortress-like barrier that keeps out the cacophony of innumerable molecular and radiant energy signals that make up a cell's environment. But the cell would die if the membrane were such a fortress, because it would get no nutrients. When you add the pimento-free olives, which allow information and food into the cell, the

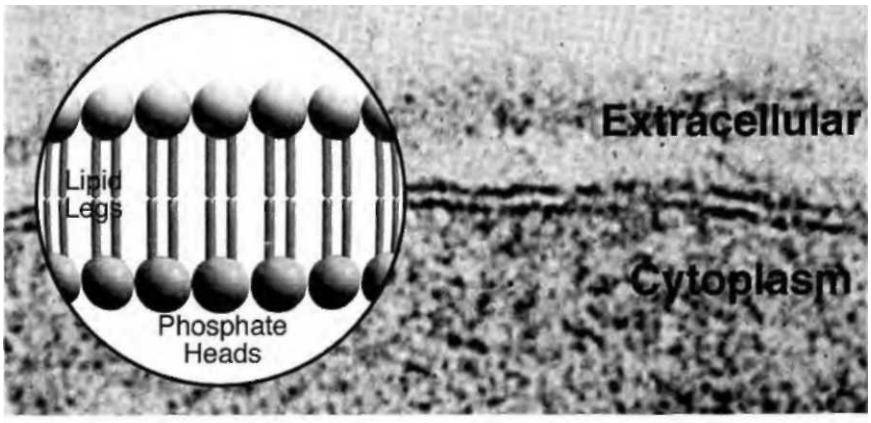


membrane becomes a vital and ingenious mechanism enabling selected nutrients to penetrate the interior of the cell, just as the teaspoonful of dye made its way to the plate.

In real-life cellular biology, the bread and butter portion of the sandwich represents the membrane's phospholipids, one of the two major chemical components of the membrane. (The other major chemical components are the "olive" proteins, which we'll get to below.) I call phospholipids "schizophrenic" because they are composed of both polar and non-polar molecules.

The fact that phospholipids contain both polar and non-polar molecules may not sound like a recipe for schizophrenia to you, but I assure you it is. All the molecules in our Universe can be divided into non-polar and polar categories based on the type of chemical bonds that hold their atoms together. The bonds among polar molecules have positive and/or negative charges, hence their polarity. These molecules' positive and negative charges cause them to behave like magnets, attracting or repelling other charged molecules.

Polar molecules include water and things that dissolve in water. Non-polar molecules include oil and substances that dissolve in oil; there are no positive or negative charges among their atoms. Remember the adage, water and oil don't mix? Neither do oily non-polar and watery polar molecules. To visualize the lack of interaction between polar and non-polar molecules, think of your bottle of Italian salad dressing. You do your best to get vinegar and oil to bond by shaking the bottle, but when you set the bottle down, they separate. That's because molecules, like people, prefer environments that offer them stability. For their stability, polar (vinegar) molecules seek out watery polar environments and non-polar (olive oil) molecules seek out non-polar environments. Phospholipid molecules, comprised of both polar and non-polar lipid regions, have a difficult time in seeking stability. The phosphate portion of the molecule is motivated to seek water, while its lipid portion abhors



Electron micrograph showing the cell membrane at the surface of a human cell. The dark-light-dark layering of the cell membrane is due to the ordering of the barrier's phospholipid molecules (inset). The lighter center of the membrane, the equivalent of the butter in our sandwich, represents the hydrophobic zone formed by the legs of the phospholipids. The dark layers above and below the central lipid zone, the equivalent of the bread slices, represents the molecule's water-loving phosphate heads.

water and seeks stability by dissolving in oil.

Getting back to our sandwich, the membrane's phospholipids are shaped like lollipops with an extra stick (see illustration above). The

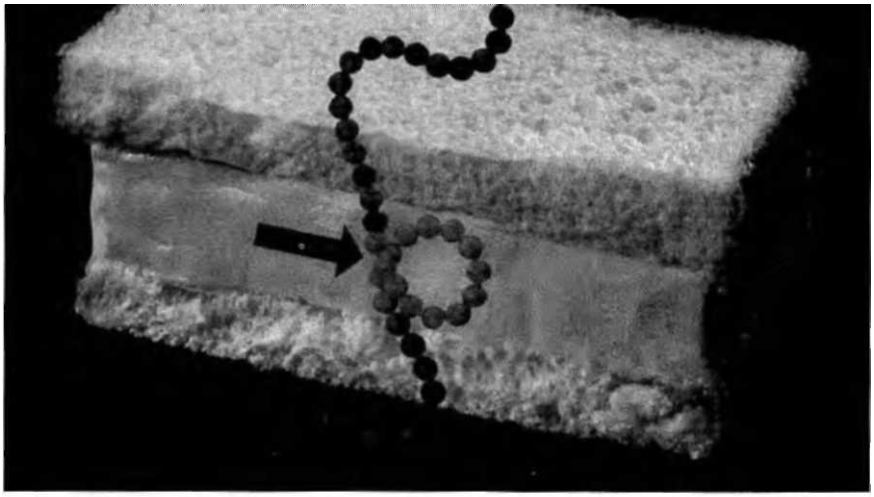
round part of the lollipop has polar charges among its atoms; it corresponds to the bread of our sandwich. The molecule's two stick-like portions are non-polar; they correspond to the butter part of our sandwich. Because the "butter" portion of the membrane is non-polar, it does not let positively or negatively charged atoms or molecules pass through it. In effect, this lipid core is an electrical insulator, a terrific trait for a membrane designed to keep the cell from being overwhelmed by every molecule in its environment.

But the cell could not survive if the membrane were the equivalent of a simple bread and butter sandwich. Most of the cell's nutrients consist of charged polar molecules that would not be able to get past the formidable non-polar lipid barrier. Neither could the cell excrete its polarized waste products.

Integral Membrane Proteins

The olives in our sandwich are the truly ingenious part of the membrane. These proteins allow nutrients, waste materials, as well as other forms of "information" to be transported across the membrane. The protein "olives" allow, not just any old molecules to get into the cell, but only those molecules necessary for the smooth functioning of the cytoplasm. In my sandwich, the olives represent Integral Membrane Proteins (IMPs). These proteins embed themselves into the "butter" layer of the membrane, just as I have embedded olives in the illustration.

How do IMPs embed themselves into the butter? Remember that proteins are composed of a linear backbone assembled from linked amino acids. Of the twenty different amino acids, some are water-loving, polar molecules and some are hydrophobic, non-polar molecules. When a region of the protein's backbone is made up of linked, hydrophobic amino acids, this segment of the protein seeks stability by finding an oil-loving environment like the membrane's lipid core (see arrow below). That's how hydrophobic parts of the protein integrate themselves into the middle layer of the membrane. Because some regions of a protein's backbone are made up of polar amino acids and



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other regions are non-polar, the protein strand will weave itself in and out of the bread and butter sandwich.

There are lots of IMPs with lots of different names, but they can be subdivided into two functional classes: *receptor proteins* and *effector proteins.* Receptor IMPs are the cell's sense organs, the equivalent of our eyes, ears, nose, taste buds, etc. Receptors function as molecular "nano-antennas" tuned to respond to specific environmental signals. Some receptors extend inward from the membrane surface to monitor the internal milieu of the cell. Other receptor proteins extend from the cell's outer surface, monitoring external signals.

Like other proteins, which we discussed earlier, receptors have an inactive and an active shape and shift back and forth between those conformations as their electrical charges are altered. When a receptor protein binds with an environmental signal, the resulting alteration in the protein's electrical charges causes the backbone to change shape and the protein adopts an "active" conformation. Cells possess a uniquely "tuned" receptor protein for every environmental signal that needs to read.

Some receptors respond to physical signals. One example is an estrogen receptor, which is specially designed to complement the shape and charge distribution of an estrogen molecule. When estrogen is in its receptor's neighborhood, the estrogen receptor locks on to it, as surely as a magnet picks up paper clips. Once the estrogen receptor and the estrogen molecule bind in a perfect "lock and key" fit, the receptor's electromagnetic charge changes and the protein shifts into its active conformation. Similarly, mstarnine receptors complement the shape of

histamine molecules and insulin receptors complement the shape of insulin molecules, etc.

Receptor "antennas" can also read vibrational energy fields such as light, sound and radio frequencies. The antennas on these "energy" receptors vibrate like tuning forks. If an energy vibration in the environment resonates with a receptor's antenna, it will alter the protein's charge, causing the receptor to change shape. [Tsong 1989] I'll cover this more completely in the next chapter, but I'd like to point out now that because receptors can read energy fields, the notion that only physical molecules can impact cell physiology is outmoded. Biological behavior can be controlled by invisible forces, including thought, as well as it can be controlled by physical molecules like penicillin, a fact that provides the scientific underpinning for pharmaceutical-free, energy medicine.

Receptor proteins are remarkable, but on their own they do not impact the behavior of the cell. While the receptor provides an awareness of environmental signals, the cell still has to engage in an appropriate, life-sustaining response, that is the venue of the effector proteins. Taken together, the receptor-effector proteins are a stimulus-response mechanism comparable to the reflex action that doctors typically test during physical examinations. When a doctor taps your knee with a mallet, a sensory nerve picks up the signal. That sensory nerve immediately passes on that information to a motor nerve that causes the leg to kick. The membrane's receptors are the equivalent of sensory nerves, and the effector proteins are the equivalent of action-generating motor nerves. Together, the receptor-effector complex acts as a switch, translating environmental signals into cellular behavior.

It is only in recent years that scientists have realized the importance of the membrane's IMPs. They are in fact so important that studying the way IMPs work has become a field of its own called "signal transduction." Signal transduction scientists are busily classifying hundreds of complex information pathways that lie between the membrane's reception of environmental signals and the activation of the cell's behavior proteins. The study of signal transduction is catapulting the membrane to center stage, just as the field of epigenetics is highlighting the role of the chromosome's proteins.

There are different kinds of behavior-controlling effector proteins because there are lots of jobs that need to be done for the smooth functioning of the cell. Transport proteins, for example, include an extensive family of channel proteins that shuttle molecules and information from one side of the membrane barrier to the other. Which brings us back to the pimentos in our bread, butter and olive sandwich. Many channel

proteins are shaped like a tightly wound sphere, resembling the pimento-stuffed olives in our pictures. (See illustration page 79) When the electrical charge on the protein is altered, the protein changes shape, a change that creates an open channel running through the protein's core. Channel proteins are actually two olives in one, depending on their electrical charge. In the active mode, their structure resembles a pimento-free olive, with an open gate. In their inactive mode the proteins' shape resembles a pimento-stuffed olive that stays closed to the world outside the cell.

The activity of one specific channel type, sodium-potassium ATPase, merits special attention. Every cell has thousands of these channels built into the membrane. Collectively, their activity uses almost half of your body's energy every day. This channel opens and closes so frequently that it resembles a revolving door in a department store on the day of a big sale. Every time this channel revolves, it shuttles three positive-charged sodium atoms out of the cytoplasm and simultaneously admits two positive-charged potassium atoms into the cytoplasm from the environment.

Sodium-potassium ATPase not only uses up a lot of energy, it also creates energy as surely as store-bought batteries provide energy for Game Boys (at least until your kids wear them out). Actually, the energy-producing activity of sodium-potassium ATPase is a lot better than the batteries your kids wear out because it turns the cell into a constantly recharging biological battery.

Here's how sodium-potassium ATPase manages that trick. Every revolution of sodium-potassium ATPase throws more positive charges out than it lets in to the cell and there are thousands of these proteins in each cell. As these proteins go through hundreds of cycles per second, the inside of the cell becomes negatively charged while the outside of the cell becomes positively charged. The negative charge below the membrane is referred to as the *membrane potential.* Of course the lipid, i.e. the butter portion of the membrane, does not let charged atoms cross the barrier, so the internal charge stays negative. The positive charge outside the cell and the negative charge inside make the cell essentially a self-charging battery whose energy is used to empower biological processes.

Another variety of effector proteins, cytoskeletal proteins, regulates the shape and motility of cells. A third variety, called enzymes, breaks down or synthesizes molecules, which is why enzymes are sold in your local health food store as a digestive aid. When activated, all forms of effector proteins, including channels, cytoskeletal and enzyme proteins or their byproducts, can also serve as signals that activate genes. These

IMPs or their byproducts provide signals that control the binding of the chromosome's regulatory proteins that form a "sleeve" around the DNA. In contrast to conventional wisdom, genes do not control their own activity. Instead it is the membrane's effector proteins, operating in response to environmental signals picked up by the membrane's receptors, which *control* the "reading" of genes so that worn-out proteins can be replaced, or new proteins can be created.

How the Brain Works

Once I understood how IMPs worked, I had to conclude that *the cell's operations are primarily molded by its interaction with the environment, not by its genetic code.* There is no doubt that the DNA blueprints stored in the nucleus are remarkable molecules, which have been accumulated over three billion years of evolution. But as remarkable as these DNA blueprints are, they do not "control" the operations of the cell. Logically, genes cannot preprogram a cell or organism's life, because cell survival depends on the ability to dynamically adjust to an ever-changing environment.

The membrane's function of interacting "intelligently" with the environment to produce behavior makes it the true brain of the cell. Let's put the membrane to the same "brain" test to which we put the nucleus. When you destroy its membrane, the cell dies just as you would if your brain were removed. Even if you leave the membrane intact, destroying only its receptor proteins, which can easily be done with digestive enzymes in the lab, the cell becomes "brain-dead." It is

The point is that single-celled organisms actually live in community when they share their "awareness" and coordinate their behaviors by releasing "signal" molecules into the environment. Cyclic AMP was one of evolution's earliest forms of secreted regulatory signals that control cell behavior. The fundamental human signal molecules (e.g., hormones, neuropeptides, cytokines, growth factors) that regulate our own cellular communities were once thought to have arisen with the appearance of complex multicellular life forms. However, recent research has now revealed that primitive single-celled organisms were already using these "human" signal molecules in the earliest stages of evolution.

Through evolution, cells maximized the number of IMP "awareness" proteins their membranes could hold. To acquire more awareness, and therefore increase their probability of surviving, cells started to assemble, first into simple colonies and later into highly organized cellular communities. As described earlier, the physiologic functions of multicellular organisms are parceled out to specialized communities of

cells forming the body's tissues and organs. In communal organizations, the cell membrane's intelligence processing is carried out by the specialized cells of the organism's nervous and immune systems.

It was only 700 million years ago, recent in regard to the time frame of life on this planet, when single cells found it advantageous to join together in tightly knit multicellular communities, organizations we recognize as animals and plants. The same coordmating signal molecules used by free-living cells were used in these newly evolved closed communities. By tightly regulating the release and distribution of these function-controlling signal molecules, the community of cells would be able to coordinate their functions and act as a single life form. In the more primitive multicellular organisms, those without specialized nervous systems, the flow of these signal molecules within the community provided an elementary "mind," represented by the coordmating information shared by every cell. In such organisms, each cell directly read environmental cues and personally adjusted its own behavior.

However, when cells came together in community, a new politic had to be established. In community, each cell cannot act as an independent agent that does whatever it wants. The term "community" implies that all of its members commit to a common plan of action. In multicellular animals, individual cells may "see" the local environment outside of their own "skin," but they may have no awareness of what is going on in more distant environments, especially those outside of the whole organism itself. Can a liver cell buried in your viscera, responding to its local environmental signals, make an informed response regarding the consequence of a mugger that jumps into your environment? The complex behavior controls needed to ensure a multicellular organization's survival are incorporated within its centralized information processing system.

As more complex animals evolved, specialized cells took over the job of monitoring and organizing the flow of the behavior regulating signal molecules. These cells provided a distributed nerve network and central information processor, a brain. The brain's function is to coordinate the dialogue of signal molecules within the community. Consequently, in a community of cells, each cell must acquiesce control to the informed decisions of its awareness authority, the *brain*. The brain *controls* the behavior of the body's cells. This is a very important point to consider as we blame the cells of our organs and tissues for the health issues we experience in our lives.

Emotions: Feeling the Language of Cells

In higher, more aware life forms, the brain developed a specialization that enabled the whole community to tune into the status of its regulatory signals. The evolution of the limbic system provided a unique mechanism that converted the chemical communication signals into sensations that could be experienced by all of the cells in the community. Our conscious mind experiences these *signals* as emotions. The conscious mind not only "reads" the flow of the cellular coordinating signals that comprise the body's "mind," it can also generate emotions, which are manifest through the controlled release of regulatory signals by the nervous system.

At the same time that I was studying the mechanics of the cell's brain and gaining insight into the operation of the human brain, Candace Pert was studying the human brain and becoming aware of the mechanics of the cell's brain. In *Molecules of Emotion,* Pert revealed how her study of information-processing receptors on nerve cell membranes led her to discover that the same "neural" receptors were present on most, if not all, of the body's cells. Her elegant experiments established that the "mind" was not focused in the head, but was distributed via signal molecules to the whole body. As importantly, her work emphasized that emotions were not only derived through a feedback of the body's environmental information. Through self-consciousness, the mind can use the brain to *generate* "molecules of emotion" and override the system. While proper use of consciousness can bring health to an ailing body, inappropriate unconscious control of emotions can easily make a healthy body diseased, a topic I will expand upon in Chapters 6 and 7. *Molecules of Emotion* is a very insightful book describing the scientific discovery process. It also provides some revealing insights into the struggles encountered when trying to introduce new "ideas" into science's Old Boy Club, a subject with which I am all too familiar! [Pert 1997]

The limbic system offered a major evolutionary advance through its ability to sense and coordinate the flow of behavior-regulating signals within the cellular community. As the internal signal system evolved, its greater efficiency enabled the brain to increase in size. Multicellular organisms gained increasingly more cells that were dedicated to responding to an ever-wider variety of *external* environmental signals. While individual cells can respond to simple sensory perceptions such as red, round, aromatic, and sweet, the extra brainpower available in multicellular animals enables them to combine those simple sensations into a higher level of complexity and perceive "apple."

Fundamental reflex behaviors acquired through evolution are passed on to offspring in the form of genetic-based instincts. The evolution of larger brains, with their increased neural cell population, offered organisms the opportunity not only to rely on instinctual behavior, but also to learn from their life experiences. The learning of novel reflex behaviors is essentially a product of *conditioning.* For example, consider the classic example of Pavlov training his dogs to salivate at the ring of a bell. He first trained them by ringing a bell and coupling that stimulus with a food reward. After awhile, he would ring the bell but not offer the food. By that time, the dogs were so programmed to expect the food that when the bell rang, they reflexively started to salivate even though no food was present. This is clearly an "unconscious," learned reflex behavior.

Reflex behaviors may be as simple as the spontaneous kick of the leg when a mallet taps the knee, or as complex as driving a car at sixty-five miles per hour on a crowded interstate highway while your conscious mind is fully engaged in conversation with a passenger. Though conditioned behavioral responses may be inordinately complex, they are "no-brainers." Through the conditioned learning process, neural pathways between eliciting stimuli and behavioral responses become hardwired to ensure a repetitive pattern. Hardwired pathways are "habits." In lower animals, the entire brain is designed to engage in purely habitual responses to stimuli. Pavlov's dogs salivate by reflex...not by deliberate intention. The actions of the subconscious mind are reflexive in nature and are not governed by reason or thinking. Physically, this mind is associated with the activities of *all* of the brain structures that are present in animals that have not evolved self-consciousness.

Humans and a number of other higher mammals have evolved a specialized region of the brain associated with thinking, planning and decision-making called the prefrontal cortex. This portion of the forebrain is apparently the seat of the "self-conscious" mind processing. The self-conscious mind is self-reflective; it is a newly evolved "sense organ" that observes our own behaviors and emotions. The self-conscious mind also has access to most of the data stored in our long-term memory bank. This is an extremely important feature allowing our history of life to be considered as we consciously plan our futures.

Endowed with the ability to be self-reflective, the self-conscious mind is extremely powerful. It can observe any programmed behavior we are engaged in, evaluate the behavior and consciously decide to change the program. We can actively *choose* how to respond to most environmental signals and whether we even want to respond at all. The

conscious mind's capacity to override the subconscious mind's preprogrammed behaviors is the foundation of free will.

However, our special gift comes with a special pitfall. While almost all organisms have to actually experience the stimuli of life first-hand, the human brain's ability to "learn" perceptions is so advanced that we can actually acquire perceptions indirectly from teachers. Once we accept the perceptions of others as "truths," *their* perceptions become hardwired into our own brains, becoming *our* "truths." Here's where the problem arises: what if our teachers' perceptions are inaccurate? In such cases, our brains are then downloaded with misperceptions. The subconscious mind is strictly a stimulus-response playback device; there is no "ghost" in that part of the "machine" to ponder the long-term consequences of the programs we engage. The subconscious works only in the "now." Consequently, programmed misperceptions in our subconscious mind are not "monitored" and will habitually engage us in inappropriate and limiting behaviors.

If I included as a bonus in this chapter a slithering snake that pops out of this page right now, most of you would run from the room or throw the book out of the house. Whoever "introduced" you to your first snake may have behaved in such a shocked way as to give your impressionable mind an apparently important life lesson: See snake.. .snake baaad! The subconscious memory system is very partial to rapidly downloading and emphasizing perceptions regarding things in your environment that are threatening to life and limb. If you were taught that snakes are dangerous, any time a snake comes into your proximity, you reflexively (unconsciously) engage in a protective response.

But what if a herpetologist were reading this book and a snake popped out? No doubt herpetologists would not only be intrigued by the snake, they would be *thrilled* with the bonus included in the book. Or at least they'd be thrilled once they figured out that the book's snake was harmless. They would then hold it and watch its behaviors with delight. They would think that *your* programmed response was an irrational one, because not all snakes are dangerous. Further they would be saddened by the fact that so many people are deprived of the pleasure of studying such interesting creatures. Same snake, same stimulus, yet greatly different responses.

Our responses to environmental stimuli are indeed controlled by perceptions, but not all of our learned perceptions are accurate. Not all snakes are dangerous! Yes, perception "controls" biology, but as we've seen, these perceptions can be true or false. Therefore, we would be more accurate to refer to these controlling perceptions as *beliefs.*

Beliefs control biology!

Ponder the significance of this information. We have the capacity to consciously evaluate our responses to environmental stimuli and change old responses any time we desire.. .once we deal with the powerful subconscious mind, which I discuss in more depth in Chapter 7. We are not stuck with our genes or our self-defeating behaviors!

How the Mind Controls the Body

My insights into how beliefs control biology are grounded in my studies of cloned endothelial cells, the cells that line the blood vessels. The endothelial cells I grew in culture monitor their world closely and change their behavior based on information they pick up from the environment. When I provided nutrients, the cells would gravitate toward those nutrients with the cellular equivalent of open arms. When I created a toxic environment, the cultured cells would retreat from the stimulus in an effort to wall themselves off from the noxious agents. My research focused on the membrane perception switches that controlled the shift from one behavior to the other.

The primary switch I was studying has a protein receptor that responds to histairiine, a molecule that the body uses in a way that is equivalent to a local emergency alarm. I found that there are two varieties of switches, HI and H2, that respond to the same histamine signal. When activated, switches with HI histamine receptors evoke a *protection response,* the type of behavior revealed by cells in toxin-containing culture dishes. Switches containing H2 histamine receptors evoke a *growth response* to liistamine, similar to the behavior of cells cultured in the presence of nutrients.

I subsequently learned that the body's system-wide emergency response signal, adrenaline, also has switches sporting two different adrenaline-sensing receptors, called *alpha* and *beta.* The adrenaline receptors provoked the exact same cell behaviors as those elicited by histamine. When the adrenal *alpha-receptor* is part of an IMP switch, it provokes a protection response when adrenaline is perceived. When the frefa-receptor is part of the switch, the same adrenaline signal activates a growth response. [Lipton, et al, 1992]

All that was interesting, but the most exciting finding was when I simultaneously introduced both histamine and adrenaline into my tissue cultures. I found that adrenaline signals, released by the central nervous system, override the influence of histamine signals that are produced locally. This is where the politics of the community described earlier comes in to play. Suppose you're working in a bank. The branch

manager gives you an order. The CEO walks in and gives you the opposite order. Which order would you follow? If you want to keep your job you'll snap to the CEO's order. There is a similar priority built into our biology, which requires cells to follow instructions from the head honcho nervous system, even if those signals are in conflict with local stimuli.

I was excited by my experiments because I believed that they revealed on the single-cell level a truth for multicellular organisms — that the mind (i.e. acting via the central nervous system's adrenaline) overrides the body (acting via the local histamine signal). I wanted to spell out the implications of my experiments in my research paper, but my colleagues almost died from apoplexy at the notion of injecting the body-mind connection into a paper about cell biology. So I put in a cryptic comment about understanding the significance of the study, but I couldn't say what the significance was. My colleagues did not want me to include these implications of my research because the mind is not an acceptable biological concept. Bio-scientists are conventional Newtonians — if it isn't matter.. .it doesn't count. The "mind" is a non-localized energy and therefore is not relevant to materialistic biology. Unfortunately, that perception is a "belief" that has been proven to be patently incorrect in a quantum mechanical universe!

Placebos: The Belief Effect

Every medical student learns, at least in passing, that the mind can affect the body. They learn that some people get better when they *believe* (falsely) they are getting medicine. When patients get better by ingesting a sugar pill, medicine defines it as the *placebo effect.* My friend Rob Williams, founder of PSYCH-K, an energy-based psychological treatment system, suggests that it would be more appropriate to refer to it as the *perception effect.* I call it the *belief effect* to stress that our perceptions, whether they are accurate or inaccurate, equally impact our behavior and our bodies.

I celebrate the *belief effect,* which is an amazing testament to the healing ability of the body/mind. However, the "all in their minds" placebo effect has been linked by traditional medicine to, at worst, quacks or, at best, weak, suggestible patients. The placebo effect is quickly glossed over in medical schools so that students can get to the real *tools* of modern medicine like drugs and surgery.

This is a giant mistake. The placebo effect should be a major topic of study in medical school. I believe that medical education should train doctors to recognize the power of our internal resources. Doctors should not dismiss the power of the mind as something inferior to the power of

chemicals and the scalpel. They should let go of their conviction that the body and its parts are essentially stupid and that we need outside intervention to maintain our health.

The placebo effect should be the subject of major, funded research efforts. If medical researchers could figure out how to leverage the placebo effect, they would hand doctors an efficient, energy-based, side effect-free tool to treat disease. Energy healers say they already have such tools, but I am a scientist and I believe the more we know about the science of the placebo, the better we'll be able to use it in clinical settings.

I believe the reason the mind has so summarily been dismissed in medicine is the result, not only of dogmatic thinking, but also of financial considerations. If the power of your mind can heal your sick body, why should you go to the doctor and *more* importantly, why would you need to buy drugs? In fact, I was recently chagrined to learn that drug companies are studying patients who respond to sugar pills with the goal of *eliminating* them from early clinical trials. It inevitably disturbs pharmaceutical manufacturers that in most of their clinical trials the placebos, the "fake" drugs, prove to be as effective as their engineered chemical cocktails. [Greenberg 2003] Though the drug companies insist they're not trying to make it easier for ineffective drugs to get approved, it is clear that effectiveness of placebo pills are a threat to the pharmaceutical industry. The message from the drug companies is clear to me: if you can't beat placebo pills fairly, simply remove the competition!

The fact that most doctors are not trained to consider the impact of the placebo effect is ironic because some historians make a strong case that the history of medicine is largely the history of the placebo effect. For most of medical history, doctors did not have effective methods to fight disease. Some of the more notorious treatments once prescribed by mainstream medicine include bloodletting, treating wounds with arsenic, and the proverbial cure-all, rattlesnake oil. No doubt some patients, the conservatively estimated one third of the population who are particularly susceptible to the healing power of the placebo effect, got better with those treatments. In today's world, when doctors wearing white coats deliver a treatment decisively, patients may *believe* the treatment works — and so it does, whether it is a real drug or just a sugar pill.

Though the question of *how* placebos work has in the main been ignored by medicine, recently some mainstream medical researchers are turning their attention to it. The results of those studies suggest that it is not only wacky, nineteenth-century treatments that can foster a placebo

effect but also modern medicine's sophisticated technology, including the most "concrete" of medical tools, surgery.

A Baylor School of Medicine study, published in 2002 in the *New England Journal of Medicine* evaluated surgery for patients with severe, debilitating knee pain. [Moseley, et al, 2002] The lead author of the study, Dr. Bruce Moseley, "knew" that knee surgery helped his patients: "All good surgeons know there is no placebo effect in surgery." But Moseley was trying to figure out which part of the surgery was giving his patients relief. The patients in the study were divided into three groups. Moseley shaved the damaged cartilage in the knee of one group. For another group, he flushed out the knee joint, removing material thought to be causing the inflammatory effect. Both of these constitute standard treatment for arthritic knees. The third group got "fake" surgery. The patient was sedated, Moseley made three standard incisions and then talked and acted just as he would have during a real surgery — he even splashed salt water to simulate the sound of the knee-washing procedure. After 40 minutes, Moseley sewed up the incisions as if he had done the surgery. All three groups were prescribed the same postoperative care, which included an exercise program.

The results were shocking. Yes, the groups who received surgery, as expected, improved. But the placebo group improved just as much as the other two groups! Despite the fact that there are 650,000 surgeries yearly for arthritic knees, at a cost of about $5,000 each, the results were clear to Moseley: "My skill as a surgeon had no benefit on these patients. The entire benefit of surgery for osteoarthritis of the knee was the placebo effect." Television news programs graphically illustrated the smnning results. Footage showed members of the placebo group walking and playing basketball, in short doing things they reported they could not do before their "surgery." The placebo patients didn't find out for two years that they had gotten fake surgery. One member of the placebo group, Tim Perez, who had to walk with a cane before the surgery, is now able to play basketball with his grandchildren. He summed up the theme of this book when he told the Discovery Health Channel: "In this world any tiling is possible when you put your mind to it. I know that your mind can work miracles."

Studies have shown the placebo effect to be powerful in treating other diseases, including asthma and Parkinson's. In the treatment of depression, placebos are stars. So much so that psychiatrist Walter Brown of the Brown University School of Medicine has proposed placebo pills as the first treatment for patients with mild or moderate depression. [Brown 1998] Patients would be told that they're getting a remedy with no active ingredient, but that shouldn't dampen the pills'

effectiveness. Studies suggest that even when people know they're not getting a drug, the placebo pills still work.)

One indication of the power of the placebo came from a report from the United States Department of Health and Human Services. The report found that half of severely depressed patients taking drugs improve versus thirty-two percent taking a placebo. [Horgan 1999] Even that impressive showing may underestimate the power of the placebo effect because many study participants figure out they're taking the real drug because they experience side effects that are not experienced by those taking the placebo. Once those patients realize they're taking the drug, i.e. once they start *believing* that they're getting the *real* pill, they are particularly more susceptible to the placebo effect.

Given the power of the placebo, it is no wonder that the $8.2 billion antidepressant industry is under attack by critics who charge that drug companies are hyping the effectiveness of their pills. In a 2002 article in the American Psychological Association's '*Prevention & Treatment,* "*The* Emperor's New Drugs," University of Connecticut psychology professor Irving Kirsch found that eighty percent of the effect of antidepressants, as measured in clinical trials, could be attributed to the placebo effect. [Kirsch, et al, 2002] Kirsch had to invoke the Freedom of Information Act in 2001 to get information on the clinical trials of the top antidepressants: these data were not forthcoming from the Food and Drug Administration. The data show that in more than half of the clinical trials for the six leading antidepressants, the drugs did not outperform placebo, sugar pills. And Kirsch noted in a Discovery Health Channel interview that: "The difference between the response of the drugs and the response of placebo was less than two points on average on this clinical scale that goes from fifty to sixty points. That's a very small difference. That difference clinically is meaningless."

Another interesting fact about the effectiveness of antidepressants is that they have performed better and better in clinical trials over the years, suggesting that their placebo effects are in part due to savvy marketing. The more the miracle of antidepressants was touted in the media and in advertisements, the more effective they became. Beliefs are contagious! We now live in a culture where people *believe* that anti-depressants work, and so they do.

A California interior designer, Janis Schonfeld, who took part in a clinical trial to test the efficacy of Effexor in 1997, was just as "stunned" as Perez when she found out that she had been on a placebo. Not only had the pills relieved her of the depression that had plagued her for thirty years, the brain scans she received throughout the study found that the activity of her prefrontal cortex was greatly enhanced. [Leuchter,

et al, 2002] Her improvements were not "all in her head." When the mind changes, it absolutely affects your biology. Schonfeld also experienced nausea, a common Effexor side effect. She is typical of patients who improve with placebo treatment and then find out they were not on the real drug—she was convinced the doctors had made a mistake in the labeling for she "knew" she was on the drug. She insisted that the researchers double-check their records to make absolutely sure she wasn't on the drug.

Nocebos: The Power of Negative Beliefs

While many in the medical profession are aware of the placebo effect, few have considered its implications for self-healing. If positive thinking can pull you out of depression and heal a damaged knee, consider what negative thinking can do in your life. When the mind, through positive suggestion improves health, it is referred to as the placebo effect. Conversely, when the same mind is engaged in negative suggestions that can damage health, the negative effects are referred to as the *nocebo* effect.

In medicine, the nocebo effect can be as powerful as the placebo effect, a fact you should keep in mind every time you step into a doctor's office. By their words and their demeanor, physicians can convey hope-deflating messages to their patients, messages that are, I believe completely unwarranted. Albert Mason for example, trunks his inability to project optimism to his patients hampered his efforts with his ichthyosis patients. Another example is the potential power of the statement: "You have six months to live." If you choose to believe your doctor's message, you are not likely to have much more time on this Earth.

I have cited the Discovery Health Channel's 2003 program "Placebo: Mind Over Medicine" in this chapter because it is a good compendium of some of medicine's most interesting cases. One of its more poignant segments featured a Nashville physician, Clifton Meador, who has been reflecting on the potential power of the nocebo effect for 30 years. In 1974 Meador had a patient, Sam Londe, a retired shoe salesman suffering from cancer of the esophagus, a condition that was at the time considered 100 per cent fatal. Londe was treated for that cancer but everyone in the medical community "knew" that his esophageal cancer would recur. So it was no surprise when Londe died a few weeks after his diagnosis.

The surprise came after Londe's death when an autopsy found very little cancer in his body, certainly not enough to kill him. There were a

couple of spots in the liver and one in the lung, but there was no trace of the esophageal cancer that everyone thought had killed him. Meador told the Discovery Health Channel: "He died with cancer, but not from cancer." What did Londe die of if not esophageal cancer? Had he died because he *believed* he was going to die? The case still haunts Meador three decades after Londe's death: "I thought he had cancer. He thought he had cancer. Everybody around him thought he had cancer...did I remove hope in some way?" Troublesome nocebo cases suggest that physicians, parents and teachers can remove hope by programming you to believe you are powerless.

Our positive and negative beliefs not only impact our health, but also every aspect of our life. Henry Ford was right about the efficiency of assembly lines and he was right about the power of the mind: "If you believe you can or if you believe you can't...you're right." Think about the implications of the man who blithely drank the bacteria that medicine had decided caused cholera. Consider the people who walk across coals without getting burned. If they wobble in the steadfastness of their belief that they can do it, they wind up with burned feet. Your beliefs act like filters on a camera, changing how you see the world. And your biology adapts to those beliefs. When we truly recognize that our beliefs are that powerful, we hold the key to freedom. While we cannot readily change the codes of our genetic blueprints, we can change our rninds.

In my lectures I provide two sets of plastic filters, one red and one green. I have the audience pick one color and then look at a blank screen. I then tell them to yell out whether the image I project next is one that generates love or generates fear. Those in the audience that don the red "belief" filters see an inviting picture of a cottage labeled "House of Love," flowers, a sunny sky and the message "I live in Love." Those wearing the green filters see a threatening dark sky, bats, snakes, a ghost hovering outside a dark, gloomy house and the words "I live in fear." I always get enjoyment out of seeing how the audience responds to the confusion when half yell out "I live in love," and the other half, in equal certainty, yells out "I live in fear" in response to the same image.

Then I ask the audience to change to the opposite colored filters. My point is that you can choose what to see. You can filter your life with rose-colored beliefs that will help your body grow or you can use a dark filter that turns everything black and makes your body/ mind more susceptible to disease. You can live a life of fear and or live a life of love. You have the choice! But I can tell you that if you choose to see a world full of love, your body will respond by growing in health. If you choose to believe that you live in a dark world full of fear, your body's health

will be compromised as you physiologically close yourself down in a protection response.

Learning how to harness your mind to promote growth is the secret of life, which is why I called this book *The Biology of Belief.* Of course the secret of life is not a secret at all. Teachers like Buddha and Jesus have been telling us the same story for millennia. Now science is pointing in the same direction. It is not our genes but our beliefs that control our lives.. .Oh ye of little belief!

That thought is a good entree into the next chapter, in which I'll detail how living in love and living in fear create opposite effects in the body and the mind. Before we leave this chapter, I'd just like to emphasize again that not only is there nothing wrong with going through life wearing the proverbial rose-colored glasses. In fact, those rose-colored glasses are necessary for your cells to thrive. Positive thoughts are a biological mandate for a happy, healthy life. In the words of Mahatma Gandhi:

> Your beliefs become your thoughts
> Your thoughts become your words
> Your words become your actions Your
> actions become your habits Your
> habits become your values Your values
> become your destiny

Chapter 6

GROWTH AND PROTECTION

Evolution has provided us with lots of survival mechanisms. They can be roughly divided into two functional categories: growth and protection. These growth and protection mechanisms are the fundamental behaviors required for an organism to survive. I'm sure you know how important it is to protect yourself. You may not realize though that growth is vitally important for your survival as well —even if you're an adult who has reached your full height. Every day billions of cells in your body wear out and need to be replaced. For example, the entire cellular lining of your gut is replaced every seventy-two hours. In order to maintain this continuous turnover of cells, your body needs to expend a significant amount of energy daily.

By now you won't be surprised to learn that I first became aware of how important growth and protection behaviors are in the laboratory where my observations of single cells have so often led me to insights about the multicellular human body. When I was cloning

human endothelial cells, they *retreated* from toxins that I introduced into the culture dish, just as humans retreat from mountain lions and muggers in dark alleys. They also *gravitated* to nutrients, just as humans gravitate to breakfast, lunch, dinner and love. These opposing movements define the two basic cellular responses to environmental stimuli. Gravitating *to* a life-sustaining signal, such as nutrients, characterizes a growth response; moving *away* from threatening signals, such as toxins, characterizes a protection response. It must also be noted that some environmental stimuli are neutral; they provoke neither a growth nor a protection response.

My research at Stanford showed that these growth/protection behaviors are also essential for the survival of multicellular organisms such as humans. But there is a catch to these opposing survival mechanisms that have evolved over billions of years. It turns out that the mechanisms that support growth and protection cannot operate optimally at the same time. In other words, cells cannot simultaneously move forward and backward. The human blood vessel cells I studied at Stanford exhibited one microscopic anatomy for providing nutrition and a completely different microscopic anatomy for providing a protection response. What they couldn't do was exhibit both configurations at the same time. [Lipton, et al, 1991]

In a response similar to that displayed by cells, humans unavoidably restrict their growth behaviors when they shift into a protective mode. If you're running from a mountain lion, it's not a good idea to expend energy on growth. In order to survive —that is, escape the lion—you summon all your energy for your fight or flight response. Redistributing energy reserves to fuel the protection response inevitably results in a curtailment of growth.

In addition to diverting energy to support the tissues and organs needed for the protection response, there is an additional reason why growth is inhibited. Growth processes require an open exchange between an organism and its environment. For example, food is taken in and waste products are excreted. However, protection requires a

closing down of the system to wall the organism off from the perceived threat.

Inhibiting growth processes is also debilitating in that growth is a process that not only expends energy but is also required to *produce* energy. Consequently, a sustained protection response *inhibits the creation of life-sustaining energy.* The longer you stay in protection, the more you compromise your growth. In fact, you can shut down growth

processes so completely that it becomes a truism that you can be "scared to death."

Thankfully, most of us don't get to the "scared to death" point. Unlike single cells, the growth/ protection response in multicellular organisms is not an either/or proposition— not all of our 50 trillion cells have to be in growth or protection mode at the same time. The proportion of cells in a protection response depends on the severity of the perceived threats. You can survive while under stress from these threats but chronic inhibition of growth mechanisms severely compromises your vitality. It is also important to note that to fully experience your vitality it takes more than just getting rid of life's stressors. In a growth/protection continuum, eliminating the stressors only puts you at the neutral point in the range. To fully thrive, we must not only eliminate the stressors but also actively seek joyful, loving, fulfilling lives that stimulate growth processes.

The Biology of Homeland Defense

In multicellular organisms, growth/protection behaviors are controlled by the nervous system. It is the nervous system's job to monitor environmental signals, interpret them, and organize appropriate behavioral responses. In a multicellular community, the nervous system acts like the government in organizing the activities of its cellular citizens. When the nervous system recognizes a threatening environmental stress, it alerts the community of cells to impending danger.

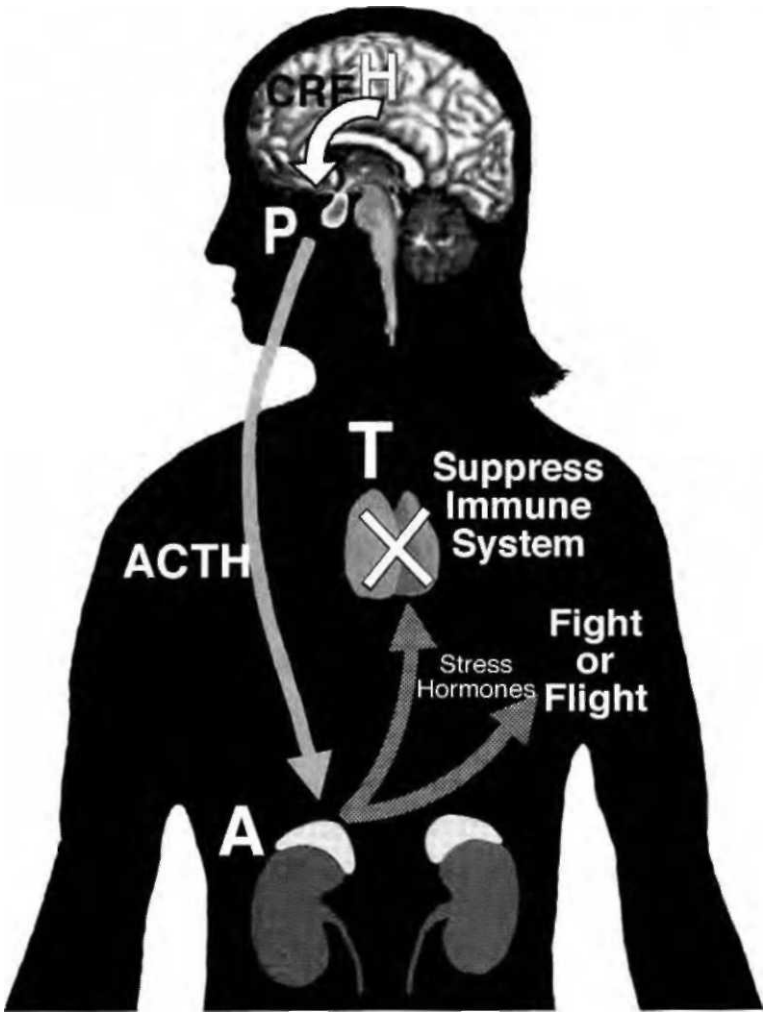
The body is actually endowed with two separate protection systems, each vital to the maintenance of life. The first is the system that mobilizes protection against *external* threats. It is called the HPA axis, which stands for the Hypothalamus-Pituitary-Adrenal Axis. When there are no threats, the HPA axis is inactive and growth flourishes. However, when the brain's hypothalamus perceives an environmental threat, it engages the HPA axis by sending a signal to the pituitary gland, the "Master Gland," which is responsible for organizing the fifty trillion cells of the community to deal with the impending threat.

Think back to the cell membrane's stimulus-response mechanism, the receptor-effector proteins — the hypothalamus and pituitary gland are behavioral equivalents. Similar to the role of a receptor protein, the hypothalamus receives and recognizes environmental signals; the pituitary's function resembles that of the effector protein in that it launches the body's organs into action. In response to threats from the external environment, the pituitary gland sends a signal to the adrenal glands, informing them of the need to coordinate the body's "fight or flight" response.

The technical details of how stress stimuli engage the HPA axis follow a simple cascade: In response to perceptions of stress registered in the brain, the hypothalamus secretes a corticotropin-releasing factor (CRF), which travels to the pituitary gland. CRF activates special pituitary hormone-secreting cells causing them to release adrenocorticotropic hormones (ACTH) into the blood. The ACTH then makes its way to the adrenal glands, where it serves as the signal to turn on the secretion of the "fight-flight" adrenal hormones. These stress hormones coordinate the function of the body's organs, providing us with great physiologic power to fend off or flee danger.

Once the adrenal alarm is sounded, the stress hormones released into the blood constrict the blood vessels of the digestive tract, forcing the energy-providing blood to preferentially nourish the tissues of the arms and legs that enable us to get out of harm's way. Before the blood was sent to the extremities, it was concentrated in the visceral organs. Redistributing the viscera's blood to the limbs in the fight or flight response results in an inhibition of growth-related functions; without the blood's nourishment the visceral organs cannot function properly. The visceral organs stop doing their life-sustaining work of digestion, absorption, excretion and other functions that provide for the growth of the cells and the production of the body's energy reserves. Hence, the stress response inhibits growth processes and further compromises the body's survival by interfering with the generation of vital energy reserves.

The body's second protection system is the immune system, which protects us from threats originating under the skin, such as those caused by bacteria and viruses. When the immune system is mobilized, it can consume much of the body's energy supply. To get a sense



of how much energy the immune system expends, recall how physically weak you become when you are fighting infections such as a flu or a cold. When the HP A axis mobilizes the body for fight or flight response, the adrenal hormones directly repress the action of the immune system to conserve energy reserves. In fact, stress hormones are so effective at curtailing immune system function that doctors provided them to recipients of transplants so that their immune systems wouldn't reject the foreign tissues.

Why would the adrenal system shut down the immune system? Imagine that you are in your tent on the African savannah suffering from a bacterial infection and experiencing a bad case of diarrhea. You hear the gutty growl of a lion outside your tent. The brain must make a decision about which is the greater threat. It will do your body no good to conquer the bacteria if you let a lion maul you. So your body halts the fight against the infection in favor of mobilizing energy for flight to survive your close encounter with a lion. Therefore, a secondary consequence of engaging the HPA axis is that it interferes with our ability to fight disease.

Activating the HPA axis also interferes with our ability to think clearly. The processing of information in the forebrain, the center of executive reasoning and logic, is significantly slower than the reflex activity controlled by the hindbrain. In an emergency, the faster the information processing, the more likely the organism will survive. Adrenal stress hormones constrict the blood vessels in the forebrain reducing its ability to function. Additionally, the hormones repress activity in the brain's prefrontal cortex, the center of conscious volitional action conscious activity. In an emergency, the vascular flow and hormones serve to activate the hindbrain, the source of life-sustaining reflexes that most effectively control fight or flight behavior. While it is necessary that stress signals repress the slower processing conscious mind to enhance survival, it comes at a cost...diminished conscious awareness and reduced intelligence. [Takamatsu, et al, 2003; Arnsten and Goldman-Rakic 1998; Goldstein, et al, 1996]

Fear Kills

Remember the shell shocked, frozen look on my Caribbean medical students' faces when they failed my test, the medical school equivalent of a voracious lion? Had my students stayed frozen in fear, I can guarantee you that they would have performed dismally on their finals. The simple truth is, when you're frightened you're dumber. Teachers see it all the time among students who "don't test well." Exam stress paralyzes these students who, with trembling hands, mark wrong answers because in their panic, they can't access cere-brally stored information they have carefully acquired all semester.

The HP A system is a brilliant mechanism for handling acute stresses. However, this protection system was not designed to be continuously activated. In today's world, most of the stresses we are experiencing are not in the form of acute, concrete "threats" that we can easily identify, respond to and move on. We are constantly besieged by multitudes of unresolvable worries about our personal lives, our jobs, and our war-torn global community. Such worries do not threaten our immediate survival but they nevertheless can activate the HPA axis, resulting in chronically elevated stress hormones.

To illustrate the adverse effects of sustained adrenaline, let's use an example of a track race. An extremely well-trained and healthy group of sprinters step up to the starting line. When they hear the command: "On your mark!" they get on their hands and knees and adjust their feet into the starting blocks. Then the starter barks out, "Get set." The athletes' muscles tighten as they prop themselves up on their fingers and toes. When they shift into "Get set" mode, their bodies release the flight-promoting adrenaline hormones that power their muscles for the

arduous task ahead. While the athletes are on hold awaiting the "Go" command, their bodies are straining in anticipation of that task. In a normal race, that strain lasts only a second or two before the starter yells, "Go!" However, in our mythical race, the "Go" command, which would launch the athletes into action, never comes. The athletes are left in the starting blocks, their blood coursing with adrenaline, their bodies fatiguing with the strain of preparing for the race that never comes. No matter how toned their physique, within seconds, these athletes will physically collapse from the strain.

We live in a "Get set" world and an increasing body of research suggests that our hyper-vigilant lifestyle is severely impacting the health of our bodies. Our daily stressors are constantly activating the HPA axis, priming our bodies for action. Unlike competitive athletes, the stresses in our bodies are not released from the pressures generated by our chronic fears and concerns. Almost every major illness that people acquire has been linked to chronic stress. [Segerstrom and Miller 2004; Kopp and Rethelyi 2004; McEwen and Lasky 2002; McEwen and Seeman 1999]

In a revealing study published in 2003 in *Science,* researchers considered why patients on SSRI antidepressants, such as Prozac or Zoloft, don't feel better right away. There is usually at least a two-week lag between starting the drugs and the time the patients feel they are getting better. The study found that depressed people exhibit a surprising lack of cell division in the region of the brain called the hippocampus, a part of the nervous system involved with memory. Hippocampal cells renewed cell division at the time patients first began to experience the mood-shifting effect of the SSRI drugs, weeks after the onset of the drug regimen. This study and others challenge the theory that depression is simply the result of a "chemical imbalance" affecting the brain's production of monoamine signaling chemicals, specifically serotonin. If it were as simple as that, the SSRI drugs would likely restore that chemical balance right away.

More researchers are pointing to the inhibition of neuronal growth by stress hormones as the source of depression. In fact, in chronically depressed patients, the hippocampus and the prefrontal cortex, the center of higher reasoning, are physically shrunken. A review of this study published in *Science* reported: "Overtaking the monoamine hypothesis in recent years has been the stress hypothesis, which posits that depression is caused when the brain's stress machinery goes into overdrive. The most prominent player in this theory is the hypothalamic-pituitary-adrenal (HPA) axis." [Holden 2003]

The HPA axis' effect on the cellular community mirrors the effect of stress on a human population. Picture a vibrant community back in the Cold War years, when the possibility of a nuclear attack by the Russians weighed heavily on Americans' minds. Like cells in a multicellular organism, the members of this Cold War society actively work at jobs that contribute to the community's growth and usually get along with each other. Factories are busy manufacturing, construction people are building new homes, grocery stores are selling food, and kids are in school learning their ABCs. The community is in a state of health and growth while its residents constructively interact toward a common goal.

Suddenly, the sound of an air raid siren rocks the town. Everyone stops working to run off, seeking the safety of bomb shelters. The harmony of the community is disrupted as individuals, acting only in support of their own survival, fight their way to a bomb shelter. After five minutes, the all-clear signal sounds. Residents return to their jobs and resume their life in a growing community.

But what would happen if the sirens sound, the residents run into their air raid shelters and there is no all-clear signal to release them? People would stay in their protective postures indefinitely. How long can they maintain their protection posture? The community eventually collapses in the face of dwindling food and water supplies. One by one even the strongest die because chronic stress is debilitating. A community can easily survive short-term stress, like an air raid drill, but when the stress goes on and on it results in cessation of growth and the breakdown of the community.

Another illustration of the influence of stress on a population is the story of the 9/11 tragedy. Up to the moment those terrorists attacked, the country was in a state of growth. Then immediately after 9/11, as the shock of the news spread to reach not just the people of New York but the entire nation, we experienced a threat to our survival. The impact of government proclamations stressing the continued presence of danger in the wake of the attack, were like the influence of the adrenal signals. They shifted the members of the community from a state of growth to a state of protection. After a few days of this heart-stopping fear, the country's economic vitality was so compromised that the president had to intervene. To stimulate growth, the president repeatedly emphasized, "America is open for business." It took awhile for the fears to subside and for the economy to rebound. However, the residual threats of terrorism are still debilitating the vitality of our country. As a nation we should look more carefully at how our fear of future acts of terrorism is undermining our quality of life. In some sense, the terrorists have

already won since they have succeeded in frightening us into a chronic, soul-sapping protective mode.

I'd also like to suggest that you examine how your fears and the ensuing protection behaviors impact your life. What fears are shmting your growth? Where did these fears come from? Are they necessary? Are they real? Are they contributing to a full life? We'll deal more with these fears and where we got them in the next chapter on conscious parenting. If we can control our fears, we can regain control over our lives. President Franklin D. Roosevelt knew the destructive nature of fear. He chose his words carefully when he told the nation in the grips of the Great Depression and looming World War: "We have nothing to fear, but *fear* itself." Letting go of our fears is the first step toward creating a fuller, more satisfying life.

Chapter 7

CONSCIOUS PARENTING: PARENTS AS GENETIC ENGINEERS

Parents Matter

No doubt you've heard the seductive argument that once parents bestow their genes on their children, they take a back seat in their children's lives —parents need only refrain from abusing their children, feed and clothe them, and then wait to see where their preprogrammed genes lead them. This notion allows parents to continue with their "pre-kids lives" — they can simply drop their children off at daycare and with babysitters. It's an appealing idea for busy and/or lazy parents.

It's also appealing for parents like me, who have biological children with radically different personalities. I used to think that my daughters are different because they inherited different sets of genes from the moment of conception—a random selection process in which their mother and I had no part. After all, I thought, they grew up in the

same environment (nurture), so the reason for their differences had to be nature (genes).

The reality, I know now, is very different. Frontier science is confirming what mothers and enlightened fathers have known forever, that parents *do* matter, despite best-selling books that try to convince them otherwise. To quote Dr. Thomas Verny, a pioneer in the field of prenatal and perinatal psychiatry: "Findings in the peer-reviewed literature over the course of decades establish, *beyond any doubt,* that parents have overwhelming influence on the mental and physical attributes of the children they raise." [Verny and Kelly 1981]

And that influence starts, says Verny, not after children are born, but BEFORE children are born. When Verny first posited the notion that the influence of parents extends even to the womb in his landmark, 1981 book, *Tlie Secret Life of the Unborn Child,* the scientific evidence was preliminary and the "experts" skeptical. Because scientists used to think that the human brain did not become functional until after birth, it was assumed that fetuses and infants had no memory and felt no pain. After all, noted Freud, who coined the termed "infantile amnesia," most people do not remember anything that happened to them before they were three or four years old.

However, experimental psychologists and neuroscientists are demolishing the myth that infants cannot remember—or for that matter learn —and along with it the notion that parents are simply spectators in the unfolding of their children's lives. The fetal and infant nervous system has vast sensory and learning capabilities and a kind of memory that neuroscientists call implicit memory. Another pioneer in pre- and perinatal psychology, David Chamberlain writes in his book *Hie Mind of Your Newborn Baby:* "The truth is, much of what we have traditionally believed about babies is false. They are not simple beings but complex and ageless — small creatures with unexpectedly large thoughts." [Chamberlain 1998]

These complex, small creatures have a pre-birth life in the womb that profoundly influences their long-term health and behavior: "The quality of life in the womb, our temporary home before we were born, programs our susceptibility to coronary artery disease, stroke, diabetes, obesity and a multitude of other conditions in later life," writes Dr. Peter W. Nathanielsz in *Life in the Womb: Tlie Origin of Health and Disease.* [Nathanielsz 1999] Recently, an even wider range of adult-related chronic disorders, including osteoporosis, mood disorders and psychoses, have been intimately linked to pre- and perinatal developmental influences. [Gluckman and Hanson 2004]

Recognizing the role the prenatal environment plays in creating disease forces a reconsideration of genetic determinism. Nathanielsz writes: "There is mounting evidence that programming of lifetime health by the conditions in the womb is equally, if not more important, than our genes in determining how we perform mentally and physically during life. *Gene myopia* is the term that best describes the current all-pervasive view that our health and destiny throughout life are controlled by our genes alone...In contrast to the relative fatalism of gene myopia, understanding the mechanisms that underlie prograinming by the quality of life in the womb, we can improve the start in life for our children and their children."

The programming "mechanisms" Nathanielsz refers to are the epigenetic mechanisms, discussed earlier, by which environmental stimuli regulate gene activity. As Nathanielsz states, parents can improve the prenatal environment. In so doing they act as genetic engineers for their children. The idea that parents can transmit hereditary changes from their life to their children is, of course, a Lamarckian concept that conflicts with Darwinism. Nathanielsz is one of the scientists now brave enough to invoke the "L" word for Lamarck: ".. .the transgener-ational passage of characteristics by nongenetic means does occur. Lamarck was right, although transgenerational transmission of acquired characteristics occurs by mechanisms that were unknown in his day."

The responsiveness of individuals to the environmental conditions perceived by theirs mothers before birth allows them to optimize their genetic and physiologic development as they adapt to the environmental forecast. The same life-enhancing epigenetic plasticity of human development can go awry and lead to an array of chronic diseases in older age if an individual experiences adverse nutritional and environmental circumstances during fetal and neonatal periods of development. [Bateson, et al, 2004]

The same epigenetic influences also continue after the child is born because parents continue to influence their child's environment. In particular, fascinating new research is emphasizing the importance of good parenting in the development of the brain: "For the growing brain of a young child, the social world supplies the most important experiences influencing the expression of genes, which determines how neurons connect to one another in creating the neuronal pathways which give rise to mental activity," writes Dr. Daniel J. Siegel in *Tlie Developing Mind.* [Siegel 1999] In other words, infants need a nurturing environment to activate the genes that develop healthy brains. Parents, the latest science reveals, continue to act as genetic engineers even after the birth of their child.

Parental Programming: The Power of the Subconscious Mind

I'd like to tell you about how I—who put myself in the category of those who were *not* prepared to have children —came to question my ingrained assumptions about parenting. You won't be surprised to hear that I started my reevaluation in the Caribbean, the place where my shift to the New Biology took root. My reassessment was actually inspired by an unlucky event, a motorcycle accident. I was on my way to present a lecture when I went off a curb at high speed. The bike wound up upside down. Luckily I was wearing a helmet because I sustained a major blow to my head when the bike hit the ground. I was unconscious for half an hour and for a while my students and colleagues thought I was dead. When I came to, I felt as if I had broken every bone in my body.

For the next few days I could hardly walk, and when doing so, I resembled a yelping version of Quasimodo. Every step was a painful reminder that "speed kills." As I creaked out of the classroom one afternoon, one of my students suggested that it might help if I visited his roommate, a fellow student, who was also a chiropractor. As I explained in the last chapter, I not only had never been to a chiropractor, I had been taught by my allopathic community to shun chiropractors as quacks. But when you're in that much pain and you're in an unfamiliar setting, you wind up trying things you would never consider in your cushier moments.

At the chiropractor's make shift dormitory "office" I was introduced for the first time to kinesiology, popularly known as muscle testing. The chiropractor told me to hold out my arm and resist the downward pressure he applied to it. I had no problem resisting the light force he put on my arm. Then he asked me to hold out my arm and resist him again while I said, "My name is Bruce." Again, I had no trouble resisting him, but by now I was starting to think that the admonishments of my academic colleagues were right on the mark — "This is nuts!" Then, the chiropractor told me to hold out my arm and resist his pressure while saying earnestly: "My name is Mary." To my amazement, my arm flopped down, despite my strong resistance. "Now wait a minute," I said. "I must not have been resisting enough, try that again." So we did, and this time I concentrated even more forcefully on resisting. Nevertheless, after repeating, "My name is Mary," my arm sunk like a stone. This student, who was now *my* teacher, explained that when your conscious mind has a belief that is in conflict with a formerly learned "truth" stored in the subconscious mind, the intellectual conflict expresses itself as a weakening of the body's muscles.

To my astonishment, I realized that my conscious mind, which I exercised so confidently in academic settings, was not in control when I voiced an opinion that differed from a truth stored in the unconscious mind. My unconscious mind was undoing the best efforts of my conscious mind to hold up my arm when I claimed my name was Mary. I was amazed to discover that there was another "mind," another force, that was co-piloting my life. More shocking was the fact that this hidden mind, the mind I knew little about (except theoretically in psychology) was actually more powerful than my conscious mind, just as Freud had claimed. All in all, my first visit to a chiropractor turned out to be a life-changing experience. I learned that chiropractors could tap into the body's innate healing power using kinesiology to target spinal misalignments. I was able to saunter out of that dorm feeling like a new man after a few simple, vertebral adjustments on the "quack's" table...all without the use of drugs. And most importantly, I was introduced to the "man behind the curtain," my subconscious mind!

As I left the campus, my conscious mind was awhirl over the implications of the superior power of my formerly hidden subconscious mind. I also coupled those musings with my study of quantum physics, which taught me that thoughts could propel behavior more efficiently than physical molecules. My subconscious "knew" that my name was not Mary and balked at my insistence that it was. What else did my subconscious mind "know" and how had it learned it?

To understand better what had happened in that chiropractor's office, I first turned to comparative neuroanatomy which reveals: the lower an organism is on the Tree of Evolution, the less developed its nervous system and thus the more it relies on preprogrammed behavior (nature). Moths fly toward the light, sea turtles return to specific islands and lay their eggs on the beach at the appropriate time, and the swallows return to Capistrano on a specific date, yet, as far as we know, none of these organisms have any knowledge of why they engage in those behaviors. The behaviors are innate; they are genetically built into the organism and are classified as *instincts.*

Organisms higher in the Tree have more complexly integrated nervous systems headed by bigger and bigger brains that allow them to acquire intricate behavioral patterns through experiential learning (nurture). The complexity of this environmental learning mechanism presumably culminates with humans, who are at the top, or at least near the top, of the Tree. To quote anthropologists Emily A. Schultz and Robert H. Lavenda: "Human beings are more dependent on learning for survival than other species. We have no instincts that automatically

protect us and find us food and shelter, for example." [Schultz and Lavenda 1987]

We do have, of course, behavioral instincts that are innate—consider the infant's instinct to suckle, to quickly move his hand away from fire, and to automatically swim when placed in water. Instincts are built in behaviors that are fundamental to the survival of all humans, independent of what culture they belong to or what time in human history they were born. We are born with the ability to swim; infants can swim like graceful porpoises moments after they are born. But children quickly acquire a fear of water from their parents — observe the response of parents when their unattended child ventures near a pool or other open water. Children learn from their parents that water is dangerous. Parents must later struggle to teach Johnny how to swim. Their first big effort is focused on overcoming the fear of water they instilled in earlier years.

But through evolution, our *learned* perceptions have become more powerful, especially because they can override genetically programmed instincts. The body's physiological mechanisms (e.g., heart rate, blood pressure, blood flow/bleeding patterns, body temperature) are by their nature, programmed instincts. However, yogis as well as everyday people using biofeedback can *learn* to consciously regulate these "innate" functions.

Scientists have focused on our big brains as the reason for our ability to learn such complex behavior. However, we should temper our enthusiasm for the big brain theory by considering that cetaceans (porpoises and dolphins) have a greater cerebral surface area packed into their craniums than we do.

And the findings of British neurologist Dr. John Lorber, highlighted in a 1980 article in *Science,* "Is your Brain Really Necessary?" also call into question the notion that the size of the brain is the most important consideration for human intelligence. [Lewin 1980] Lorber studied many cases of hydrocephalus ("water on the brain") and concluded that even when most of the brain's cerebral cortex (the brain's outer layer) is missing, patients can live normal lives. *Science* writer Roger Lewin quotes Lorber in his article:

> "There's a young student at this university [Sheffield University] who has an IQ of 126, has gained a first-class honors degree in mathematics, and is socially completely normal. And yet the boy has virtually no brain.. .When we did a brain scan on him, we saw that instead of the normal 4.5 centimeter thickness of brain tissue between the ventricles and the cortical surface, there

was just a thin layer of mantle measuring a millimeter or so. His cranium is filled mainly with cerebrospinal fluid."

Lorber's provocative findings suggest that we need to reconsider our long-held beliefs about how the brain works and the physical foundation of human intelligence. I submit in the epilogue of this book that human intelligence can only be fully understood when we include spirit ("energy") or what quantum physics-savvy psychologists call the "superconscious" mind. But for the moment, I'd like to stick to the conscious and subconscious minds, concepts that psychologists and psychiatrists have long grappled with. I'm grappling with it here to provide the biological foundation for conscious parenting as well as energy-based psychological healing methods.

Human Programming: When Good Mechanisms Go Bad

Let's go back to the evolutionary challenge for human beings, who have to learn so much so quickly to survive and become a part of their social community. Evolution has endowed our brains with the ability to rapidly download an unimaginable number of behaviors and beliefs into our memory. Ongoing research suggests that a key to understanding how this rapid downloading of information works is the brain's fluctuating electrical activity as measured by electroencephalograms. The literal definition of electroencephalograms (EEGs) is "electric head pictures." These increasingly sophisticated head pictures reveal a graded range of brain activity in human beings. Both adults and children display EEG variations that range from low frequency *Delta* waves through high frequency *Beta* waves. However, researchers have noted that EEG activity in children reveals, at every developmental stage, the predominance of a specific brain wave.

Dr. Rima Laibow in *Quantitative EEG and Neurofeedback* describes the progression of these developmental stages in brain activity. [Laibow 1999 and 2002] Between birth and two years of age, the human brain *predominantly* operates at the lowest EEG frequency, 0.5 to 4 cycles per second (Hz), known as *Delta* waves. Though *Delta* is their predominant wave activity, babies can exhibit periodic short bursts of higher EEG activity. A child begins to spend more time at a higher level of EEG activity characterized as *Theta* (4-8 Hz) between two and six years of age. Hypnotherapists drop their patients' brain activity into *Delta* and *Tlieta* because these low frequency brain waves put them into a more suggestible, programmable state.

This gives us an important clue as to how children, whose brains are mostly operating at these same frequencies between birth and six years of age, can download the incredible volume of information they need to thrive in their environment. The ability to process this vast quantity of information is an important neurologic adaptation to facilitate this information-intense process of enculturation. Human environments and social mores change so rapidly that it would not be an advantage to transmit cultural behaviors via genetically programmed instincts. Young children carefully observe their environment and download the worldly wisdom offered by parents directly into their subconscious memory. As a result, their parents' behavior and beliefs become their own.

Researchers at Kyoto University's Primate Research Institute have found that baby chimps also learn by simply observing their mothers. In a series of experiments, a mother was taught to identify the Japanese characters for a variety of colors. When the Japanese character for a specific color was flashed on a computer screen, the chimp learned to choose the right color swatch. Upon selecting the right color, the chimp received a coin that she could then put in a vending machine for a fruit treat. During her training process, she was holding her baby close. To the surprise of researchers, one day, as the mother was retrieving her fruit from the vending machine, the infant chimp activated the computer. When the character appeared on the screen, the chimp selected the correct color, received a coin and then followed his mother to the vending machine. The astonished researchers were left to conclude that infants can pick up complex skills solely by observation and don't have to be actively coached by their parents. [Science 2001]

In humans as well, the fundamental behaviors, beliefs and attitudes we observe in our parents become "hard-wired" as synaptic pathways in our subconscious minds. Once programmed into the subconscious mind, they control our biology for the rest of our lives...unless we can figure out a way to reprogram them. Anyone who doubts the sophistication of this downloading should think about the first time your child blurted out a curse word picked up from you. I'm sure you noted its sophistication, correct pronunciation, its nuanced style and context carrying your signature.

Given the precision of this behavior-recording system, imagine the consequences of hearing your parents say you are a "stupid child," you "do not deserve things," will "never amount to anything," "never should have been born" or are a "sickly, weak" person. When unthinking or uncaring parents pass on those messages to their young children, they are no doubt oblivious to the fact that such comments are downloaded into the subconscious memory as absolute "facts" just as surely as bits

and bytes are downloaded to the hard drive of your desktop computer. During early development, the child's consciousness has not evolved enough to critically assess that those parental pronouncements were only verbal barbs and not necessarily true characterizations of "self." Once programmed into the subconscious mind, however, these verbal abuses become defined as "truths" that unconsciously shape the behavior and potential of the child through life.

As we get older, we become less susceptible to outside programming with the increasing appearance of higher frequency *Alpha* waves (8-12 HZ). *Alpha* activity is equated with states of calm consciousness. While most of our senses, such as eyes, ears and nose, observe the outer world, consciousness resembles a "sense organ" that behaves like a mirror reflecting back the inner workings of the body's own cellular community; it is an awareness of "self."

At around twelve years of age, the child's EEG spectrum begins to show sustained periods of an even higher frequency defined as *Beta* waves (12-35 Hz). Beta brain states are characterized as "active or focused consciousness," the kind of brain activity used in reading this book. Recently, a fifth, higher state of EEG activity has been defined. Referred to as *Gamma* waves (>35Hz), this EEG frequency range kicks in during states of "peak performance," such as when pilots are in the process of landing a plane or a professional tennis player is engaged in a rapid-fire volley.

By the time children reach adolescence, their subconscious minds are chock-full of information that range from the knowledge of how to walk, to the "knowledge" they will never amount to anything, or the knowledge, fostered by loving parents, they can do anything they set out to do. The sum of our genetically programmed instincts and the beliefs we learned from our parents collectively form the subconscious mind, which can undo both our ability to keep our arm raised in a chiropractor's office and our best New Year's resolutions to stop sabotaging ourselves with drugs or food.

Again I go back to cells, which can teach us so much about ourselves. I've said many times that single cells are intelligent. But remember, when cells band together in creating multicellular communities, they follow the "collective voice" of the organism, even if that voice dictates self-destructive behavior. Our physiology and behavior patterns conform to the "truths" of the central voice, be they constructive or destructive beliefs.

I've described the power of the subconscious mind, but I want to emphasize that there is no need to consider the subconscious a scary,

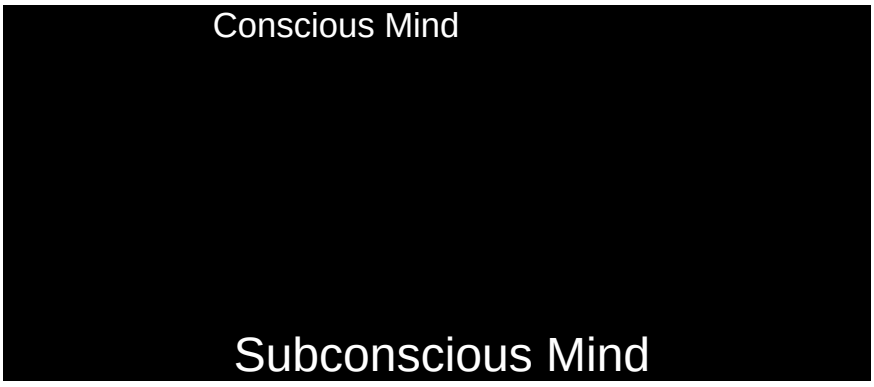
super-powerful, Freudian font of destructive "knowledge." In reality, the subconscious is an emotionless database of stored programs, whose function is strictly concerned with reading environmental signals and engaging in hard-wired behavioral programs, no questions asked, no judgments made. The subconscious mind is a programmable "hard drive" into which our life experiences are downloaded. The programs are fundamentally hardwired stimulus-response behaviors. Behavior activating stimuli may be signals the nervous system detects from the external world and/or signals that arise from within the body such as emotions, pleasure and pain. When a stimulus is perceived, it will automatically engage the behavioral response that was learned when the signal was first experienced. In fact, people who realize the automated nature of this playback response frequently admit to the fact that their "buttons have been pushed."

Before the evolution of the conscious mind, the functions of animal brains consisted only of those that we link with the subconscious mind. These more primitive minds were simple stimulus-response devices that automatically responded to environmental stimuli by engaging genetically programmed (instincts) or simple learned behaviors. These animals do not "consciously" evoke such behaviors, and in fact, may even be oblivious to them. Their behaviors are programmed reflexes, like the blink of an eye in response to a puff of air or the kick of a leg after tapping the knee joint.

The Conscious Mind: The Creator Within

The evolution of higher mammals, including chimps, cetaceans and humans, brought forth a new level of awareness called "self-consciousness," or, simply, the conscious mind. The newer conscious mind is an important evolutionary advance. The earlier, subconscious mind is our "autopilot"; the conscious mind is our manual control. For example, if a ball comes near your eye, the slower conscious mind may not have time to be aware of the threatening projectile. Yet the subconscious mind, which processes some 20,000,000 environmental stimuli per second v. 40 environmental stimuli interpreted by the conscious mind in the same second, will cause the eye to blink.

[Norretranders 1998] (see illustration below). The subconscious mind, one of the most powerful information processors known, specifically observes both the surrounding world and the body's internal awareness, reads the environmental cues and immediately engages previ-



Visualizing the information-processing powers of the conscious and subconscious minds. Consider that the image of Machu Picchu above is comprised of 20,000,000 pixel dots, each representing a BIT of information received by the nervous system in one second. How much of that information enters the conscious mind? In the lower picture, the dot represents the total amount of information that is processed by the conscious mind. (Actually the dot is 10X more than enters consciousness, I had to enlarge it because it was barely visible.) In contrast, the powerful subconscious mind processes *all* the remaining incoming information (the black area) in the same second.

ously acquired (learned) behaviors —all without the help, supervision or even awareness of the conscious mind.

The two minds make a dynamic duo. Operating together, the conscious mind can use its resources to focus on some specific point, such as the party you are going to on Friday night. Simultaneously, your subconscious mind can be safely pushing the lawn mower around and successfully not cutting off your foot or running over the cat—even though you are not consciously paying attention to mowing the lawn.

The two minds also cooperate in acquiring very complex behaviors that can subsequently be unconsciously managed. Remember the first day you excitedly sat in the driver's seat of a car, preparing to learn how to drive? The number of things that had to be dealt with by the

conscious mind was staggering. While keeping your eyes on the road, you had to also watch the rear and side view mirrors, pay attention to the speedometer and other gauges, use two feet for the three pedals of a standard shift vehicle and try to be calm, cool and collected as you drove past observing peers. It took what seemed to be a long time before all these behaviors were "programmed" into your mind.

Today, you get in the car, turn the ignition on and consciously review your shopping list as the subconscious mind dutifully engages all the complex skills you need to successfully navigate through the city —without even once having to think about the mechanics of driving. I know I am not the only one out there who has experienced this. You are driving and having a delightful discussion with the passenger sitting next to you. In fact, your consciousness gets so caught up in the conversation, that somewhere down the road it dawns on you that you haven't even paid attention to your driving for five minutes. After a momentary start, you realize that you are still on your side of the road and steadily moving along with the flow of traffic. A quick check of the rear view mirror reveals that you did not leave a wake of crumpled stop signs and smashed mailboxes. If you weren't consciously driving the car during that time, then who was? The subconscious mind! And how well did it do? Although you didn't observe its behavior, the subconscious mind apparently performed just as well as it was taught during your driver education experience.

In addition to facilitating subconscious habitual programs, the conscious mind also has the power to be spontaneously creative in its responses to environmental stimuli. In its self-reflective capacity, the conscious mind can observe behaviors as they're being carried out. As a preprogrammed behavior is unfolding, the observing conscious mind can step in, stop the behavior and create a new response. Thus the conscious mind offers us free will, meaning we are not just victims of our programming. To pull that off however, you have to be fully conscious lest the programming take over, a difficult task, as anyone who's tried willpower can attest. Subconscious prograrnming takes over the moment your conscious mind is not paying attention.

The conscious mind can also think forward and backward in time, while the subconscious mind is always operating in the present moment. When the conscious mind is busy daydreaming, creating future plans or reviewing past life experiences, the subconscious mind is always on duty, efficiently managing the behaviors required at the moment, without the need of conscious supervision.

The two minds are truly a phenomenal mechanism, but here is how it can go awry. The conscious mind is the "self," the voice of our own

thoughts. It can have great visions and plans for a future filled with love, health, happiness and prosperity. While we focus our consciousness on happy thoughts, who is running the show? The subconscious. How is the subconscious going to manage our affairs? Precisely the way it was programmed. The subconscious mind's behaviors when we are not paying attention may not be of our own creation because most of our fundamental behaviors were downloaded without question from observing other people. Because subconscious-generated behaviors are *not* generally observed by the conscious mind, many people are stunned to hear that they are "just like their mom or their dad," the people who programmed their subconscious minds.

The learned behaviors and beliefs acquired from other people, such as parents, peers and teachers, may not support the goals of our conscious mind. The biggest impediments to realizing the successes of which we dream are the limitations programmed into the subconscious. These limitations not only influence our behavior, they can also play a major role in determining our physiology and health. As we've seen earlier, the mind plays a powerful role in controlling the biological systems that keep us alive.

Nature did not intend the presence of the dual minds would be our Achilles heel. In fact, this duality offers a wonderful advantage for our lives. Consider it this way: What if we had conscious parents and teachers who served as wonderful life models, always engaging in humane and win-win relations with everyone in the community? If our subconscious mind were programmed with such healthy behaviors, we could be totally successful in our lives without ever being conscious!

The Subconscious Mind: I Keep Calling and No One Answers

While the "thinking-self" nature of the conscious mind evokes images of a "ghost in the machine," there is no similar self-awareness operating in the subconscious mind. The latter mechanism is more akin to a jukebox loaded with behavioral programs, each ready to play as soon as appropriate environmental signals appear and press the selection buttons. If we don't like a particular song in the jukebox, how much yelling at or arguing with the machine will cause it to reprogram its play list? In my college days, I saw many an inebriated student, to no avail, curse and kick jukeboxes that were not responsive to their requests. Similarly, we must realize that no amount of yelling or cajoling by the conscious mind can ever change the behavioral "tapes" programmed into the subconscious mind. Once we realize the

ineffectiveness of this tactic, we can quit engaging in a pitched battle with the subconscious mind and take a more clinical approach to reprogramming it. Engaging the subconscious in battle is as pointless as kicking the jukebox in the hope that it will reprogram its play list.

The futility of battling with the subconscious is a hard message to get across because one of the programs most of us downloaded when we were young is that "will power is admirable." So we try over and over again to override the subconscious program. Usually such efforts are met with varying degrees of resistance because the cells are obligated to adhere to the subconscious program.

Tensions between conscious will power and subconscious programs can result in serious neurological disorders. For me, a powerful image of why we should not challenge the subconscious comes from the movie "Shine." In the movie, based on a true story, Australian concert pianist David Helfgott defies his father by going off to London to study music. Helfgott's father, a survivor of the Holocaust, programmed his son's subconscious mind with the belief that the world was unsafe, that if he "stood out" it might be life threatening. His father insisted he would be safe only if he stayed close to his family. In spite of his father's relentless programming, Helfgott knew that he was a world-class pianist who needed to break from his father to realize his dream.

In London, Helfgott played the notoriously difficult "Third Piano Concerto" of Rachmaninoff in a competition. The film shows the conflict between his conscious mind wanting success and his subconscious mind concerned that being visible, being internationally recognized, was life-threatening. As he labors through the concerto, sweat pouring from his brow, Helfgott's conscious mind fights to stay in control, while his subconscious mind, fearful of winning, tries to take control of his body. Helfgott consciously forces himself to maintain control through the concerto until he plays the last note. He then passes out, overcome by the energy it took to battle his subconscious programming. For that "victory" over the subconscious, he pays a high price: When he comes to, he is insane.

Most of us engage in less dramatic battles with our subconscious mind as we try to undo the programming we received as children. Witness our ability to continually seek out jobs that we fail at, or remain in jobs we hate, because we don't "deserve" a better life.

Conventional methods for suppressing destructive behaviors include drugs and talk therapy. Newer approaches promise to change our programming, recognizing that there is no use "reasoning" with the subconscious tape player. These methods capitalize on the findings of quantum physics that connect energy and thought. In fact, these

modalities that reprogram previously learned behaviors can be collectively referred to as energy psychology, a burgeoning field based on the New Biology.

But how much easier it would be to be nurtured from the beginning of life so that you can reach your genetic and creative potential? How much better to become a conscious parent so that your children and their children will be conscious parents, making reprogramming unnecessary and making for a happier, more peaceful planet!

A Twinkle In Your Parents[7] Eyes: Conscious Conception & Conscious Pregnancy

You all know the expression, "When you were only a twinkle in your parents' eyes." A phrase that conjures up the happiness of loving parents who truly want to conceive a child. It turns out it is also a phrase that sums up the latest genetic research suggesting that parents should cultivate that twinkle in the months before they conceive a child. That growth-promoting awareness and intention can produce a smarter, healthier and happier baby.

Research reveals that parents act as genetic engineers for their children in the months before conception. In the final stages of egg and sperm maturation, a process called *genomic imprinting* adjusts the activity of specific groups of genes that will shape the character of the child yet to be conceived. [Surani 2001; Reik and Walter 2001] Research suggests that what is going on in the lives of the parents during the process of genomic imprinting has a profound influence on the mind and body of their child, a scary thought given how unprepared most people are to have a baby. Verny writes in *Pre-Parenting: Nurturing Your Child from Conception:* "It makes a difference whether we are conceived in love, haste or hate, and whether a mother wants to be pregnant...parents do better when they live in a calm and stable environment free of addictions and supported by family and friends." [Verny and Weintraub 2002] Interestingly, aboriginal cultures have recognized the influence of the conception environment for millennia. Prior to conceiving a child, couples ceremonially purify their minds and bodies.

Once the child is conceived, an impressive body of research is documenting how important parents' attitudes are in the development of the fetus. Again Verny writes: "In fact, the great weight of the scientific evidence that has emerged over the last decade demands that we reevaluate the mental and emotional abilities of unborn children. Awake or asleep, the studies show, they [unborn children] are constantly tuned in to their mother's every action, thought and feeling. From the moment of conception, the experience in the womb shapes the brain and lays the

groundwork for personality, emotional temperament, and the power of higher thought."

Now is the time to stress that the New Biology is *not* a return to the old days of blaming mothers for every ailment that medicine didn't understand —from schizophrenia to autism. Mothers and fathers are in the conception and pregnancy business together, even though it is the mother who carries the child in her womb. What the father does profoundly affects the mother, which in turn affects the developing child. For example, if the father leaves and the mother starts questioning her own ability to survive, his leaving profoundly changes the interaction between the mother and the unborn baby. Similarly, societal factors, such as lack of employment, housing and healthcare or endless wars that pull fathers into the military, can affect the parents and thus the developing child.

The essence of conscious parenting is that both mothers and fathers have important responsibilities for fostering healthy, intelligent, productive and joy-filled children. We surely cannot blame ourselves, nor our parents for failures in our own or our children's lives. Science has kept our attention focused on the notion of genetic determinism, leaving us ignorant about the influence beliefs have on our lives, and more importantly, how our behaviors and attitudes program the lives of our children.

Most obstetricians are also still uneducated about the importance of parental attitudes in the development of the baby. According to the notion of genetic determinism that they were steeped in as medical students, fetal development is mechanically controlled by genes with little additional contribution from the mother. Consequently, Ob-Gyns are only concerned with a few maternal prenatal issues: Is she eating well? Taking vitamins? Does she exercise regularly? Those questions focus on what they believe is the mother's principal role, the provision of nutrients to be used by the genetically programmed fetus.

But the developing child receives far more than nutrients from the mother's blood. Along with nutrients, the fetus absorbs excess glucose if the mother is diabetic, and excess Cortisol and other fight or flight hormones if the mother is chronically stressed. Research now offers insights into how the system works. If a mother is under stress, she activates her HPA axis, which provides fight or flight responses in a threatening environment.

Stress hormones prepare the body to engage in a protection response. Once these maternal signals enter the fetal blood stream, they affect the same target tissues and organs in the fetus as they did in the

mother. In stressful environments, fetal blood preferentially flows to the muscles and hindbrain, providing nutritional requirements needed by the arms and legs, and by the region of the brain responsible for life-saving reflex behavior. In supporting the function of the protection-related systems, blood flow is shunted from the viscera organs and stress hormones suppress forebrain function. The development of fetal tissue and organs is proportional to both the amount of blood they receive and the function they provide. When passing through the placenta, the hormones of a mother experiencing chronic stress will profoundly alter the distribution of blood flow in her fetus and change the character of her developing child's physiology. [Lesage, et al, 2004; Christensen 2000; Arnsten 1998; Leutwyler 1998; Sapolsky 1997; Sandman, et al, 1994]

At the University of Melbourne, E. Marilyn Wintour's research on pregnant sheep, who are physiologically quite similar to humans, has found that prenatal exposure to Cortisol eventually leads to high blood pressure [Dodic, et al, 2002]. Fetal Cortisol levels play a very important regulatory role in the development of the kidney's filtering units, the nephrons. A nephron's cells are intimately involved with regulating the body's salt balance and consequently are important in controlling blood pressure. Excess Cortisol absorbed from a stressed mother modifies fetal nephron formation. An additional effect of excess Cortisol is that it simultaneously switches the mother's and the fetus' system from a growth state to a protection posture. As a result, the growth-inlubiting effect of excess Cortisol in the womb causes the babies to be born smaller.

Suboptimal conditions in the womb that lead to low birth-weight babies have been linked to a number of adult ailments that Nathanielsz outlines in his book *Life In The Womb,* [Nathanielsz 1999] including diabetes, heart disease and obesity. For example, Dr. David Barker [ibid.] of England's University of Southampton has found that a male who weighs less than 5.5 pounds at birth has a 50% greater chance of dying of heart disease than one with a higher birth weight. Harvard researchers have found that women who weigh less than 5.5 pounds at birth have a 23 percent higher risk of cardiovascular disease than women born heavier. And David Leon *[ibid.] of the London* School *of* Hygiene and Tropical Medicine has found that diabetes is three times more common in 60-year-old men who were small and thin at birth.

The new focus on the influences of the prenatal environment extends to the study of IQ, which genetic determinists and racists once linked simply to genes. But in 1997, Bernie Devlin, a professor of psychiatry at the University of Pittsburgh School of Medicine, carefully

analyzed 212 earlier studies that compared the IQs of twins, siblings, and parents and their children. He concluded that genes account for only forty-eight percent of the factors that determine IQ. And when the synergistic effects of mingling the mother and father's genes are factored in, the true inherited component of intelligence plummets even further, to thirty-four percent. [Devlin, et al, 1997; McGue 1997]

Devlin, on the other hand, found that conditions during prenatal development significantly impact IQ. He reveals that up to fifty-one percent of a child's potential intelligence is controlled by environmental factors. Previous studies had already found that drinking or smoking during pregnancy can cause decreased IQ in children, as can exposure to lead in the womb. The lesson for people who want to be parents is that you can radically shortchange the intelligence of your child simply by the way you approach pregnancy. These IQ changes are not accidents; they are directly linked to altered blood flow in a stressed brain.

In my lectures on conscious parenting, I cite research, but I also show a video from an Italian conscious parenting organization, Associazione Nazionale Educazione Prenatale, which graphically illustrates the interdependent relationship between parents and their unborn child. In this video, a mother and father engage in a loud argument while the woman is undergoing a sonogram. You can vividly see the fetus jump when the argument starts. The startled fetus arches its body and jumps up, as if it were on a trampoline when the argument is punctuated with the shattering of glass. The power of modern technology, in the form of a sonogram, helps to lay to rest the myth that the unborn child is not a sophisticated enough organism to react to anything other than its nutritional environment.

Nature's Head Start Program

You may be wondering why evolution would provide such a system for fetal development that seems so fraught with peril and is so dependent on the environment of the parents. Actually, it's an ingenious system that helps ensure the survival of your offspring. Eventually, the child is going to find itself in the same environment as its parents. Information acquired from the parents' perception of their environment transits the placenta and primes the prenate's physiology, preparing it to more effectively deal with future exigencies that will be encountered after birth. Nature is simply preparing that child to best survive in that environment. However, armed with the latest science, parents now have a choice. They can carefully reprogram their limiting beliefs about life before they bring a child into their world.

The importance of parental programming undermines the notion that our traits, both positive and negative, are fully determined by our genes. As we have seen, genes are shaped, guided and tailored by environmental learning experiences. We have all been led to believe that artistic, athletic and intellectual prowess are traits simply passed on by genes. But no matter how "good" one's genes may be, if an individual's nurture experiences are fraught with abuse, neglect or mis-perceptions, the realization of the genes' potentials will be sabotaged. Liza Minelli acquired her genes from her superstar mother Judy Garland and her father filmmaker Vincent Minelli. Liza's career, the heights of her stardom and the lows of her personal life, are scripts that were played out by her parents and downloaded into her subconscious mind. If Liza had the same genes, but was raised by a nurturing Pennsylvania Dutch farming family, that environment would have epigenetically triggered a different selection of genes. The genes that enabled her to pursue a successful entertainment career would have likely been masked or inhibited by the cultural demands of her agrarian community.

A wonderful example of the effectiveness of conscious parenting programming is superstar golfer Tiger Woods. Although his father was not an accomplished golfer, he made every effort to immerse Tiger in an environment that was rich with opportunities to develop and enhance the mindset, skills, attitudes and focus of a master golfer. No doubt, Tiger's success is also intimately connected with the Buddhist philosophy that his mother contributed. Indeed, genes are important — but their importance is only realized through the influence of conscious parenting and the richness of opportunities provided by the environment.

Conscious Mothering and Fathering

I used to close mv public lectures with the admonition that we are personally responsible for everything in our lives. Such a closure did