NEW YORK TIMES BESTSELLING AUTHOR

KABIR SEHGAL

COINED

THE RICH LIFE OF MONEY AND HOW ITS HISTORY HAS SHAPED US

FOREWORD BY MUHAMMAD YUNUS, NOBEL PEACE LAUREATE

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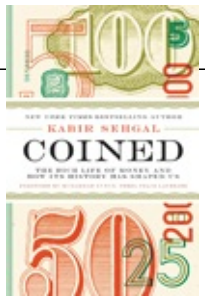

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For Douglas Brinkley, mentor and friend

Foreword

In 1974, I was teaching economics at Chittagong University in Bangladesh. In order to reach th campus, I had to travel through Jobra, a typical Bangladeshi village next to the newly built universi campus. That same year a terrible famine caused millions across Bangladesh to suffer, and when realized I could do nothing to ease all that suffering, I felt the arrogance of knowledge and learnin begin to melt away. I wanted to overcome this feeling of uselessness by helping at least one person a time.

I started walking around the village every day with that tiny mission in mind. There were so man things to be done that I hardly knew where to begin. Then I noticed loan-sharking was being practice widely in the village, which was an ugly thing to watch—a mechanism that exploited the poore people. Using my one-person-at-a-time approach, I started lending to people out of my own pocke and that is how the idea of microcredit was born.

My work as a banker to the poor has helped me reevaluate money. The traditional definition o money found in economics narrowly categorizes it as an instrument to be used either to maximize o self-interest or to give away as charity. Money, however, can also be applied to advance importan social goals, such as reducing poverty and preserving the environment—but these objectives requi innovative applications and a willingness to look at money from new perspectives and through th lenses of multiple disciplines. Kabir Sehgal's new book, *Coined: The Rich Life of Money and How I History Has Shaped Us*, does precisely that.

I first met Kabir in New York City in 2010. He showed deep concern about the misery that th financial crisis of 2008 brought to millions of people around the world, and he agreed with me that w needed to redesign financial institutions to make them more responsible and inclusive. He went eve further, wanting to determine why and how money shapes our lives, perhaps even reassessing the ro it should play in our lives. He mentioned his interest in writing a book that would enrich o understanding of money, broaden our perspective, and augment our financial literacy.

The book that resulted from his efforts is a unique and fascinating study of money, not just as a instrument for buying and selling but also as an extension of humankind through the ages. This boo reflects our multidimensional nature, as it is an exploration of money and exchange through th perspective of various disciplines from biology and anthropology to history and theology. Kab examines the uses of money, its invention, its change over time, its future forms, why it is such powerful force in our lives, and, ultimately, how it should be used.

Kabir examines the past and present of money and projects its likely future. I am most interested the future incarnation of money: what it can be, and how it holds the power for changing society. Th is the role of money I recognized through microcredit, a construct that can empower people and brin about meaningful and sustainable change in a society. That is how I see its power through soci business with non-dividend companies that are dedicated to solving human problems. As more peop

read this book and broaden their understanding of money beyond the goal of accumulation, I hope th they will start social businesses in the future.

But whatever the future of money might be, Kabir Sehgal has done us a great service in writing th book. He has presented in this book everything that money has meant to people over the centuries ar with a panoramic perspective. He has prepared the ground for us to take it forward, to give ne meaning to money, to assign it new roles in our lives, and to imagine the future of money as foundation upon which we can build the future of the world we all cherish. Thank you, Kabir.

Muhammad Yun

Nobel Peace Laurea

Founder of Grameen Ba

It is more easy to write on money than to obtain it; and those who gain it, jest much at those who only know how to write about it.

—*Voltaire*[1]

The image propagated by tradition is that of a city of pure gold, with silver locks and diamond gates, a jewel-city, all inset and inlaid, as a maximum of laborious study might produce when applied to materials of the maximum worth. True to this belief, Beersheba's inhabitants honor everything that suggests for them the celestial city: they accumulate noble metals and rare stones, they renounce all ephemeral excesses, they develop forms of composite composure.

—*Italo Calvino*[2]

To Whom It May Concern,

We regret to inform that the mounted centenary coins displayed at the museum are missing from their place. Whoever is in possession of the same is earnestly requested to return them to us in view of the historical importance of those particular coins which were presented personally to the Superior General of the Missions of Charity by the President of India, on the occasion of the Centenary Celebration of Our Mother Teresa.

We can make a gift of coins of the same value on return of those coins. We assure that the entire matter would be kept private and confidential.

—*Letter posted at Mother Teresa's Motherhouse in Kolkata, India*

Introduction

Red light.

Jakarta.

Running late.

An emaciated barefoot beggar paces in front of my taxi while carrying a baby in her arms. W make eye contact. I look away. In the other direction, I see several more beggars standing in lin index fingers raised.

Odd.

Street sounds blend harmoniously with a fainter, distant call to prayer. The *adhan*, now in its min third interval, reminds me of Islam's role in this city—a vibrant amalgamation of nearly 10 millio residents.

Here I am, far from home, smack-dab in the middle of them.

Green light.

Off and away.

Or not.

"Let's go, bro," I urge the driver. But he sits, heavy foot on brake, while others blare their horn The beggar approaches. Expecting the inevitable knock, the curled hand, I look away again.

The front door opens.

Um.

My protest is ended by her taking a seat, fiddling with the air-conditioning.

Four of us. Driver, pedestrian, baby, and I sit in silence as the car motors away. Is this kidnapping? If so, it is the quietest and most orderly kidnapping ever. Maybe I should flip through th Lonely Planet guide to Indonesia. Where is the self-defense section?

We speed onto the expressway and into the carpool lane, and it suddenly becomes clear.

It's not a kidnapping. It's a transaction. For a cut, this pedestrian-now-passenger has enabled th driver (and me) to use the fast lane. She is one of Jakarta's many small-time hustlers. These foll don't care where they go. Neither does my driver. And in a certain sense, neither do I.

We are all after the same thing. We are all out to make a buck. The pedestrian is happy to travel to kilometers for a few rupiah, my taxi driver one hundred kilometers more for a fare, and me to thousand kilometers for an investment opportunity.

At first it may appear that money is merely an instrument of exchange, the turnstile of th transaction, moving from hand to hand. But money is far more than just an item to be swapped. See through a more panoramic lens, money plays a social, mental, natural, and even artistic role in th exchange.

Because of money, I encountered three people whom I probably would not have met otherwis Though I didn't add them as Facebook friends (Indonesia is one of Facebook's largest markets

money helped to create a relationship where one didn't exist previously. Money spurred and shape our interactions.

Money also stimulates the brain: The thought of expected gain activates the nucleus accumber part of the reward center of the brain. The thought of making money probably stimulated the nucle accumbens in the brains of the driver and pedestrian. The thought of losing money, thinking that would be robbed, activated my amygdala, the fear center of the brain.

Money plays a natural or evolutionary role. At the most basic level, humans are driven by a nee and desire to survive. And all humans must exchange with each other in order to survive. The fo passengers, in a sense, relied on each other: I wanted a ride, the driver wanted a fare, the pedestria wanted a cut, and the baby wanted a place to sleep. Money helps us obtain the resources to surviv from a bite to eat to a place to rest. While money is a human invention, all organisms rely o exchange in order to survive. From sea urchins and algae to birds and flowers, exchange fundamental to life on this planet.

In this corner of the world, in Indonesia, birds and flowers are even on the money. In 1960, Ban Indonesia issued rupiah banknotes with indigenous organisms: sunbirds, green jungle fowl, tuberos bougainvillea. Money, in this case, was a symbol not just *of* value but of things that *are* valuable Indonesian society, like indigenous flora and fauna, a national crest and motto, or a foundin president. On some rupiah notes is the Garuda Pancasila, the national emblem of Indonesia, whic depicts an eagle clutching a ribbon. The Garuda is actually a symbol of the Hindu god Vishnu— peculiar image for the nation with the largest Islamic population in the world to put on its money. B the symbol reveals a chapter of Indonesia's cultural history, and how Hinduism spread to this islan nation in the second century AD. In fact, the symbol can be traced back to the eagle and snake my found in ancient Mesopotamia during the third millennium BC. It's a symbol that has spread acro many geographies and been incorporated by several cultures over thousands of years. For example, t back of the US one-dollar bill features the Great Seal, with an eagle at its center. In its beak is a ribbo that looks like a snake. The symbols on money are cultural fossils—links to our past. They can serv as a guidepost for our future, reminders of the virtues to which citizens should aspire.

I never wanted to work at an investment bank. In fact, I cried on my first day on the job. Aft completing my graduate degree in London, I moved to Mangalore, India, to start an online educatio company with my buddy. We ran out of money, so I applied to be a computer coder at investmen banks in London to cover our bills. I received two offers: Lehman Brothers and J. P. Morgan. I wish could say that I picked J. P. Morgan due to my remarkable foresight and careful consideration of i historical importance, fortress balance sheet, and stellar management, but I decided based on offi location. J. P. Morgan's office was in Central London whereas Lehman was in Canary Wharf, financial district in East London. And I didn't want to ride the Tube.

On my first day, it sank in—I was working at a bank. There's nothing wrong with working at bank, but it just wasn't for me. I would have to wear an ironed collar and write "Best Regards" close my emails. I would have to learn how to use financial jargon and manage my managers. It w all so very corporate, different from what I had envisioned for my life. I grew up wanting to be character in Michael Lewis's *The New New Thing*, a story about Silicon Valley tycoons like Jim Clar and Marc Andreessen. Instead, I had just walked into what I thought would be *Liar's Poker*.

After a few months in London and a quick stint in San Francisco, I was placed at the emergin markets equities desk in New York in 2008. I was a stockbroker who sold the stocks of corporations developing markets to large institutional investors like pension funds, mutual funds, and hedge fun

managing billions of dollars in assets. I worked diligently, but in the back of my mind, I thought wouldn't be around for long.

But then the world started to shake. First, the J. P. Morgan office in New York sits above Gran Central Terminal, so you can feel the rumble when a train approaches. And second, Lehman Brothe failed (as did my Indian enterprise), and the great financial crisis was under way. I had a uniqu position. I had a desk in a row on a trading floor in a building that belonged to a bank in the middle the crisis. I didn't just have a courtside seat. I was in the game. It occurred to me then, as it does no that I was a part of history. I decided to stay (and wasn't fired).

Being new to global markets, I had trouble keeping up with the alphabet soup of news: AIG, AA CDS, TARP, VOL, ZIRP. I created an "SGO" or "Shit Going On" folder on my laptop in which I save stories to read over the weekend. I was alarmed with the damage wrought by the financial crisis, and had difficulty grasping how it could have happened in the first place. I rode the No. 6 train and sa grown men crying while they carried cardboard boxes of office supplies. I remember watching o television the misery in the eyes of Americans who had lost their homes. Seven years later and now vice president, I am still working out the meaning of it all.

I made it a personal project to learn about the financial crisis and its root causes. I began a odyssey that took years and culminates in this book. I started by reading books on the financial cris and quickly learned that historically, busts are as much a part of the financial system as booms: fro tulip mania, which gripped the Netherlands in the 1630s, to the dot-com crash at the turn of th twenty-first century. I read historical works such as Charles Kindleberger and Robert Aliber's *Mania Panics, and Crashes* and Roger Lowenstein's *When Genius Failed.* These older texts deepened m interest in economic history and reintroduced me to the works of economic philosophers like Ada Smith, David Ricardo, John Stuart Mill, Karl Marx, John Maynard Keynes, Friedrich Hayek, Murra Rothbard, and Milton Friedman. In total, I read hundreds of sources looking for answers. The more read, the more I wanted to know.

My investigation into financial crises provoked me to ask a more sweeping question: What is about money that we can't master? There's something about it that makes us act in bizarre an irrational ways. I looked for answers in the texts of behavioral economists like Daniel Kahnema Amos Tversky, and Richard Thaler, who study the psychology of people when making econom decisions. Their research led me to that of neuroeconomists like Brian Knutson and Paul Glimche who examine and interpret brain scans of people while they make financial decisions. Since a decisions, including financial ones, are made in the brain, I delved into the research of evolutiona economists like Haim Ofek, who examines how the brain developed over thousands of years, an whether money was an output of an evolutionary process. My quest for depth resulted in breadth. grew fascinated with the many approaches through which one can understand money.

It became apparent that to focus only on financial crises or to consider money with a tradition economic lens belies the full range of what money means to us. Besides, the world didn't need anoth book on the 2008 financial crisis.

Money is like a musical note. In one note, there are more notes vibrating at other frequencies; v just can't hear them. Similarly, there is more to money than there may first appear. Take, for instanc $2,500. It means something different if it's booked as revenue, income, taxes, plunder, bribe earmarks, or an honorarium—even though it's the same amount. Whether someone hoards $2,500 donates it to the Red Cross may reveal their values, character, and even religious beliefs. Say someon pays $250 to his mother-in-law as payment for her preparing Thanksgiving dinner. If this is acceptab behavior, it provides anthropological insights into the society itself: Norms of the marketplace hav

replaced those found in the familial sphere. In this case, money has altered a societal norm an modified human behavior.

The necessity of money, and its multiple frequencies, led me to an even broader question: What it about money that makes the world go ’round? My obsession for money, not making it b understanding it, was governed by this question. It’s this question that is at the center of this book.

The traditional definition of money is that it’s a medium of exchange, unit of account, and store o value. It likely originates from economist William Stanley Jevons’s 1875 text, *Money and th Mechanism of Exchange*. The definition adequately describes the economic function of money. Durin my taxi ride, the rupiah acted as a medium of exchange, the valuable item that changed hands. It als acted as an Indonesian unit of account because it provided a standard measurement for the servic being rendered, in this case, the taxi ride. We didn’t haggle about how much 10,000 rupiah was worth It also acted as a store of value in that I could keep it in my wallet and retrieve it hours, weeks, eve years later and it would have roughly the same value (not considering inflation and oth developments that impact the value of money over time).

But as my taxi experience suggests, money doesn’t just play an economic role, and the tradition definition seems limited. It doesn’t account for various other ways one can interpret money.

A wider perspective begets a broader definition: I define money as a symbol of value. A symbol i used to represent something else. It’s an abstraction from the thing that it represents. Value is th importance or worth of something. Money is therefore a sign of something valuable and important.

This simple yet expansive definition isn’t original. But it gets us past seeing money purely as monetary instrument. It helps us to listen in to money’s various frequencies and set the frame for th collage of topics found in this book. Despite the kaleidoscopic lenses in which money is viewed with this book, it can be understood throughout as a symbol of value. Each chapter unpacks money throug the prism of a different critical perspective in order to see the same topic in a new light. And that’s th purpose of this book: to coin a multiplicity of ways to think about money.

One of these ways is to see money as alive. It lives. It sleeps. It breathes. It adapts. That’s becaus we as humans are ever changing. Ever since the creation of money, we have adapted it to better fit ou needs, from precious metals to plastic. But just as we think we determine the form of money, it als shapes us. Our skin conductance increases at the thought of money. Our brains register money as stimulus, so much so that the brain scan of someone about to receive a hit of cocaine is virtual indistinguishable from someone about to gain money. Money has done to us what Pavlov did to h dog: Anticipated gain stimulates and conditions the brain.

Some scholars contend that money may have led to the creation or spread of religions. As coinag was invented in Greece, India, and China, leaders like Pythagoras, Buddha, and Confucius gaine legions of followers. Dealing with money is a central theme of many religious lessons. In the Gosp of Matthew, eight of the ten parables reference money or wealth in some way. That money may shap our religious beliefs and rewires our neural circuitry demonstrates its omnipresent and dynamic fore on our lives. It intrudes in almost every part of our lives from birth, presenting gifts to a newborn; death, receiving an inheritance; to the hereafter, buying indulgences to save the soul.

I personify money with the subtitle *The Rich Life of Money and How Its History Has Shaped Us* highlight its influence. I also invoke a biographical device to serve as the organizational skeleton f this text. This book, this life of money, is divided into three sections: Mind, Body, and Soul.

In Mind, I ask “Why?” That is, why do we use money? I answer this question by using biolog psychology, and anthropology. In chapter 1, I travel to the Galapagos Islands in search of the origin

exchange. It's a peculiar place to start, but before examining money, one must understand the natu
of exchange. On these islands, I meet scientists who teach me about the evolutionary biologic
process and how exchange is fundamental to life on this planet. I boil things down to the cellular lev
to understand why organisms exchange with one another and enter into symbiotic relationships-
usually to obtain food and resources to survive. In the natural world, energy functions as currency. B
in the human world, money is also a primary currency. In order to deal in money, humans must b
able to think symbolically. Thus I trace the evolution and expansion of the brain, and how the fir
signs of symbolic thought are found in cave drawings that were made tens of thousands of years ago.

In chapter 2, I go inside the brain, examining the psychology and neuroscience of financi
decision making. The subconscious operates quietly beneath the surface, making financial decisio
even when we think we're not. For example, the weather impacts how much one tips a waiter. Th
type of music playing in a store influences what type of wine one buys. There may even be a gene th
determines whether someone is predisposed to making riskier financial decisions. The promise
neuroeconomics, the nexus of neuroscience and economics, may tell us more than convention
economic models ever did about human behavior. Neuroeconomics may reveal why we use money
the first place—or at least how to be more aware of the hidden forces guiding our financial decisions

In chapter 3, I examine the social brain, the collective wisdom of crowds. Some anthropologis
contend that debt, not barter, was the forerunner to money. I discover how various cultures deal wi
social debt or gifts: the Maori people of New Zealand, residents of the Trobriand Islands in th
Solomon Sea, the Kwakiutl people of the Pacific Northwest; even netizens who use Napster an
Kickstarter. I examine the edge of where the gift economy ends and the market economy begin
When market values reign supreme, and everything has a price, it can lead to the dark side of deb
When social debt is transformed into market debt, it may result in disgusting practices like de
bondage and slavery.

In Body, I ask "What?" That is, what is money? I answer this question by focusing on the physic
forms of money throughout the ages, and also on the possible futures of it. Chapter 4 is the story
hard money, made from precious metals. I visit the gold vault beneath the Federal Reserve Bank
New York and see the elaborate measures the government takes to safeguard yellow metal. I trace th
origin of metal as money from ancient Mesopotamia to ancient Egypt. In the seventh century B
coinage was invented in Lydia. It spread throughout Greece and the Mediterranean world in th
subsequent centuries. During the Roman Empire, coins were debased and manipulated for politic
reasons. In altering the physical form of money, man was also trying to shape society and contr
others.

Chapter 5 is the story of soft money, which is not linked to metal. I discover the early uses of pap
money in tenth-century China. It was used widely by Kublai Khan to unify his empire during th
thirteenth century. But paper money is only one part of the modern monetary system. Eighteent
century France is an example of how paper money can reboot a flagging economy. John Law
monetary system may have lasted only four years, but it achieved a financial resurrection, thanks
part to soft money. The modern financial system relies on soft money, so I briefly survey the histor
of the dollar until it was unhooked from gold in 1971, and explain how the Federal Reserve and ban
work together to create money today.

Chapter 6 is the story of the future—the good, the bad, and the incredible. If the world suffers a
economic cataclysm, we may return to using goods and services. In the 2008 financial crisis, the pri
of gold soared. Many returned to bartering, the exchange of hard commodities, instead of just usi
money. If the world avoids disaster, it's likely that money will be increasingly plastic and invisible.

the emerging world, there is a lack of credit cards but a plethora of mobile phones. The future money will be realized when mobile phones become the preferred method of payment for billio around the world. The future of money may also resemble science fiction: the rise of a “neural walle in which everyone is plugged into a grid that enables people to trade ideas and energy.

In Soul, I ask “How?” That is, how should we use money? I answer this question by turning to t humanities, such as religion and art. Money isn’t just a symbol of value but a symbol of our value depending on how it’s used and expressed. In chapter 7, I highlight how major religions provide amp instruction on how to handle money. I recount lessons from the Bible, Torah, Koran, and Vedas. In a these scriptures, there seems to be a spiritual logic of *less is more* or *enough is enough* when it com to material wealth. For example, Jesus advises a rich man to sell his earthly treasures and follow hi In Hinduism, it’s through experiencing *artha*, or material pleasures, that one is awakened to the ne to renounce it and achieve *moksha*, or liberation.

In chapter 8, I travel with an archaeologist to rural Bangladesh in search of a lost civilization th Ptolemy once described. It’s through a hoard of coins discovered at the ruins, the symbols on t money, that one can identify this civilization. The symbols, the art, help to elevate money to i valuable, monetary status. They also express a nation’s identity and cultural history. For my job I hav traveled more than 700,000 miles to more than twenty-five developing nations, from Turkey Thailand, South Africa to Sri Lanka. I use my spare moments to meet with coin collectors. I ask the which coins best represent their countries, and what the symbols on these coins mean. This bo begins with a historical explanation of symbolic Paleolithic cave art, and it ends with a geographic safari in which I interpret the creativity found on monetary art.

This book does not advance a grand theory, nor does it provide completely unique perspectives. synthesizes the work of others that is detailed in the selected bibliography, and to whom I am gratef Indeed, there is an infinite amount of topics that I could have included, or the subjects that I d choose could have been investigated with more depth. Each chapter could be the subject of an enti book. But every chapter is meant to spark your curiosity, not satisfy it.

The financial crisis ignited my curiosity and exploded my perception of money. It caused me think about an ancient topic in new ways, to hear the different frequencies of money. Master musici Duke Ellington’s adage, “No boxes,” became my mantra. My quest led me to examine money fro cell to community, from life to death, from inner spirit to outer space. I blurred the lines amo sciences, social sciences, and the humanities. I traversed every hemisphere, over twenty-fi countries. I explored its past and dreamed about its future. This book presents a multidimensional a interdisciplinary portrait of currency through the ages. It seeks to deepen your understanding of t history of money, and to show how it continues to shape our future in often imperceptible ways. I ho this book will explode your perception of money, and help you coin new ways to think about it.

PART I

MIND

The Roots of an Idea

CHAPTER ONE

It’s a Jungle Out There

The biology of exchange

I keep the subject of my inquiry constantly before me, and wait till the first dawning opens gradually, by little and little, into a full and clear light.
—*Isaac Newton*[1]

But man has almost constant occasion for the help of his brethren.
—*Adam Smith*[2]

But several seedling mistletoes, growing close together on the same branch, may more truly be said to struggle with each other. As the mistletoe is disseminated by birds, its existence depends on them; and it may metaphorically be said to struggle with other fruit-bearing plants.
—*Charles Darwin*[3]

An example of symbiotic exchange in the natural world: fish cleaning a green sea turtle.

The bay buzzed with underwater activity as sea lions and colorful fish rushed past me. A current o frigid water enveloped me as I swam in the direction of the ocean. Looking for a warmer spot, whirled around and headed for a narrow crevice that was receiving more sunlight. But instead scratched my foot on a jagged boulder, and stayed put—waiting. I held on to black lava rock that ha been covered with a bed of slimy algae. And then I saw it.

My quest to understand the origin of money began underwater. I wasn't looking for the booty of sunken pirate ship, but another type of treasure. My friend took a deep breath and dove eleven feet the bottom of a ridge, where she scooped up a small dollar-green-colored object with her bare hand She surfaced and swam to me so that I could see it more closely.

"This is what we were looking for," she said.

She would certainly know, as marine ecosystems are her field of expertise.

My friend's name is Rachel Gittman. And for her, it ain't about the money.

"Nobody goes into science for the money," she says, laughing. "I didn't have much to begin with.

Rachel grew up on a farm in Prince George County, Virginia, where she spent much of her tim outside, in nature, exposed to the elements. "As a child, I was fascinated by nature and wanted understand more about the natural world." Now in her late twenties, she is a PhD candidate in ecolog at the University of North Carolina at Chapel Hill. And she would help me understand more about th world, and more about money.

But in order to learn from her, I had to trek to her.

I began my search for the roots of money in a peculiar place. An obvious place to start my quest understand money would have been the Great Rift Valley in East Africa, to search for artifacts tha were used as currency, and where many early human fossils have been discovered; or in weste Turkey, once the site of the Kingdom of Lydia, where coinage was likely invented in the sevent century BC. But to start my quest in these places would be like tuning in to a baseball game in th eighth inning. NASA calculates that eight hundred generations span the thousands of years of huma existence. Of these, more than six hundred resided in caves and only the last few generations sa words in print.[4] Put another way, humans have existed for 0.004 percent of earth's history.[5] I voyage to a place where modern humans have made a smaller imprint, where I could observe the organ origin of exchange.

I found myself in the Pacific Ocean, near the equator, far from the Ecuadorian coast, in a undulating motorboat appropriately named *Destiny*. I was journeying to Isabela Island, part of th Galapagos Islands, to meet Rachel.

I picked these islands for a reason. They were the same islands that inspired Charles Darwin arrive at his theory of evolution by natural selection. He wrote in his book *On the Origin of Speci* that his journey aboard the HMS *Beagle* and his observations of the Galapagos would "throw som light on the origin of species—that mystery of mysteries."[6] An expedition to the Galapagos might als throw some light on the roots of money, and specifically, the nature of exchange.

It was a picture-perfect day under an enormous blue sky, with an ocean breeze to soften the hea

Rachel met me at the dock, wearing a Carolina-blue UNC baseball hat, similar-colored T-shirt, blac shorts, and sunglasses. She was in the Galapagos as part of a research project to study marine life mangrove ecosystems. We ambled down a sandy road, and after thirty-five minutes, my lesson begar

"Exchange happens everywhere on these islands," said Rachel. "From the bottom of the food cha to the top."

So we started at the bottom.

We walked through the mangroves, over a sleeping sea lion (and its poop), under a blue-foote booby that had taken flight, around three dozen marine iguanas, until we arrived at Concha de Perla, small bay in the southeast part of Isabela Island. We put on our snorkels and flippers—and dove in.

When Rachel surfaced, she held in her hand a dollar-green sea urchin. She had told me about ther but I couldn't find one on my own—I benefited from her expertise. This would be my first lesson how exchange happens in the Galapagos. The sea urchin needs energy to survive, so it eats algae. Tl sea urchin is a herbivore and grazes on the algae, transferring the energy to itself. It's not the on organism that feeds on algae, as the damselfish competes with the sea urchin. A damselfish sometim picks up a sea urchin by its spine and takes it elsewhere, away from the algae.[7] But this is an examp of how one organism benefits at the expense of another.

To find an example of symbiosis, when the exchange of two different organisms benefits both, only had to submerge and look around. Resting on a lava rock was a sea turtle with a shell two feet diameter. It had exposed its fins so that five wrasse fish could eat parasites on it, cleaning the turtl Left to fester, the parasites could cause to form on the turtle's shell a calcium carbonate barnacle th doesn't usually harm it, but some species of barnacles have been known to cause damage. In son cleaning stations, a cleaning fish even swims into the mouth of the larger fish being cleaned, so that can remove parasites in hard-to-reach areas.

Rachel explained to me that symbiosis is a crucial component of marine ecosystems, as mar organisms rely on each other to survive and reproduce. She told me about the exchange between cor polyps and zooxanthellae. Though it's difficult to observe with the naked eye, she walked me throug it. Corals form hard skeletons by secreting calcium carbonate, which then form reefs that serve as tl habitat for thousands of marine species. Zooxanthellae (pronounced zo-uh-zan-THELL-ee) a microalgae that live in the tissue of corals. Through the process of cellular respiration, the cor produces carbon dioxide. The zooxanthellae use carbon dioxide in photosynthesis. The by-products photosynthesis are oxygen and organic compounds that provide energy that the coral needs.[8] Tl zooxanthellae supply the coral with food. The coral provides the zooxanthellae with shelter.

My quest to understand money begins with asking why we use it in the first place. To use my baseba analogy again, it's difficult to determine the objective of baseball just by looking at a bat. The aim baseball is to score more runs than the other team. The bat is a tool that helps accomplish thi Similarly, a dollar bill is an instrument that facilitates exchange.

At the most basic level, humans exchange with one another to acquire the items that we need survive, like food and shelter. While money is a human invention, all organisms exchange in order survive. We as humans rely on other organisms to stay healthy, like microorganisms found on our sk and inside our mouth. More than 100 trillion live in the intestine, where bacteria help digest nutrient metabolize energy, and synthesize vitamins. The bacteria in our gut may also keep out parasit bacteria.[9] Our intestine provides bacteria a place to live, and it helps keep us well.

In the parlance of Dr. Seuss, exchange happens on a boat, with a goat, in a hut, and in the gut. It

everywhere and so much a part of life on earth, we often don't notice it. From the beginnings of lif ~~when sperm hits the egg, to the end of it, when maggots feast on a corpse, exchange is at work.~~

To be sure, there is a distinction between exchange that happens between humans and that whic happens among other organisms. The difference is that the human brain makes us aware of exchang It enables us to think tactically about it. As the human brain became capable of symbolic thought, was possible for us to see the potential value in things. Commodities like salt, barley, and cacao we early forms of currency. As humans began to produce more than they could consume, a surplu handful of barley became an item that might be traded to acquire something else. The surplus becan a symbol of value. Its value was realized when it was exchanged for something else. It becan currency.

It is easy to understand the transfer of energy taking place in an exchange of one organ commodity for another, when they are then consumed naturally as food. There's no denying that th need for energy serves as a primary catalyst for exchange among all species, both humans ar nonhumans. The difference, again, is that humans can trade energy tactically, seeing the symbol value of it and turning it into realized value. Early humans who traded food items like meat and barle were exchanging energy but in a new way. That they exchanged the energy-rich commodities in more deliberate manner points to the evolving nature of humans.

Evolutionary economist Haim Ofek asks in his masterful book *Second Nature*: "Was exchange a early agent of human evolution, or is it a mere *de novo* artifact of modern civilization?"[10] He rais the possibility that exchange is an evolutionary force: Organisms that exchange are more likely survive and reproduce, and pass down an "exchange trait" to future generations. Exchanging- working together—is evolutionarily advantageous. And there is compelling evidence that soci people actually live longer.[11] Later in his book, Ofek reasons that human exchange may be continuation and advancement of that found among the earliest organisms. The development exchange from microorganisms, to the animal kingdom, to Paleolithic tribes, to Wall Street trade reveals a fascinating progression of an evolutionary force.

Ofek notices patterns in *how* organisms of the same species exchange. Ants and humans, f example, both rely on division of labor in order to more efficiently accomplish a task. Some membe of the same species forage for food and others rear the young. Individual organisms that a responsible for certain parts of the larger task become specialists in that part. A specialist creat specific tools in order to accomplish this task.

In the case of humans, we became aware that exchange increases our chances of survival. Th awareness would lead to the creation of tools that fostered cooperation, maybe even to outcompe other species. At first these tools would be used to accomplish a simple task, but the brain's capaci for symbolic thought enabled humans to see these instruments as more than just physical object Perishable commodities gave way to nonperishable items like agricultural tools, weapons, ar jewelry, which all functioned as early currencies. Humans could see the symbolic value of these too —they could be exchanged for other valuable items. As the human brain became more sophisticate and as civilization became more complex, there would be a need for a uniform and universal tool th would facilitate exchange more broadly. This tool was money.

It's an intriguing theory—that exchange is part of our evolutionary algorithm. And, ultimatel money is an output of exchange. Ofek's theory provoked me to consider an alternative, biologic explanation for why we use money in the first place. To understand the basis for money, I would nee to learn about the origin of exchange.

In the Beginning

Long before money was invented or humans roamed the earth, organisms exchanged with one anoth in order to survive. Some 3.8 billion years ago, the first signs of life emerged: single-cell prokaryotes, such as bacteria that lack nuclei. Two billion years ago, multicellular eukaryot appeared. These cells make up fungi, plants, animals, and people. It was through symbiosis th eukaryotes formed. Eukaryotes developed when one prokaryote ingested another prokaryote. Instea of being destroyed, the smaller cell stuck around forever as a specialized structure known as a organelle, like a houseguest who never moved out.

The organelle in question is the mitochondrion. Biologists suspect it used to be a prokaryot Mitochondria resemble prokaryotes and reproduce like them, dividing independently of the great cell, which means it's semiautonomous, but it relies on the cell for many of its proteins.[12] Eventual mitochondria lost their ability to live outside the greater cell. The family adopted the housegues Thankfully, it does some chores.

One of those chores is providing food for the family. The mitochondria provide energy to th greater cell. It has two membranes, which are like walls in a house. One membrane is folded to boo its surface area, so that it can produce more energy in the form of adenosine triphosphate (ATP). A organisms need energy to reproduce and operate. A molecule found in all living cells, ATP deliver energy from foods to the cell. Like the coral and zooxanthellae, the cell provides shelter, and th mitochondria supply energy.

This theory about the creation of eukaryotes is known as symbiogenesis, the union of two cells create one, and it explains the basis of earthly life. Russian botanist Boris Mikhaylovich Koz Polyansky first proposed symbiogenesis in the early twentieth century.[13] It's a plausible and wide accepted explanation of how eukaryotes developed. Kozo-Polyansky's theory implies that symbiosi working together, is foundational to the life of all multicellular organisms.

The Garden of Symbiosis

A discussion of symbiosis seems incomplete without including that found between two multicellul organisms: insects and plants. Sure, some plants like ragweed and grass rely on wind rather tha insects to spread their pollen, but that's inefficient. These plants have to produce excess pollen so th the wind will carry enough to exactly the right flower.

Plants need insects to reproduce. Insects need plants to eat. Flowers advertise with pleasant arom and colorful pigments, inviting insects, as well as birds and bats, to visit. Flowers furnish them necta which is a sugary water solution derived from sunlight. A sampling of nectar shows quantities of sug that range from 18 percent to 68 percent. Nectar, with its saccharides, proteins, amino acids, an enzymes, provides energy for insects to persist. Bees turn nectar into honey, which is in essen conserved energy, like a reserve generator, which switches on during winter when flowers have wilte

Bees need not only nectar but the nutrients stored in the amino acids of pollen. Produced by th anthers of a flower, pollen is the male fertilizing agent. Many of the twenty-five thousand species bees use nectar and pollen as the sole type of nutrition for their young. Bees have body hair that hel collect pollen. The pollen is stored in the corbicula, a type of pollen container connected to a bee back leg. Bees transport pollen like couriers making an express delivery. Trade terms of the flowe I'll give you food. You deliver my package.

This relationship has been studied dating back to at least the eighteenth century. The large body

research has led many scientists to conclude that it's impossible to imagine a world in which plan and insects existed without each other. The symbiosis is an example of coevolution, a mutual beneficial partnership. The history of this exchange goes back more than 100 million years, to wh specimens of female insects were found to be carrying pollen, a sign that they were likely searchi for food for their young.[14]

Bees and flowers—like the cell and mitochondria, coral and zooxanthellae, sea turtles and wrasse and humans and intestinal bacteria—help each other to survive.

The Currency of Nature

In all these examples of symbiosis, energy is being exchanged. It can be said that energy is t currency of nature.[15] To highlight the role of energy in symbiosis, consider again the electr exchange between bees and flowers. When a bumblebee lands on a flower, it buzzes in a higher pit to shake the pollen out of it. One estimate is that 8 percent of flowers are pollinated using th method.[16] The bee's flapping wings even jolt the flower with electricity. A flower has a negativ charge compared to the air surrounding it. Bees have a positive charge. When a bee lands on t flower, negatively charged pollen attaches to the bee.

Researchers decided to test whether electricity actually makes a difference in the symbiot relationship between flowers and bees. They created a flower bed with fake flowers. Half the flowe had a solution akin to nectar; the others had a repellent one. The bumblebees foraged randomly in t flower bed. When the researchers introduced a negative charge to certain flowers, bees visited the more frequently. When the charge was removed, the random foraging resumed. After the bee depart the flower keeps the positive charge for more than a minute, as if to hang a "Do Not Disturb" sign f the next guest.[17]

Bees and flowers are also part of a greater exchange that encompasses all living organisms. T grandest example of symbiotic energy transfer is that of photosynthesis and cellular respiratio Consider the chemical reaction of photosynthesis:

$$6H_2O + CO_2 + \text{light particles} \rightarrow C_6H_{12}O_6 + O_2$$

In the first part of the reaction, there are water (H_2O), carbon dioxide (CO_2), and light particle Water enters the plant through its roots. Carbon dioxide is absorbed by a green plant's leaves, lik those that the bee visits. They combine with invisible particles of sunlight called photons, which a captured by pigment molecules such as chlorophylls in green plants. When combined, they produ glucose, $C_6H_{12}O_6$, to be used immediately or saved for later to create more complicated foods li fruit. Oxygen (O_2) is a by-product of photosynthesis. Though this is a basic explanatio photosynthesis is essential in creating oxygen and energy, the currency of nature. All food chains sta with organisms that create organic molecules from inorganic material—like the algae I swam throu in Concha de Perla.

Cellular respiration is photosynthesis in reverse. It's the process of breaking down foods to relea energy. Animals ingest organic molecules like fruits and vegetables and, with oxygen, convert the into carbon dioxide and ATP. Consider the chemical reaction of cellular respiration:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 + ATP$$

Glucose breaks down through a process called glycolysis into molecules known as pyruvate which are processed in the mitochondria, which emit carbon dioxide. The energy found in glucose transported through an electronic transport chain that creates oxygen as a by-product. The cha eventually yields ATP. Photosynthesis and cellular respiration constitute a virtuous cycle of symbioti exchange that makes life as we know it possible.[18] It converts sugar molecules into energy usable b organisms like bees, converting a foreign currency into a more usable one.

Energy and money are both currencies that circulate and flow. The word *currency* comes from th Latin word *currere*, which means "to flow" or "to run."[19] Both energy and money are valuable, an organisms compete to obtain them. Though the earth absorbs a significant amount of solar energ only a small percentage makes it to organisms in need. So there is intense competition for it: Som plants grow taller to attract more sunlight, shading and starving other plants. Remarkably, the starve plant informs its stem to grow more quickly, a response that botanists call "shade avoidanc syndrome."[20]

If an organism must use energy immediately after obtaining it, the creature is dangerous dependent on the source. If the source is interrupted, the organism may die. That's why man organisms store energy. Whales amass fat for their protracted journeys. Birds and squirrels store foo in caches, like a savings account to draw upon in times of need. Storing energy allows organisms degree of sureness in the face of uncertainty. Because it's valuable, desirable, and storable, energ bears a similar role to money in the human world.

Money may be an evolutionary substitute for energy. As our ancestors evolved from hunting an gathering food to cultivating and preserving it, humans produced more than they could consume. Th surplus took on symbolic importance. An extra barrel of salt mined was more than a mineral to b consumed. It could help preserve other food, other sources of energy. One of the first civilizations o the Neolithic Age in 9000 BC was Jericho, and it became a trading center for Dead Sea salt. Human were eating more meat like pigs and cattle, and salt preserved it.[21] There was a strong demand for sal so it became a currency.

Salt had gone from being just a rock, and a way of conserving food, to an item that could obta more of it. Salt blurs the line between commodity and currency because it has historically been use as both. Instead of humans consuming the mineral immediately, like an animal might, they *thoug* about what else they could do with it. They could see that salt could represent something else, lik pepper. By focusing on the commodity aspect of salt, one can see how one form of energy exchanged and turned into another:

$$C \rightarrow C$$

The *C* stands for "commodity." In this barter trade, both the salt and the pepper are represented b C. You trade salt for pepper. You are still trading commodities that fulfill their evolutionary purpos of sustaining humans and helping them survive. But, like energy, the commodity has been converte from one form into another by trading it. In a more advanced society that uses money, the exchange still a conversion of energy forms. In his book *Capital*, volume 1, Karl Marx considers the conversio of commodities into money as the most basic form of monetary exchange:

Again, the *C* stands for "commodity" which is sold and turned into M, or money, like coins. Th money is used to buy another commodity, like pepper.[22] As you will see, the human awareness that was convertible and exchangeable was a first step in the creation of M. But I use this example highlight how a source of energy like barley can be converted into different forms through exchang Money, too, can be converted into various forms. Even today, money is used to obtain perishab commodities, which in essence are forms of energy that we need in order to live. Though mode money has been abstracted from its evolutionary role, it is still the tool we use to acquire the calori that we need.

The Human Connection

Darwin's phrase "the survival of the fittest" is often used to describe the competition with others. F basic necessities like food to a rank in the social ladder, humans struggle against others at time Darwin adopted the phrase at the suggestion of British philosopher Herbert Spencer, who believe evolution was a universal theory. Spencer believed in what later became known as "Soci Darwinism," that evolution shaped not only humans but society: A simple society evolved into a mo complex one. A more pernicious interpretation is that the stronger or more "fit" persons will rea more rewards.

However, Darwin meant the phrase as a broad explanation to account for the biologic development of all species—not as a description or justification of human society.[23] Instead, Darw recognized that symbiosis and cooperation were critical to survival. He found that organic cells we microcosms, systems that work together. He even advanced a theory of pangenesis, in which ti particles called gemmules were marked with data and fused with reproductive cells. The fusion cells was how parents transmitted familial instructions to their offspring, such as beak size and e color.[24] His theory was later replaced with insights into genetics, but it underscores Darwin realization that cooperation is fundamental to life. In *The Descent of Man*, Darwin takes it furthe positing that sympathy within the same species is an output of evolutionary forces: "[Sympathy] w have increased, through natural selection; for those communities which included the greatest numb of the most sympathetic members, would flourish best and rear the greatest number of offspring."[25]

In his landmark book, *The Evolution of Cooperation*, political scientist Robert Axelrod conclud that cooperation helps people survive and is therefore evolutionarily beneficial. His conclusion supported by the results generated from a simulated tournament he ran.

He used the well-known Prisoner's Dilemma game in his tournament. Prisoner's Dilemma star with you and your friend being arrested. The police question you separately. You face a year in priso but if you snitch on your friend, your sentence will be reduced. Your friend is offered the same deal. you both snitch, you will both receive longer sentences. But if you both remain silent, and coopera with one another, you will both benefit. It's a dilemma because you don't know what your friend wi choose.

In 1980, Axelrod planned a computer tournament to see which strategy is best, whether you shou cooperate with your friend or not. He assigned points to each of the four outcomes:

(1) If both you and your friend cooperate, you are both rewarded with three points; (2) if y snitch, and your friend cooperates, then you receive five points, and your friend receives zero; (

conversely, if you cooperate, and your friend snitches, then you receive zero points, and your frier receives five points; and (4) if you both snitch, you both receive one point. The incentive to snitch significant: You will receive points regardless of whether your friend snitches or cooperates.[26]

Scholars from several academic disciplines, such as evolutionary biology and economics, wh were knowledgeable about Prisoner's Dilemma submitted strategies that were pitted against eac other in more than two hundred iterations of the game. The winning strategies remained in th tournament, and the losing ones were discarded. Axelrod writes, "This process simulates survival o the fittest… At first, a rule that is successful… will proliferate, but later as the unsuccessful rule disappear, success requires good performance with other successful rules."[27] He found that the exper who submitted strategies took too competitive an approach and assumed that the other prisoner wou snitch.[28]

The winning strategy was known as "Tit for Tat." Even when contestants were aware that Tit fo Tat had won the initial round, they couldn't beat it in subsequent ones. The strategy calls fo cooperation on the first move and reciprocation on subsequent moves. Tit for Tat shows that it pays t cooperate. But if someone attacks you, you should strike back to punish them. But if then the perso reverts to cooperation, you should forgive them and cooperate, too. Axelrod recognizes that sel interest is the basis for cooperation. It helps your individual situation if you both cooperate. He write "You benefit from the other player's cooperation. The trick is to encourage that cooperation. A goo way to do it is to make it clear that you will reciprocate."[29]

Though Axelrod's tournament was a theoretical game, it had profound implications. His book ha had more than twenty thousand citations across a broad range of academic disciplines, including tho who have considered whether cooperation was part of the evolutionary algorithm. At first glanc Axelrod's results support Ofek's theory that cooperation is evolutionarily advantageous.

Axelrod and evolutionary biologist William D. Hamilton translated their findings to biology. The provide the example of fig trees and wasps, which are symbiotic organisms. Wasps pollinate the tir flowers inside figs. In return, they have shelter to lay eggs, so their larvae have an immediate sourc of nourishment. A wasp could "snitch" by underpollinating the flowers found inside figs. The tre could "snitch" by stopping the growth of a fig that has been underpollinated, killing the larvae of th wasps.[30] Both these organisms seem to be reflexively following Tit for Tat. Evolutionary biologi Richard Dawkins agrees with Axelrod's results and writes that "many wild animals and plants ar engaged in ceaseless games of Prisoner's Dilemma, played out in evolutionary time."[31]

It's not just wild animals, but apparently humans, too. In Axelrod's tournament, even when it pai not to cooperate, for some reason, cooperation among humans prevailed. That may be because huma are aware that cooperation increases the chances of survival. Unlike most animals, humans can thir before they act, and they reason that it's better to cooperate. The results reinforced the view o economist Ludwig von Mises, who writes in *Human Action* that "human beings are potenti collaborators in the struggle for survival because they are capable of recognizing the mutual benefi of cooperation."[32] We seem to be biologically wired to cooperate, and an awareness of this help improve our chances of enduring as a species, even though, as many biologists contend, individua cooperate because of their own self-interest, not because of what may ultimately benefit the species.

Indeed, cooperation and socializing increase our chances of survival. Dr. Dean Ornish found that leading cause for heart disease was isolation from others.[33] In her book *The Bond*, Lynne McTagga writes that "healthy adults with good support networks have lower blood cholesterol levels and high levels of immune function than those without emotional support."[34]