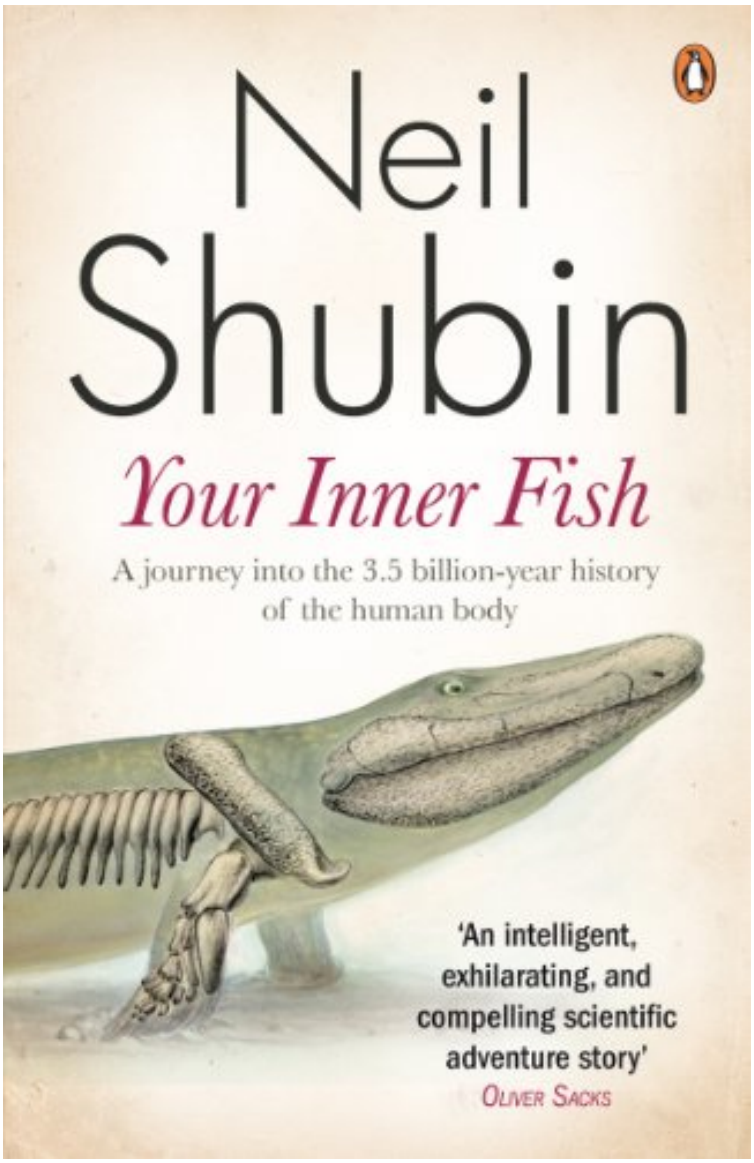
Your Inner Fish: The amazing discovery of our 375-million-year-old ancestor



Par Neil Shubin
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Par Neil Shubin : Your Inner Fish: The amazing discovery of our 375-million-year-old ancestor before purchasing it in order to gage whether or not it would be worth my time, and all praised Your Inner Fish: The amazing discovery of our 375-million-year-old ancestor:

Description :

Prsentation de l'diteurYour Inner Fish tells the extraordinary history of the human body and gives answers to some of the questions that only evolution can. Why do we look the way we do? Why are we able to do all the different things we do? And, finally, why do we fall ill in the way that we do? Neil Shubin draws on the latest genetic research and his huge experience as an expeditionary paleontologist to show the incredible impact the 3.5 billion year history of life has had on our bodies. He takes readers on a fascinating, unexpected journey and allows us to discover the deep connection to nature in our own bodies..comOliver

Sacks on Your Inner Fish Since the 1970 publication of Migraine, neurologist Oliver Sacks's unusual and fascinating case histories of "differently brained" people and phenomena--a surgeon with Tourette's syndrome, a community of people born totally colorblind, musical hallucinations, to name a few--have been marked by extraordinary compassion and humanity, focusing on the patient as much as the condition. His books include The Man Who Mistook His Wife for a Hat, Awakenings (which inspired the Oscar-nominated film), and 2007's Musicophilia. He lives in New York City, where he is Professor of Clinical Neurology at Columbia University. Your Inner Fish is my favorite sort of book--an intelligent, exhilarating, and compelling scientific adventure story, one which will change forever how you understand what it means to be human. The field of evolutionary biology is just beginning an exciting new age of discovery, and Neil Shubin's research expeditions around the world have redefined the way we now look at the origins of mammals, frogs, crocodiles, tetrapods, and sarcopterygian fish--and thus the way we look at the descent of humankind. One of Shubin's groundbreaking discoveries, only a year and a half ago, was the unearthing of a fish with elbows and a neck, a long-sought evolutionary "missing link" between creatures of the sea and land-dwellers. My own mother was a surgeon and a comparative anatomist, and she drummed it into me, and into all of her students, that our own anatomy is unintelligible without a knowledge of its evolutionary origins and precursors. The human body becomes infinitely fascinating with such knowledge, which Shubin provides here with grace and clarity. Your Inner Fish shows us how, like the fish with elbows, we carry the whole history of evolution within our own bodies, and how the human genome links us with the rest of life on earth. Shubin is not only a distinguished scientist, but a wonderfully lucid and elegant writer; he is an irrepressibly enthusiastic teacher whose humor and intelligence and spellbinding narrative make this book an absolute delight. Your Inner Fish is not only a great read; it marks the debut of a science writer of the first rank. (Photo Elena Seibert) A Note from Author Neil Shubin This book grew out of an extraordinary circumstance in my life. On account of faculty departures, I ended up directing the human anatomy course at the University of Chicago medical school. Anatomy is the course during which nervous first-year medical students dissect human cadavers while learning the names and organization of most of the organs, holes, nerves, and vessels in the body. This is their grand entrance to the world of medicine, a formative experience on their path to becoming physicians. At first glance, you couldn't have imagined a worse candidate for the job of training the next generation of doctors: I'm a fish paleontologist. It turns out that being a paleontologist is a huge advantage in teaching human anatomy. Why? The best roadmaps to human bodies lie in the bodies of other animals. The simplest way to teach students the nerves in the human head is to show them the state of affairs in sharks. The easiest roadmap to their limbs lies in fish. Reptiles are a real help with the structure of the brain. The reason is that the bodies of these creatures are simpler versions of ours. During the summer of my second year leading the course, working in the Arctic, my colleagues and I discovered fossil fish that gave us powerful new insights into the invasion of land by fish over 375 million years ago. That discovery and my foray into teaching human anatomy led me to a profound connection. That connection became this book. Click on thumbnails for larger images The crew removing the first Tiktaalik in 2004 Ted Daeschler and Neil Shubin propecting for new sites (Credit: Andrew Gillis) The valley where Tiktaalik was discovered (credit: Ted Daeschler, Academy of Natural Sciences) The models of Tiktaalik being constructed for exhibition (Tyler Keillor, University of Chicago) Me with one of the models (John Weinstein, Field Museum) ExtraitFINDING YOUR INNER FISHTypical summers of my adult life are spent in snow and sleet, cracking rocks on cliffs well north of the Arctic Circle. Most of the time I freeze, get blisters, and find absolutely nothing. But if I have any luck, I find ancient fish bones. That may not sound like buried treasure to most people, but to me it is more valuable than gold.Ancient fish bones can be a path to knowledge about who we are and how we got that way. We learn about our own bodies in seemingly bizarre places, ranging from the fossils of worms and fish recovered from rocks from around the world to the DNA in virtually every animal alive on earth today. But that does not explain my confidence about why skeletal remains from the pastand the remains of fish, no lessoffer clues about the fundamental structure of our bodies.How can we visualize events that happened millions and, in many cases, billions of years ago? Unfortunately, there were no eyewitnesses; none of us was around. In fact, nothing that talks or has a mouth or even a head was around for most of this time. Even worse, the animals that existed back then have been dead and buried for so long their bodies are only rarely preserved. If you consider that over 99 percent of all species that ever lived are now extinct, that only a very small fraction are preserved as fossils, and that an even smaller fraction still are ever found, then any attempt to see our past seems doomed from the start.DIGGING FOSSILSSEEING OURSELVESI first saw one of our inner fish on a snowy July afternoon

while studying 375-million-year-old rocks on Ellesmere Island, at a latitude about 80 degrees north. My colleagues and I had traveled up to this desolate part of the world to try to discover one of the key stages in the shift from fish to land-living animals. Sticking out of the rocks was the snout of a fish. And not just any fish: a fish with a flat head. Once we saw the flat head we knew we were onto something. If more of this skeleton were found inside the cliff, it would reveal the early stages in the history of our skull, our neck, even our limbs.What did a flat head tell me about the shift from sea to land? More relevant to my personal safety and comfort, why was I in the Arctic and not in Hawaii? The answers to these questions lie in the story of how we find fossils and how we use them to decipher our own past.Fossils are one of the major lines of evidence that we use to understand ourselves. (Genes and embryos are others, which I will discuss later.) Most people do not know that finding fossils is something we can often do with surprising precision and predictability. We work at home to maximize our chances of success in the field. Then we let luck take over.The paradoxical relationship between planning and chance is best described by Dwight D. Eisenhowers famous remark about warfare: In preparing for battle, I have found that planning is essential, but plans are useless. This captures field paleontology in a nutshell. We make all kinds of plans to get us to promising fossil sites. Once were there, the entire field plan may be thrown out the window. Facts on the ground can change our best-laid plans.Yet we can design expeditions to answer specific scientific questions. Using a few simple ideas, which Ill talk about below, we can predict where important fossils might be found. Of course, we are not successful 100 percent of the time, but we strike it rich often enough to make things interesting. I have made a career out of doing just that: finding early mammals to answer questions of mammal origins, the earliest frogs to answer questions of frog origins, and some of the earliest limbed animals to understand the origins of land-living animals.In many ways, field paleontologists have a significantly easier time finding new sites today than we ever did before. We know more about the geology of local areas, thanks to the geological exploration undertaken by local governments and oil and gas companies. The Internet gives us rapid access to maps, survey information, and aerial photos. I can even scan your backyard for promising fossil sites right from my laptop. To top it off, imaging and radiographic devices can see through some kinds of rock and allow us to visualize the bones inside.Despite these advances, the hunt for the important fossils is much what it was a hundred years ago. Paleontologists still need to look at rockliterally to crawl over itand the fossils within must often be removed by hand. So many decisions need to be made when prospecting for and removing fossil bone that these processes are difficult to automate. Besides, looking at a monitor screen to find fossils would never be nearly as much fun as actually digging for them.What makes this tricky is that fossil sites are rare. To maximize our odds of success, we look for the convergence of three things. We look for places that have rocks of the right age, rocks of the right type to preserve fossils, and rocks that are exposed at the surface. There is another factor: serendipity. That I will show by example.Our example will show us one of the great transitions in the history of life: the invasion of land by fish. For billions of years, all life lived only in water. Then, as of about 365 million years ago, creatures also inhabited land. Life in these two environments is radically different. Breathing in water requires very different organs than breathing in air. The same is true for excretion, feeding, and moving about. A whole new kind of body had to arise. At first glance, the divide between the two environments appears almost unbridgeable. But everything changes when we look at the evidence; what looks impossible actually happened.In seeking rocks of the right age, we have a remarkable fact on our side. The fossils in the rocks of the world are not arranged at random. Where they sit, and what lies inside them, is most definitely ordered, and we can use this order to design our expeditions. Billions of years of change have left layer upon layer of different kinds of rock in the earth. The working assumption, which is easy to test, is that rocks on the top are younger than rocks on the bottom; this is usually true in areas that have a straightforward, layer-cake arrangement (think the Grand Canyon). But movements of the earths crust can cause faults that shift the position of the layers, putting older rocks on top of younger ones. Fortunately, once the positions of these faults are recognized, we can often piece the original sequence of layers back together.The fossils inside these rock layers also follow a progression, with lower layers containing species entirely different from those in the layers above. If we could quarry a single column of rock that contained the entire history of life, we would find an extraordinary range of fossils. The lowest layers would contain little visible evidence of life. Layers above them would contain impressions of a diverse set of jellyfish-like things. Layers still higher would have creatures with skeletons, appendages, and various organs, such as eyes. Above those would be layers with the first animals to have backbones. And so on. The layers with the first people would be found higher still. Of course, a single column containing the entirety of earth history does not exist. Rather, the rocks in each location on

earth represent only a small sliver of time. To get the whole picture, we need to put the pieces together by comparing the rocks themselves and the fossils inside them, much as if working a giant jigsaw puzzle.That a column of rocks has a progression of fossil species probably comes as no surprise. Less obvious is that we can make detailed predictions about what the species in each layer might actually look like, by comparing them with species of animals that are alive today; this information helps us to predict the kinds of fossils we will find in ancient rock layers. In fact, the fossil sequences in the worlds rocks can be predicted by comparing ourselves with the animals at our local zoo or aquarium.How can a walk through the zoo help us predict where we should look in the rocks to find important fossils? A zoo offers a great variety of creatures that are all distinct in many ways. But lets not focus on what makes them distinct; to pull off our prediction, we need to focus on what different creatures share. We can then use the features common to all species to identify groups of creatures with similar traits. All the living things can be organized and arranged like a set of Russian nesting dolls, with smaller groups of animals comprised in bigger groups of animals. When we do this, we discover something very fundamental about nature.Every species in the zoo and the aquarium has a head and two eyes. Call these species Everythings. A subset of the creatures with a head and two eyes has limbs. Call the limbed species Everythings with limbs. A subset of these headed and limbed creatures has a huge brain, walks on two feet, and speaks. That subset is us, humans. We could, of course, use this way of categorizing things to make many more subsets, but even this threefold division has predictive power.The fossils inside the rocks of the world generally follow this order, and we can put it to use in designing new expeditions. To use the example above, the first member of the group Everythings, a creature with a head and two eyes, is found in the fossil record well before the first Everything with limbs. More precisely, the first fish (a card-carrying member of the Everythings) appears before the first amphibian (an Everything with limbs). Obviously, we refine this by looking at more kinds of animals and many more characteristics that groups of them share, as well as by assessing the actual age of the rocks themselves.In our labs, we do exactly this type of analysis with thousands upon thousands of characteristics and species. We look at every bit of anatomy we can, and often at large chunks of DNA. There are so much data that we often need powerful computers to show us the groups within groups. This approach is the foundation of biology, because it enables us to make hypotheses about how creatures are related to one another.Besides helping us refine the groupings of life, hundreds of years of fossil collection have produced a vast library, or catalogue, of the ages of the earth and the life on it. We can now identify general time periods when major changes occurred. Interested in the origin of mammals? Go to rocks from the period called the Early Mesozoic; geochemistry tells us that these rocks are likely about 210 million years old. Interested in the origin of primates? Go higher in the rock column, to the Cretaceous period, where rocks are about 80 million years old.The order of fossils in the worlds rocks is powerful evidence of our connections to the rest of life. If, digging in 600-million-year-old rocks, we found the earliest jellyfish lying next to the skeleton of a woodchuck, then we would have to rewrite our texts. That woodchuck would have appeared earlier in the fossil record than the first mammal, reptile, or even fishbefore even the first worm. Moreover, our ancient woodchuck would tell us that much of what we think we know about the history of the earth and life on it is wrong. Despite more than 150 years of people looking for fossilson every continent of earth and in virtually every rock layer that is accessiblethis observation has never been made.Lets now return to our problem of how to find relatives of the first fish to walk on land. In our grouping scheme, these creatures are somewhere between the Everythings and the Everythings with limbs. Map this to what we know of the rocks, and there is strong geological evidence that the period from 380 million to 365 million years ago is the critical time. The younger rocks in that range, those about 360 million years old, include diverse kinds of fossilized animals that we would all recognize as amphibians or reptiles. My colleague Jenny Clack at Cambridge University and others have uncovered amphibians from rocks in Greenland that are about 365 million years old. With their necks, their ears, and their four legs, they do not look like fish. But in rocks that are about 385 million years old, we find whole fish that look like, well, fish. They have fins, conical heads, and scales; and they have no necks. Given this, it is probably no great surprise that we should focus on rocks about 375 million years old to find evidence of the transition between fish and land-living animals.We have settled on a time period to research, and so have identified the layers of the geological column we wish to investigate. Now the challenge is to find rocks that were formed under conditions capable of preserving fossils. Rocks form in different kinds of environments and these initial settings leave distinct signatures on the rock layers. Volcanic rocks are mostly out. No fish that we know of can live in lava. And even if such a fish existed, its fossilized bones would not survive the superheated conditions in which basalts, rhyolites, granites, and other

igneous rocks are formed. We can also ignore metamorphic rocks, such as schist and marble, for they have undergone either superheating or extreme pressure since their initial formation. Whatever fossils might have been preserved in them have long since disappeared. Ideal to preserve fossils are sedimentary rocks: limestones, sandstones, siltstones, and shales. Compared with volcanic and metamorphic rocks, these are formed by more gentle processes, including the action of rivers, lakes, and seas. Not only are animals likely to live in such environments, but the sedimentary processes make these rocks more likely places to preserve fossils. For example, in an ocean or lake, particles constantly settle out of the water and are deposited on the bottom. Over time, as these particles accumulate, they are compressed by new, overriding layers. The gradual compression, coupled with chemical processes happening inside the rocks over long periods of time, means that any skeletons contained in the rocks stand a decent chance of fossilizing. Similar processes happen in and along streams. The general rule is that the gentler the flow of the stream or river, the better preserved the fossils.From the Hardcover edition.