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BOOK REVIEW

Your Inner Fish

Your Inner Fish: *A Journey Into the 3.5-Billion-Year History of the Human Body*, by Neil Shubin. Pantheon Books, 2008, 229 pages

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> All animals are the same but different. Like a cake recipe passed down from generation to generation—with enhancements to the cake in each—the recipe that builds our bodies has been passed down and modified for eons. We may not look like sea anemones and jellyfish, but the recipe that builds us is a more intricate version of the one that builds them (p. 115).

This is the theme of Neil Shubin's *Your Inner Fish*: the commonality of living things which are seemingly unrelated. Dr. Shubin seeks out similarities (primarily anatomical) between humans and an array of creatures such as worms, sponges, jellyfish, and, yes, fish. The ambitiousness of the topic immediately sparked my interest. As a novice, I was concerned that the text would be a bit dry, full of Latin terminology and esoteric concepts, but I was pleasantly surprised to find the book very readable to a lay audience—with enough sophistication to excite those with a biology background. Additionally, the work contains enough practical analogies to make it accessible to those who have never taken a comparative anatomy class. Furthermore, Dr. Shubin's references to his field experience make the text personable and add an element of adventure often absent in scientific literature.

The book begins by acknowledging the limitations of paleontology. "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 even a smaller fraction still are ever found, then any attempt to see our past seems doomed from the start" (p. 3). Yet Dr. Shubin quickly replaces any pessimism in the reader with a riveting account of his most famous discovery, *Tiktaalik*, or the "fishapod," and its scientific importance as an "intermediate" or transitional species.

My favorite chapter in the book is Chapter 2, which focuses on the similarities of limb structures in various creatures. This is one of the oldest (and strongest) pieces of evidence supporting evolution. I remember attending the opening of the Darwin exhibit at the American Museum of Natural History and viewing the bone structure of a bat wing. Although I have seen it illustrated many times, in a variety of textbooks, seeing the actual bones themselves immediately elicited this vision of a spidery, "Nosferatu-" type hand. At that point in my mind, there was no doubt that a bat wing was a hand with modified elongated fingers. Shubin points out the basic common design shared by all limbed vertebrates: "One bone, followed by two bones, then little blobs, then fingers or toes" (p. 31). The only differences across taxa are the shapes and sizes of the bones and number of blobs and digits. This is a brilliant example of homology, that is, similarities in structure across taxa that are due to inheritance by a common ancestor.

Chapter 3 discusses genes, an important commonality among related species. Shubin does a fine job keeping the reader interested. He takes a "forest to the tree" approach, starting with limbs and getting progressively smaller, analyzing tissue, cells, and finally genes. From here, Dr. Shubin looks at an often overlooked piece of anatomy, teeth. He points out the importance of teeth to the paleontologist. First, the shape and size can provide important information about the diet of creature and clues

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as to how the animal lived. Second, because teeth are harder than bone, they are among the most commonly available fossils. Shubin talks of fieldwork in Arizona and Nova Scotia before explaining the molecular composition, development, and use of teeth, which he does in an engaging way with some interesting information. The descriptions and illustrations are excellent. When talking about ostracoderms, which existed about 500 million years ago, Shubin describes them as being "fish [that] look like hamburgers with fleshy tails" (p. 77). From there, Shubin talks about the development of the head. Here, he makes an interesting comparison between developing shark and human embryos, focusing on the four arches that make up the gill region. He explains how each of the four arches develops in a manner specific to each species. There appear to be striking similarities between the cranial nerves and muscles in both sharks and humans that develop in the third and fourth arches.

The next two chapters deal with the development of bodies. I expected references to organisms from the Cambrian because it was at this time that body structures were being "tinkered" with. Instead, Shubin pays careful attention to the similarities present in developing embryos of different species. "Embryos hold the clues to some of the profound mysteries of life" (p. 98), he states. What I found particularly insightful was the comparison of Von Baer and Haeckel's early comparative analysis of early embryos. Shubin also talks about the genetics of body development.

The next three chapters compare the human senses of smell, vision, and hearing with those of other creatures. Shubin shows that, although the mechanisms that allow us to smell may appear different, the way they function is fundamentally the same in such diverse creatures as lampreys, fish, rats, and humans. Shubin takes a similar approach when comparing the eyes of a limpet, nautilus, scallop, and human, pointing out similarities in tissue and genes with attention to the role of opsins in the seeing process. The chapter on hearing is a bit more complicated, as the hearing process is different in aquatic and terrestrial environments. What I found of particular interest was Shubin's anatomical comparison of the function of bones in reptiles and mammals. "The origin of mammals involved not only new patterns of chewing...but new patterns of hearing. In fact, this shift was accomplished not by evolving new bones per se, but by repurposing existing ones" (p. 162).

Shubin concludes using a humorous cladogram, "the bozo family tree," to illustrate the concept of common descent (evolution). Shubin states that the "biological 'law of everything' is that every living thing on the planet had parents" (p. 174). I thought of fission, budding, regeneration, and vegetative propagation as possible exceptions, but Shubin clarifies his assertion by stating that "every living thing sprang from some parental genetic information" (p. 174). Under that umbrella, asexual as well as sexual reproduction would support Shubin's statement.

Shubin succeeds in showing that evolution by natural selection can cause adaptation but is not always perfect. For example, he compares the position of the gonads in sharks (upper chest, close to the heart) to that of humans (outside of the body cavity in the scrotum). Though external gonads function well in reproduction, they create a weak spot in the space in the body wall, leaving human males susceptible to inguinal hernias. This, as well as other amazing and strange aspects of our evolutionary history called attention to by Shubin, was astonishing to learn about. I was glad to have discovered *My Inner Fish* and found it to be a truly engaging read.