# “A Gene, a Fin, a Hand” Excerpt Transcript

*Excerpt from (August 26, 2016) episode of Science Friday.*

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| **IRA FLATOW** | This is Science Friday. I'm Ira Flatow. Have you ever looked at your hand or you five fingers and thought that it must be an evolutionary descendant of all those long tiny bones at the end of a fish's pectoral fins? Up til now, many scientists have said, no, the bones even formed through different processes during development. Can't be the same thing. But new research from the University of Chicago says, actually, there may be an evolutionary link, after all.<br><br>Here to explain it Dr. Kim Cooper, Assistant Professor of Biological Sciences, University of California San Diego. She looks at the evolution and development of bones in other animals and wrote a commentary about the research. In Chicago, Kimberly Cooper, welcome to Science Friday. |
| **DR. KIM COOPER** | Hello, Ira. |
| **FLATOW** | Hey, there. Well, let's go back a little bit and talk about what we used to think. Why wouldn't fins and hands be related? You know, you look at them and they look like, hey, they should be related. |
| **COOPER** | So, superficially, they look related because both have long bones that are oriented away from the body, but actually, the skeleton of our limbs develops entirely differently. It forms in the embryo on a cartilage scaffold that is then replaced by bone, whereas in the fish fin, those long, skinny bones are actually directly formed by ossification in the skin itself. |
| **FLATOW** | Hm. So this new research found that there really is a connection. |
| **COOPER** | So there is. Right. So we've known for a long time that the arm, the upper and lower arm bones were similar to other bones that are in the fish's fin, but we long thought that those long, skinny bones were lost in the common ancestor leading to the lineage to humans and that the hand was this novel structure. And so what they found is that instead of-- so if you think about building a building, instead of going and buying all new construction materials to make a hand, you've gone to the salvage yard and taken some of the information that was there in the fish to make it a hand by similar processes. |
| **FLATOW** | Hm. So is that kind of exciting, kind of shocking? |

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| **COOPER** | It is. It was really surprising because the two structures have a very, very different outcome in the way the bones form. |
| **FLATOW** | Mm-hm. What does this say about the big picture of how mammals evolved in our relationship to modern fish? |
| **COOPER** | It tells us that the early developmental mechanisms that give rise to the structures of our skeleton, of our hand, if you look at a fish, the cells and the genes that make those long, skinny bones in the fish were repurposed to make our own hands. So it makes me look at fish a lot differently. |
| **FLATOW** | Hm. And the discovery that there might be a common gene for both of them . |
| **COOPER** | Yes. Yes. |
| **FLATOW** | Tell us about them. |
| **COOPER** | Right. So the Hox genes are known to give segments throughout the body identity and some of these Hox genes are expressed in our hands. And in mice, if you mutate these Hox genes, then the mice don't have hands. And nobody had actually done the Hox mutation in fish before because there are more of the genes that you would have to mutate, but with the CRISPR-Cas9 technology that lets you edit a genome very rapidly, the Shubin Lab was able to eliminate the three Hox genes that they were interested in and they found, surprisingly, that just like in a mouse that is missing its hand, the fish fin has a very, very severely reduced skeleton. So the same genes that are responsible for forming our hand are also responsible for forming this part of the fish fin skeleton that we thought had absolutely no relationship to our hands. |
| **FLATOW** | So there's the connection. Right? |
| **COOPER** | That is the connection. |
| **FLATOW** | In the genes. |
| **COOPER** | Right. Exactly. |
| **FLATOW** | Did something happen along the way? I mean, just thinking out loud there. If we change the gene in our bodies, could we make it into a fish fin or vice versa? |

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| **COOPER** | So the way that they did the experiment, actually, it was very interesting because the fish have these Hox genes that we have, but they don't actually have the regulatory sequence that expresses that gene in fingers. And so what they did is they took that regulatory sequence and they put it into the fish and that's what they used to permanently mark cells that gave rise to those long, skinny bones. And so what is interesting is where did those regulatory sequences come from? How did the cells manage to develop a new program to turn those cells into fingers instead of turning them into fins? |
| **FLATOW** | Huh. So what does this say about the bigger picture of how mammals evolved in our relationship to modern fish? |
| **COOPER** | It tells us where our hand came from. But the lineage to mammals has been elaborated even further by evolution. So if you look at-- this is one of the things that my lab is really interested in-- if you look at many, many species of mammals, you'll see that like bats have wings and horses have a single toe and dolphins have flippers. And we study this little bipedal rodent that has a very dramatically changed hindlimb that lets it jump around.<br><br>And so the work by the Shubin Lab tells us where the hand came from and then other mechanisms elaborated that structure to give us the great diversity and form that you see today. |
| **FLATOW** | Wow. So where do you go from here? |
| **COOPER** | Including our own. |
| **FLATOW** | What's the next research question you want to answer? |
| **COOPER** | Well, the next research question that my lab wants to answer or the follow-up of the Shubin paper? |
| **FLATOW** | Take your pick. |
| **COOPER** | Right. OK. The next research question that my lab wants to answer is to try to understand how the integrated musculoskeletal system of the limb is shaped by the genome. What are the changes in the DNA sequences that deploy genes in different ways to give you different shapes of a limb? And so specifically, we're interested in scaling of the digits. So in the Shubin work, they're showing where the digits came from. And we're interested in seeing |

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| | how those digits get reshaped by rewriting the information, how evolution has rewritten the information in the genome to do that. |
| **FLATOW** | Wow. Sounds fascinating. You'll have it figured out by Monday, I'm sure. |
| **COOPER** | Yeah, you know, I'm going to just work all weekend. |
| **FLATOW** | Thank you, Dr. Cooper. Nice to have you. Kimberly Cooper, Assistant Professor of Biological Sciences, University of California in San Diego. |