Extracts

Research Links Lampreys, Sharks and Humans

The first multi-celled animals from which humans evolved shared unique features with modern sharks and lampreys, say University of Florida genetics researchers.

Boneless lampreys, long thought to have taken a different evolutionary road than almost all other backboned animals, may not be so different after all, especially in terms of the genetics that govern their skeletal development, according to findings published in February in the online *Proceedings of the National Academy of Sciences*.

And sharks' uncanny ability to detect electrical signals while hunting and navigating arose from the same type of embryonic cells that give rise to many head and facial features in humans. Findings published in the journal *Evolution & Development* identify neural crest cells, which are common in vertebrate development, as a source of sharks' electrical ESP.

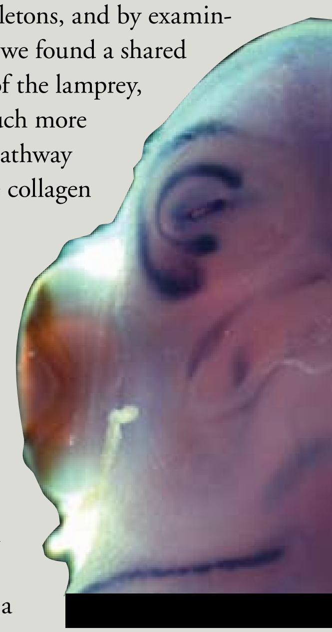
The researchers found that lamprey cartilage is made from the same collagen that is found in all vertebrates with backbones and jaws, including humans.

"It was thought collagen was a relatively recent invention in vertebrate evolution that unites us with reptiles, amphibians, sharks and bony fishes, while the lamprey skeleton was based on quite different proteins," said Martin Cohn, a developmental biologist and associate professor with the UF departments of zoology and anatomy and cell biology. "Knowing that lampreys also use collagen to build their skeletons makes sense. Lampreys and jawed vertebrates inherited the same genetic program for skeletal development from our common ancestor."

Lampreys live today in the Great Lakes and other freshwater bodies that connect to the sea. They are considered a nuisance, largely because of their unsettling appearance.

But they offer insight into the early Cambrian period 540 million years ago, when multicellular animals first began to make shell and other hard body parts. About 40 million years into the process, jawed and jawless vertebrates branched into different paths.

"The lamprey is like the great-, great-, great-aunt descended from the earliest backboned animal," said Michael Miyamoto, a professor and associate chair of UF's zoology department. "Our question was whether the earliest vertebrates used a collagen recipe or a non-collagen recipe to form their skeletons, and by examining the lamprey, we found a shared recipe. Because of the lamprey, we know it is much more ancient genetic pathway that activates the collagen matrix."

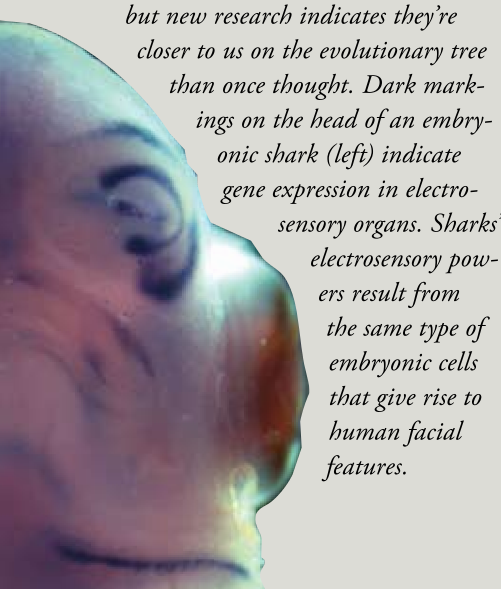


The research on sharks fortifies the idea that before our early ancestors emerged from the sea, they too had the ability to detect electric fields.

"Sharks have a network of electrosensory cells that allows them to hunt by detecting electrical signals generated by prey," said Cohn. "They can sense electricity generated by a muscle twitch, even if it's the weak signal of a flounder buried under sand."

Likewise, sharks are widely thought to use the Earth's magnetic field for navigation, enabling them to swim in precise paths across large expanses of featureless ocean, Cohn said.

"If you think of this in the big picture of evolution of sensory systems, such as olfaction, hearing, vision and touch, this shows sharks took a pre-existing genetic program and used it to build yet another type of sensory system," Cohn said.



Boneless lampreys (bottom) couldn't look more different from humans, but new research indicates they're closer to us on the evolutionary tree than once thought. Dark markings on the head of an embryonic shark (left) indicate gene expression in electrosensory organs. Sharks' electrosensory powers result from the same type of embryonic cells that give rise to human facial features.

Renata Freitas

UF and University of Louisiana researchers analyzed electroreceptor development in the embryos of the lesser spotted catshark, an animal that is largely motionless during the day and hunts at night, mainly in the seagrass beds of the eastern Atlantic Ocean.

They found two independent genetic markers of neural crest cells in the animal's electricity-sensing organs. Analysis shows these cells migrate from the brain and travel into the developing shark's head, creating the framework for the electrosensory system, said Renata Freitas, a doctoral candidate in the zoology department and first author of the paper.

The process mirrors the development of the lateral line that allows fish to mechanically sense their environment, and organs of the inner ear that enable humans to keep their balance. Scientists suspect that as human ancestors emerged from the sea, they discarded their lateral lines as well as their ability to sense electrical fields.

Martin Cohn, cohn@zoo.ufl.edu

John Pastor

Satellite System Tracks Firefighters, Soldiers

The old technique of using push pins and maps to track troop movements just got a radical new upgrade for soldiers or firefighters in rugged terrains.

A group of University of Florida engineering students has designed a system to locate, track and communicate with special forces troops or firefighters in remote areas where no cell towers or other communications infrastructure exist.

The system allows soldiers or firefighters to pinpoint their own and their comrades' whereabouts on digital maps displayed on handheld personal digital assistants. It can transmit this information via satellite phone, making it available to Internet-connected commanders or observers anywhere in the world.

"It's live and it's in real time," said UF electrical and computer engineering senior Rolando Estrella.

Estrella is among seven UF engineering seniors who spent the spring semester creating the system as part of the College of Engineering's Integrated Product & Process Design program. The 11-year-old program's goal is to assist corporations, small businesses and government agencies with engineering problems while giving engineering students practical experience working on real-world projects.

The team was sponsored by defense contractor WinTec Arrowmaker Inc., Chang Industries, U.S. Special Operations and the U.S. Forest Service. Karl Gugel, a lecturer in electrical and computer engineering and the faculty leader, said the U.S. Forest Service's goal was to explore ways to upgrade its World War II-era equipment, which for communications purposes consists of traditional two-way radios.

The team sought to design an inexpensive system using off-the-shelf equipment or parts that would function in areas with no other available communications technology. The technology also had to be easy to use, robust and secure.

To achieve that goal, team members created a system with several different parts. Each firefighter carries a "FieldUnit," a cellphone-sized device equipped with a Global Positioning System. The unit communicates via radio signal with a "SmartNode," a nearby laptop equipped with radio transmitter and receiver. The laptop then transmits this information via satellite phone or other means if available.

At its most stripped-down, the system provides only location information for firefighters or soldiers to observers elsewhere. But users can add the PDAs to their FieldUnits. That gives them the capability to send messages and see their locations on road maps, terrain maps or satellite maps — whatever happens to be available for the area. In theory, FieldUnits could also add sensors, such as temperature gauges, or even cameras.

The other students on the team were Zachery Jacobson, Julie Ramirez, Adnan Rashid and Andrew Sciullo.

William Goh, gohak@ufl.edu
Karl Gugel, gugel@ecel.ufl.edu

Aaron Hoover

Kristen Bartlett

Electrical and computer engineering student William Goh demonstrates a map and GPS device designed for soldiers and firefighters.