Electric organs are masses of flattened cells, called electrocytes, which are stacked in regular rows along the sides of certain fishes, e.g., the electric eel of South America. The posterior surface of each electrocyte is supplied with a motor neuron, the anterior surface is not.

At rest, the interior of each electrocyte, like a nerve or muscle cell, is negatively charged with respect to the two exterior surfaces. The potential is about 0.08 volt, but because the charges alternate, no current flows. When a nerve impulse reaches the posterior surface, the inflow of sodium ions momentarily reverses the charge just as it does in the action potential of nerves and muscles. (In most fishes, electrocytes are, in fact, modified muscle cells.) Although the posterior surface is now negative, the anterior surface remains positive. The charges now reinforce each other and a current flows just as it does through an electric battery with the cells wired in "series".

With its several thousand electrocytes, the South American electric eel (*Electrophorus electricus*) produces voltages as high as 600 volts. The flow (amperage) of the current is sufficient (0.25–0.5 ampere) to stun, if not kill, a human. The pulse of current can be repeated several hundred times each second.
Powerful electric organs like those of the electric eel are used as weapons to stun prey as well as potential predators.

The Mechanism

In the 5 December 2014 issue of *Science*, Kenneth Catania describes his experiments that revealed how the electric eel captures its prey.

While exploring its environment, the eel emits a continuous series of low-voltage discharges. Periodically it interrupts these with a discharge of 2 or 3 high-voltage pulses. These cause nearby prey, e.g. a fish, to twitch. Within a tiny fraction of a second (20–40 ms) of detecting the twitch, the eel unleashes a volley (~400 per second) of high-voltage discharges that stun the prey enabling the eel to capture it.

Remarkably, both the twitch response and the immobilization are triggered by the prey’s own motor neurons. A pair of pulses induces a brief contraction while a volley of discharges induces tetanus.

Although action potentials in the prey's motor neurons were not measured directly, two pieces of evidence support this mechanism.

1. The responses remained intact even when the brain and spinal cord of the prey were destroyed thus eliminating the possibility that the prey was relying on a sensory→cns→motor reflex.
2. Curare, which blocks the transmission of action potentials across the neuromuscular junction did block the prey’s responses.

So hunting by the electric eel involves a preliminary 2 or 3 powerful pulses to - in Catania's words - answer the question "Are you living prey?". If the answer is "yes", the prey is quickly stunned and ready to eat.

Weak Electric Organs

The electric organs of many fishes are too weak to be weapons. Instead they are used as signaling devices.

Many fishes, besides the electric eel, emit a continuous train of electric signals in order to detect objects in the water around them. The system operates something like an underwater radar and requires that the fishes also have electroreceptors (which are located in the skin). The presence of objects in the water distorts the electric fields created by the fish, and this alteration is detected by the electroreceptors.

Electric fishes use their system of transmitter and receiver for such functions as

- navigating in murky water and/or at night
- locating potential mates
- defense of their territory against rivals of the same species
- attracting other members of their species into schools
Electroreceptors

Electroreceptors are also found in some nonelectric fishes and in some amphibians. Even the duckbill platypus, a mammal, has electroreceptors (located in its bill). With these it can detect the weak currents created by the muscle activity of its prey (e.g., small crustaceans) as it noses around in the muddy bottom where it feeds.

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