ELECTRIC ORGANS

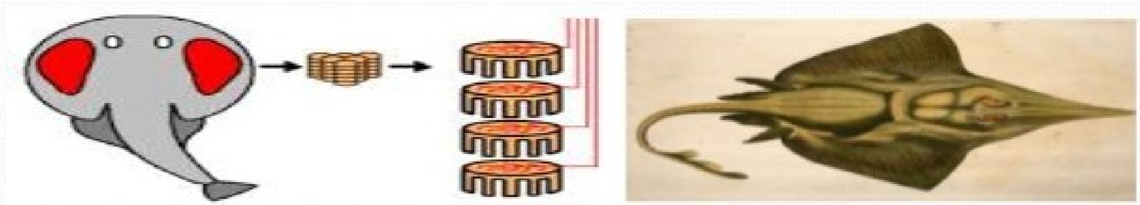
Electric organs are masses of flattened cells, called **electrocytes**, which are stacked in regular rows along the sides of certain fishes.

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.

DISTRIBUTION OF ELECTRIC ORGAN

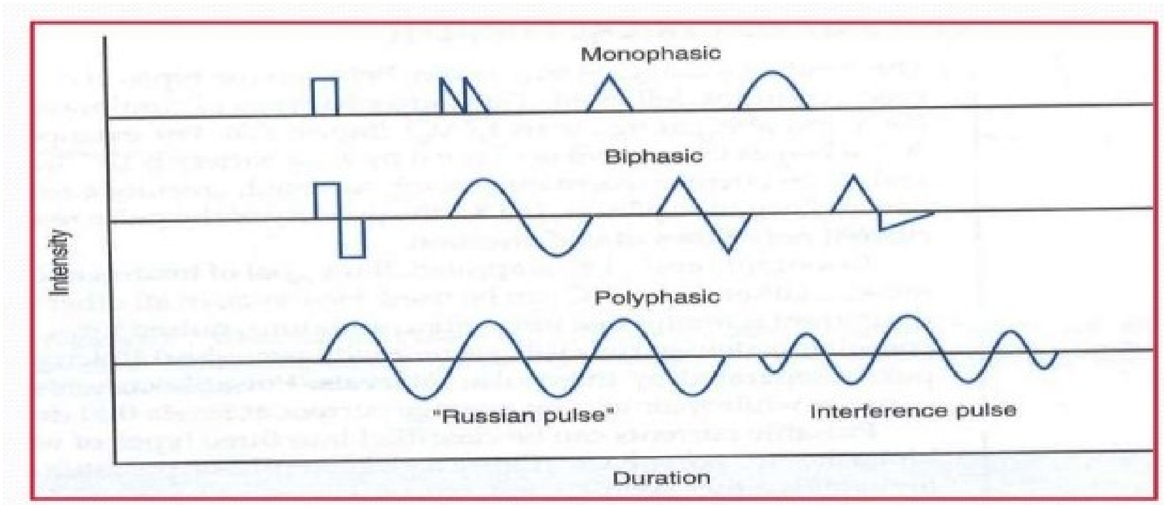
Name of fish	Shape of electric organ	Location of electric organ
Torpedo	**Flat kidney shape**	**On either side of mid-line**
***Raja* (Sting ray)**	**Spindle shape**	**Lying parallel to the spinal cord in the tail**
Malapterurus	**Lozenge (= rhombus) shape**	**Located in skin**



Torpedo Raja

PATTERNS OF ELECTRIC ORGAN DISCHARGE

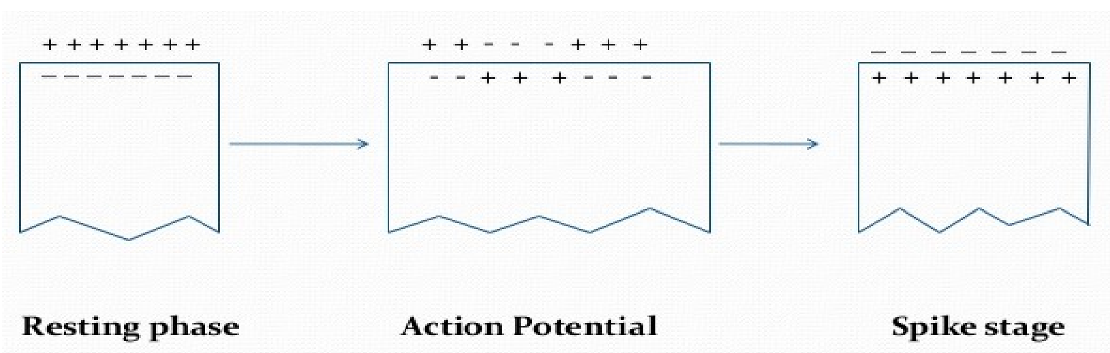
- **Monophasic pulses**
- **Biphasic pulses**
- **Polyphasic phases**



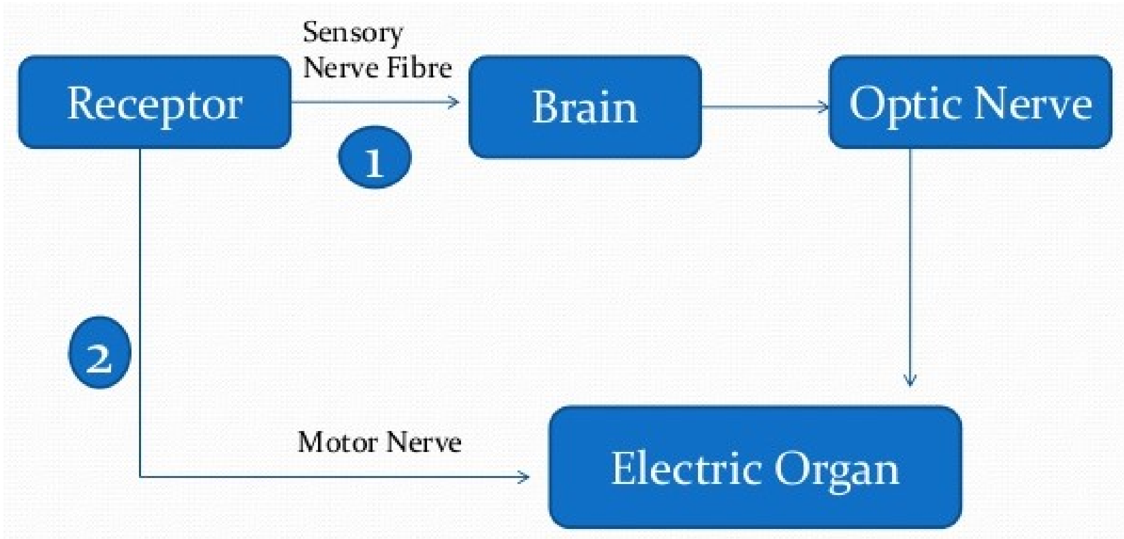
KINDS OF ELECTRIC ORGAN DISCHARGE

- ***Electrophorus*: one small pulse followed by four large pulses.**
- **Electric shark: repetition of sequence of events.**
- ***Torpedo*: four large pulses which are continuously repeated.**

MECHANISM OF ELECTRIC ORGAN DISCHARGE



PATHWAYS OF NEURAL CONTROL OF ELECTRIC ORGAN



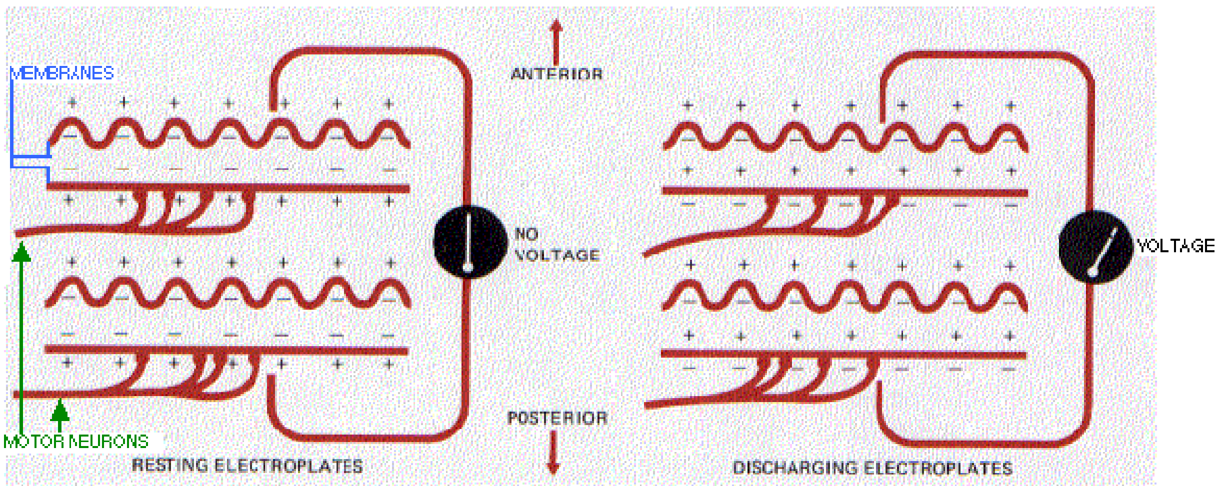
FUNCTIONS OF ELECTRIC ORGAN

- **Food procurement**
- **Defence**
- **Species and sex recognition**
- **Direction finding**
- **Communication**
- **Navigation**

Electric Organs and Electroreceptors

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.



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 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

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.

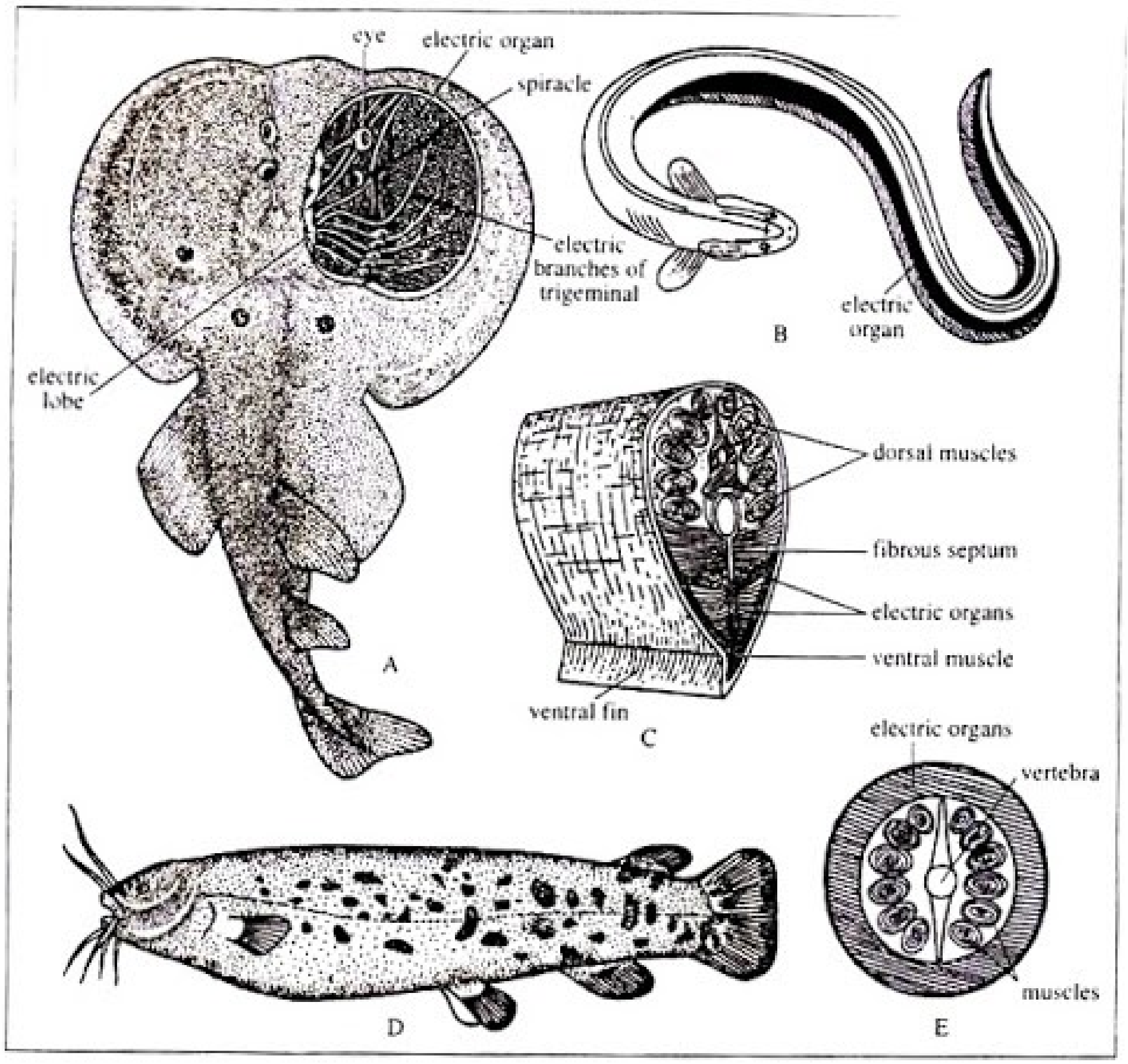
Weak Electric Organs

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



Electric organs in different fishes. A. *Torpedo.* A portion of the right dorsolateral side of the head region is removed to show the electric organ and its innervation. B. *Electrophorus electricus* showing the extent of the electric organ. C. Transverse section of *Electrophorus electricus* to show the position of the electric organ. D. *Malapterurus.* E. Transverse section of *Malapterurus.* Note the peripheral position of electric organ.

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.