

Action Potential and Ion Channels

Lecture 11

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Ion channels

- The rate and direction of ion movement is governed by the electrochemical gradient.
- The rate of ion transport through the channel is very high 10^7 ions/sec. Transport is always down the gradient

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History

- In 1880s, Sidney Ringer used a solution of water and ran it through the vessels of an isolated heart from a frog and discovered that in order for the heart to continue beating salts needed to be present in the water.
- Sodium, calcium, and potassium salts were important and had to be in specific concentration relative to each other

CONCERNING THE INFLUENCE EXERTED BY EACH OF THE CONSTITUENTS OF THE BLOOD ON THE CONTRACTION OF THE VENTRICLE. By SYDNEY RINGER, M.D., *Professor of Medicine at University College, London.* Plate XIX.

IN this paper I record experiments designed to ascertain the influence each constituent of the blood exercises on the contraction of the ventricle.

By "saline solution" I mean the ordinary 0.75 per cent. solution of sodium chloride. "Blood mixture" was made from dried bullock's blood dissolved in water to represent normal blood, and this I diluted with five parts of saline solution.

In each experiment I always used 100 c. c. of saline solution or of blood mixture. The tracings were taken with Roy's tonometer, and run from left to right. The experiments were made in April and May. The ventricle was tied on the cannula as nearly as possible in the auriculo-ventricular groove. A figure or * over the trace indicates that the contraction was excited by faradaic stimulation, the figure showing the position of the secondary coil.

When the circulating fluid consists only of "saline solution" the ventricular beats undergo the following changes (see Fig. O, Oa, 1, 5, 6). The contraction at first becomes more complete if the ventricle empties itself imperfectly. The trace soon becomes broader, its summit rounder (see Fig. O, B), at the same time there is slight diastolic contraction (persistent spasm). Next, the period of relaxation becomes greatly prolonged (see C; Fig. 5, B, and Fig. 6, B), and the whole trace is permanently raised higher above the base line.

During these changes affecting the expansion of the ventricle the contraction is very little altered, being rather accelerated, see Fig. Oa (trace taken with quicker rate), where A shows the trace with blood mixture, B the trace after saline solution was substituted for blood

History

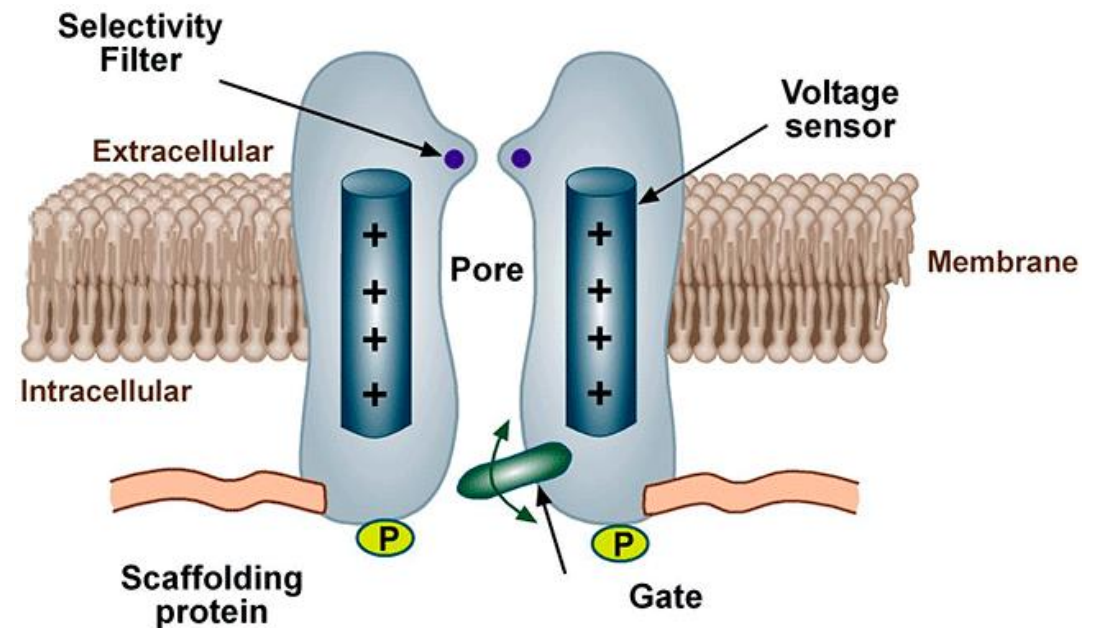
- In 1970s, the existence of ion channels was confirmed by the invention of 'patch clamp' technique by Erwin Neher and Bert Sakmann who won a Nobel Prize for it.
- In 2003, the Nobel Prize was awarded to American scientists, Roderick MacKinnon and Peter Agre for their x-ray crystallographic structure studies on ion channel



Erwin Neher (left) and Bert Sakmann (right)

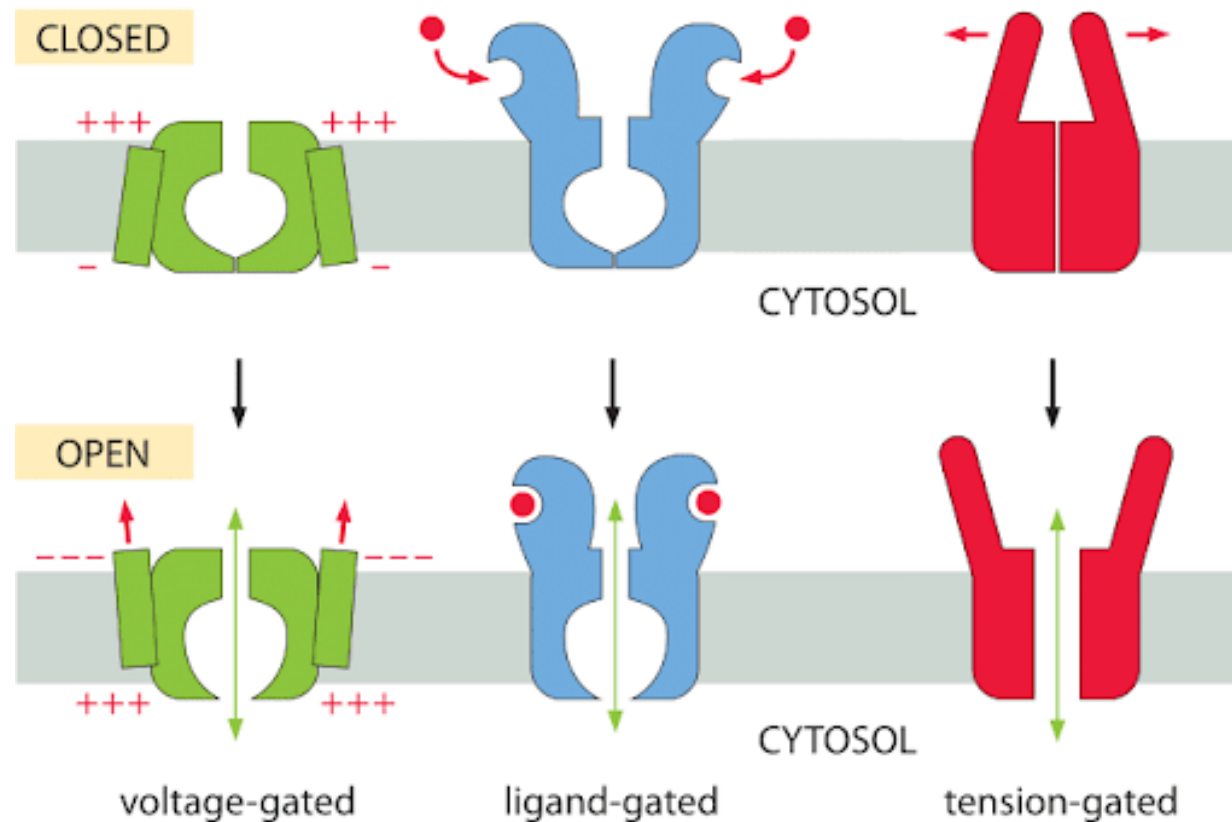
Selectivity:

- Permit ions of a specific size and charge.
- The permeating ions will lose their dissociated water molecules and pass through the hole in the channel which is known as **SELECTIVITY FILTER**.
- This limits their rate of passage.



Gating:

- Two discrete states –
 - open(conducting) or closed(nonconducting)



STATES OF ION CHANNEL- CLOSED, OPEN, INACTIVATED

Voltage-Gated Sodium Channel Activation and Inactivation of the Channel

