Resting membrane potential

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THE RESTING MEMBRANE POTENTIAL (RMP)

Under normal conditions

- **All points on the outer surface of the nerve fiber are isopotential.**
- **All points in the inside of the nerve fiber are also isopotential.**

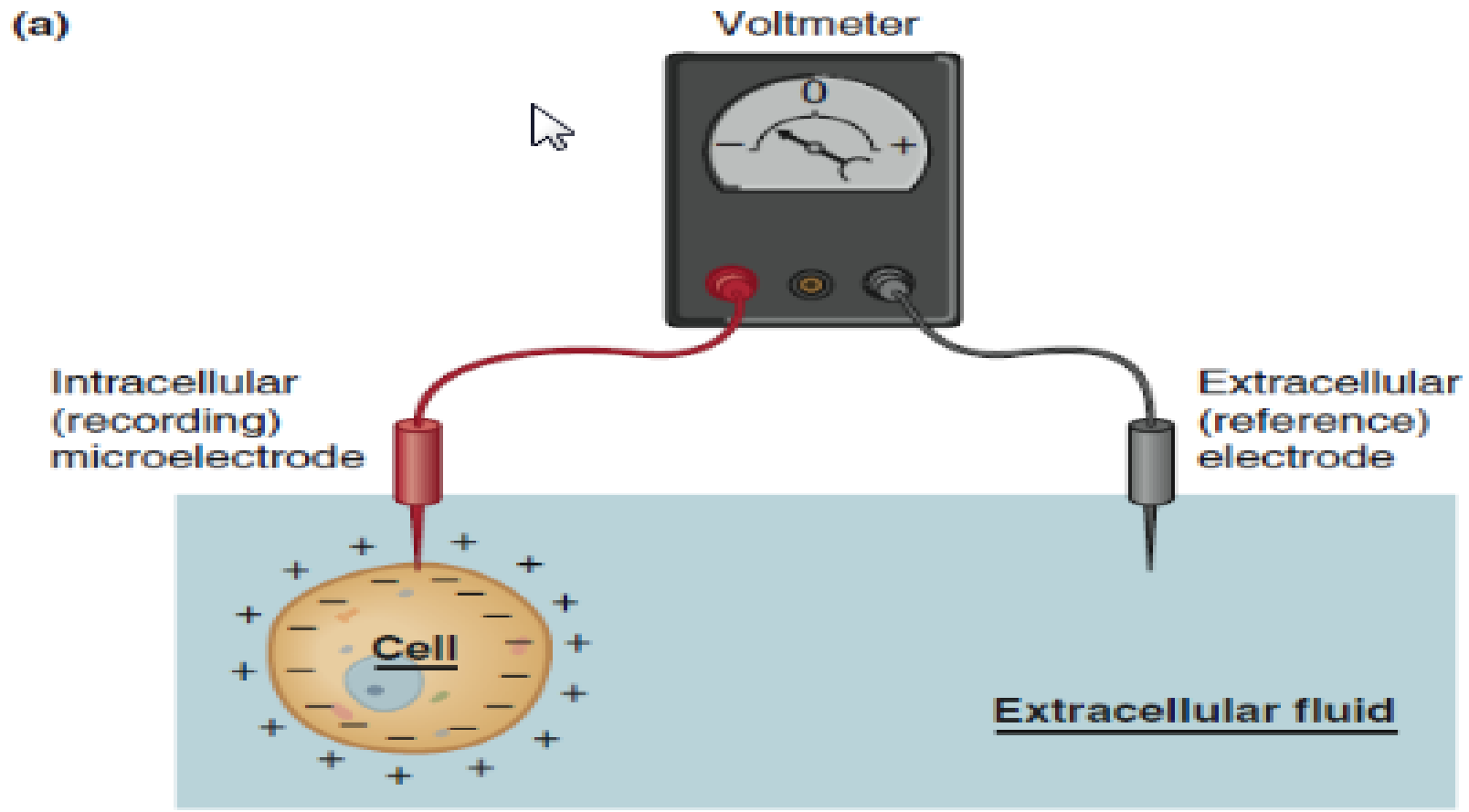
There is a potential difference of -70 mV between the inner & outer sides with the negativity inside during rest (unstimulated state). This potential difference is called the resting membrane potential (i.e. RMP).

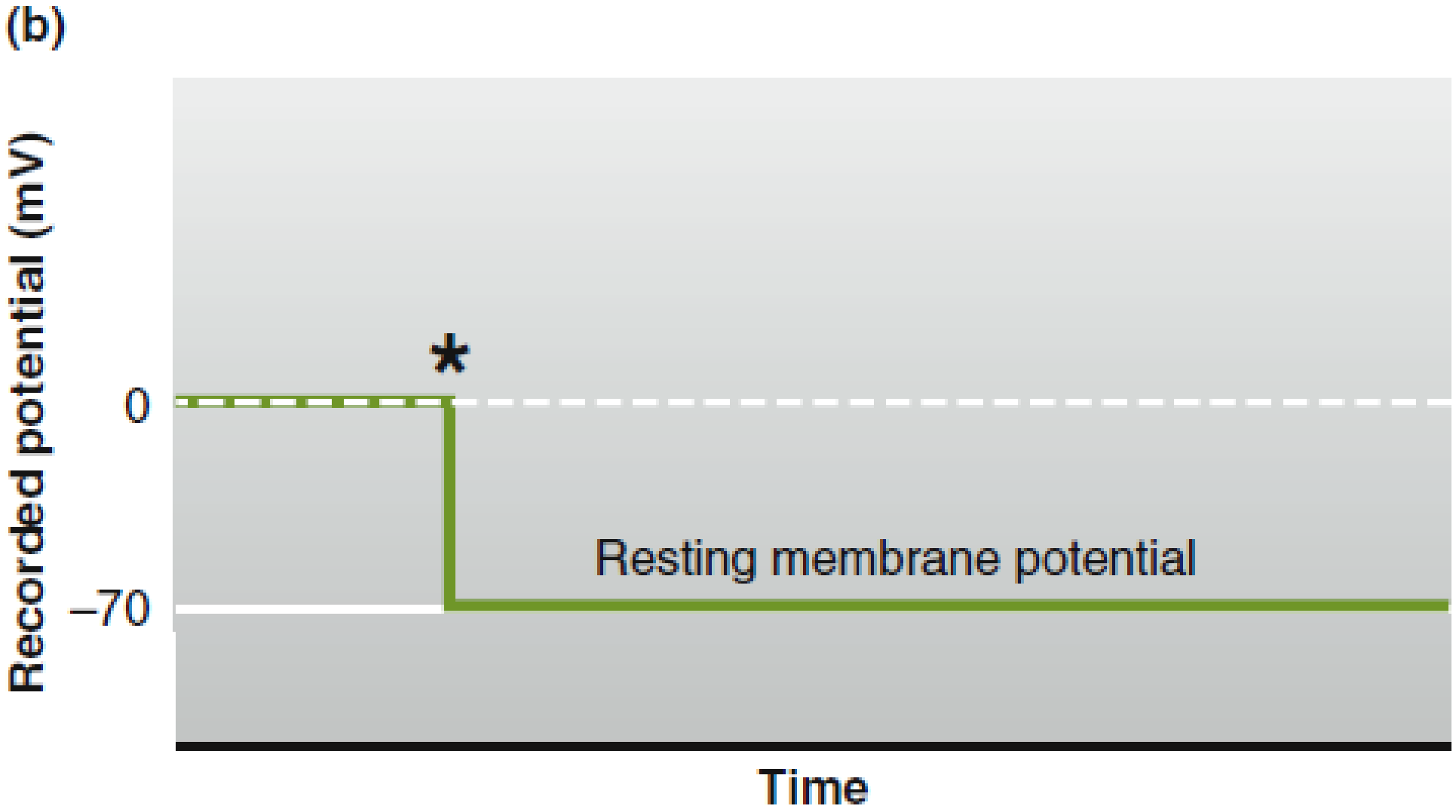
Normal value:

- Nerve – 70 mV.

- Skeletal muscle – 90 mV.

Apparatus for measuring membrane potentials. The voltmeter records the difference between the intracellular and extracellular electrodes.




(b)
Recorded potential (mV)
0
–70
*
Resting membrane potential
Time

- **Cause of RMP:**

It is due to **unequal distribution of electrically charged ions** on both sides of the cell membrane with more cations outside & more anions inside.

This unequal distribution is caused by:

- **I) Selective permeability of the cell membrane**
- **2) The Na^+ - K^+ pump.**

Selective Permeability of the membrane:

- The resting membrane is **50-100 times** more **permeable** to **K+ than Na+**. **This is due to:**

1. The membrane **Na+ channels are closed** under resting conditions, while the **K+ channels are opened.**

2. The nerve cell membrane contains channel proteins called **K+ leak channels.** K+ can leak through these channels even in the resting state. These channels may also leak Na+ slightly, but they are **100 times** permeable to K+ than to Na+.

3. The Na+ channels are **guarded** by Ca2+ from outside.

4. The hydration energy for Na+ is **greater** than that for K+. Thus, the size of hydrated **Na+** ion is **greater than** that of **K+** (i.e. the hydration energy is **inversely** proportionate with the **atomic number**).

- **N.B.** Most of resting membrane potential is obtained by selective permeability, with almost all of it being determined by **potassium** diffusion (about **-86 mv**) in large nerves.

- **The Na+- K+ Pump:**

 It is an **electrogenic** pump.

 It transmits **3Na+** ions to the **exterior** for each **2K+** ions transmitted to the **interior**.

Thus, creating **negativity (-) inside** and **positivity (+) outside** the nerve membrane.

 The pump is an active process (i.e. it requires ATP and Na+- K+ ATPase).

 It is **stimulated** by either **excess Na+** or **excess ATP** inside the cell.

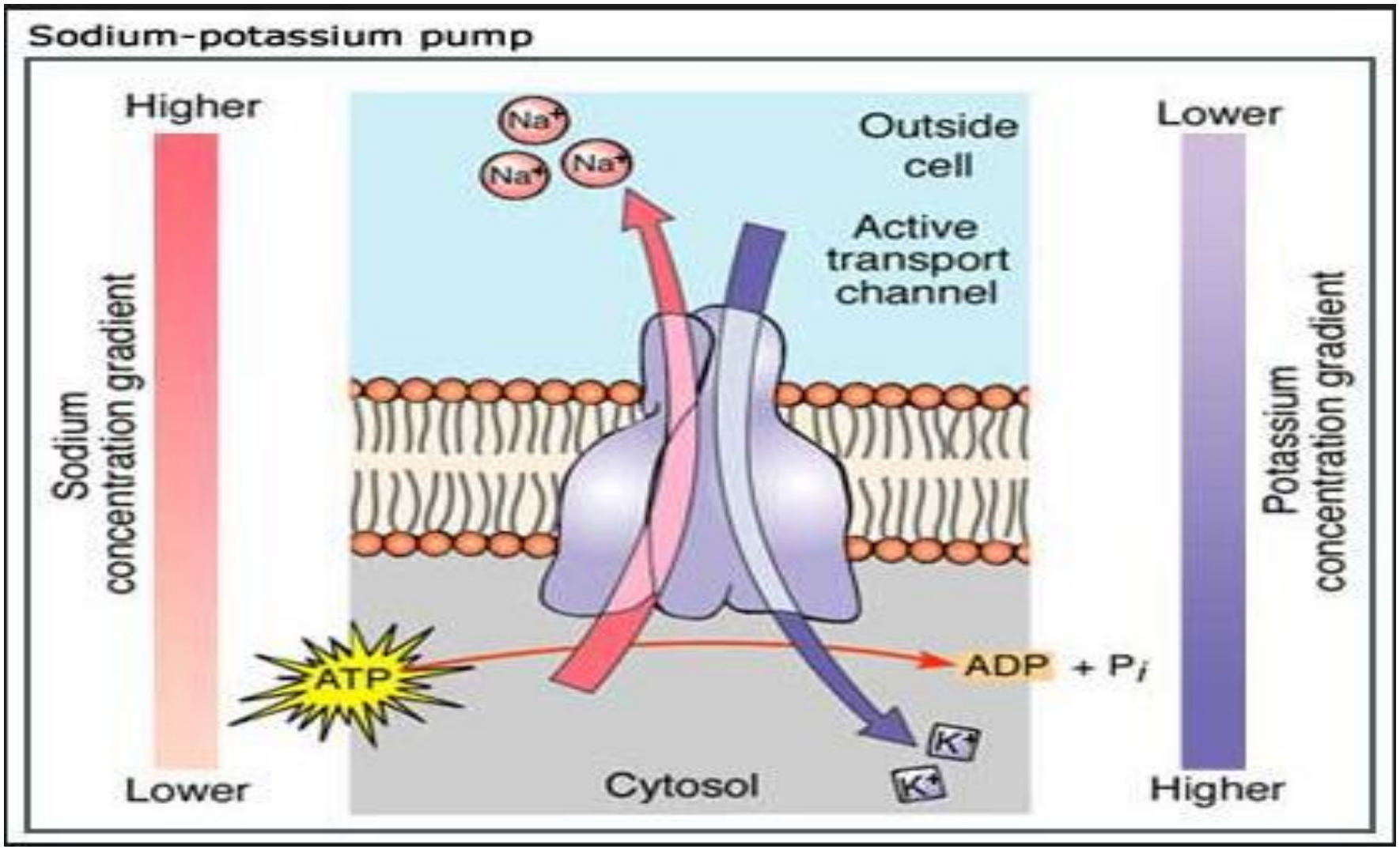
 It is **inhibited** by **decreased temperature** (i.e. cooling) or by a drug called **ouabain** (a drug used in heart failure).

- **Development of the RMP:**

 The Na+-K+ pump causes **more** transport of positive ions to the outside (3Na+) than to the inside (2K+).

 An additional few millivolts (about - 4 mv in large nerves) is contributed to the membrane potential by the continuously acting Na+- K+ Pump.

 Most of the -ve ions inside the nerve fiber are **non-diffusible** and remain inside. So the **inside** becomes **negative** while the **outside** becomes **positive**.


Sodium-potassium pump
Higher
Sodium concentration gradient
Lower
Na+
Na+
Na+
Outside cell
Active transport channel
ATP
ADP + Pi
K+
K+
Cytosol
Lower
Potassium concentration gradient
Higher


THANK
YOU