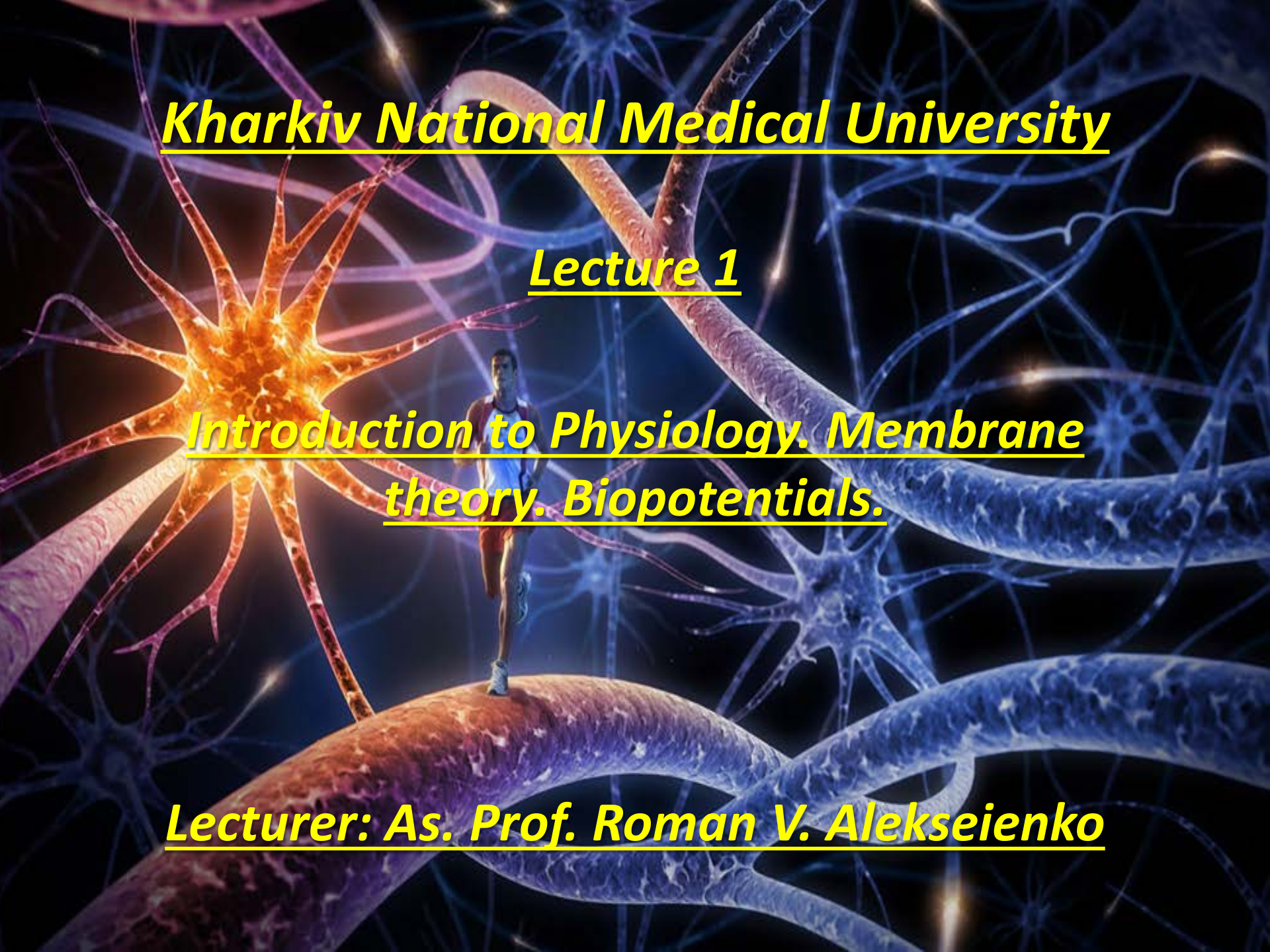


Kharkiv National Medical University

Lecture 1

Introduction to Physiology. Membrane theory. Biopotentials.

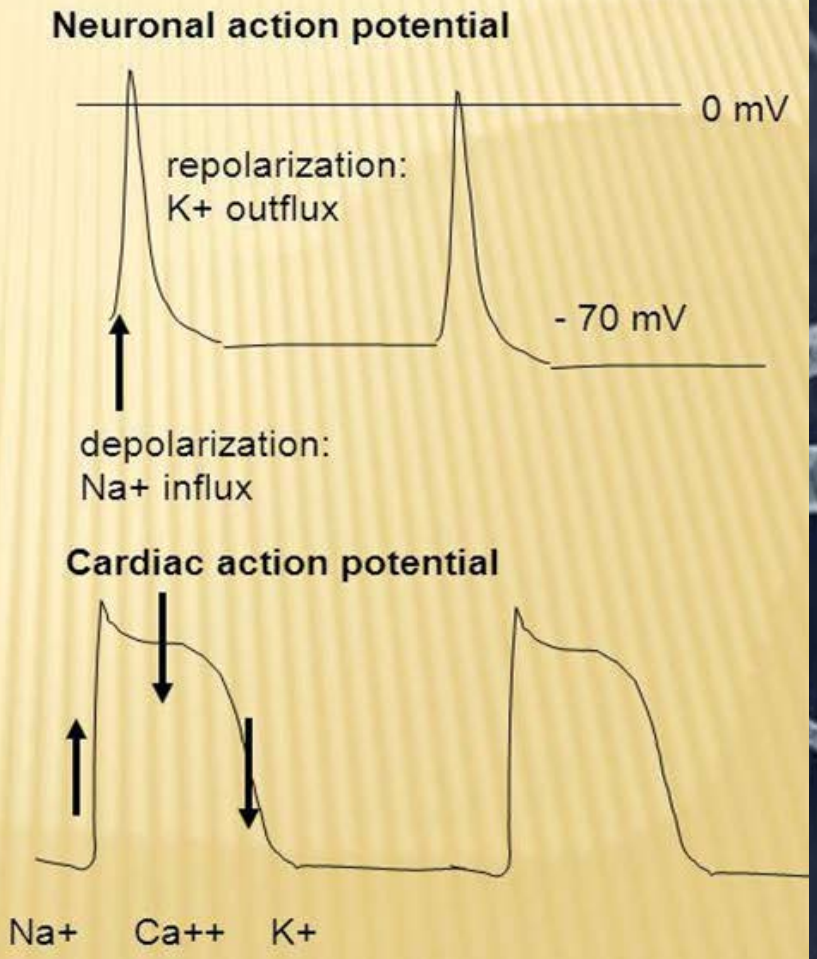
Lecturer: As. Prof. Roman V. Alekseienko

Theoretical questions of lecture:

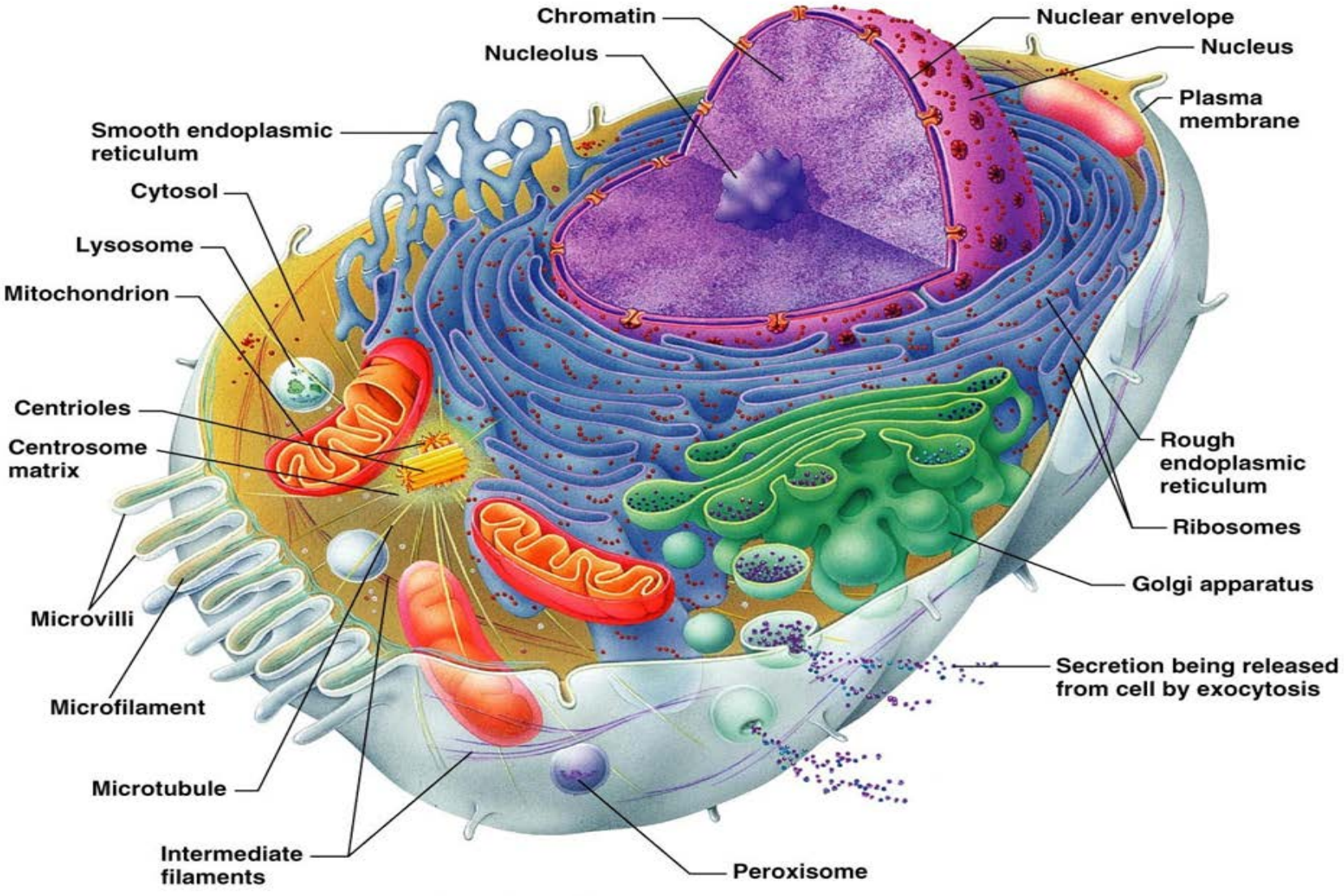
1. Introduction to Physiology. Subject and tasks of physiology. Methods of physiology researches ;
2. Properties of excitable tissues. The ion channels of cell membrane. Registration of rest potential and action potential;
3. Laws of stimulation. Comparison of action potential and local response.

ELECTRICAL ACTIVITY OF EXCITABLE CELLS

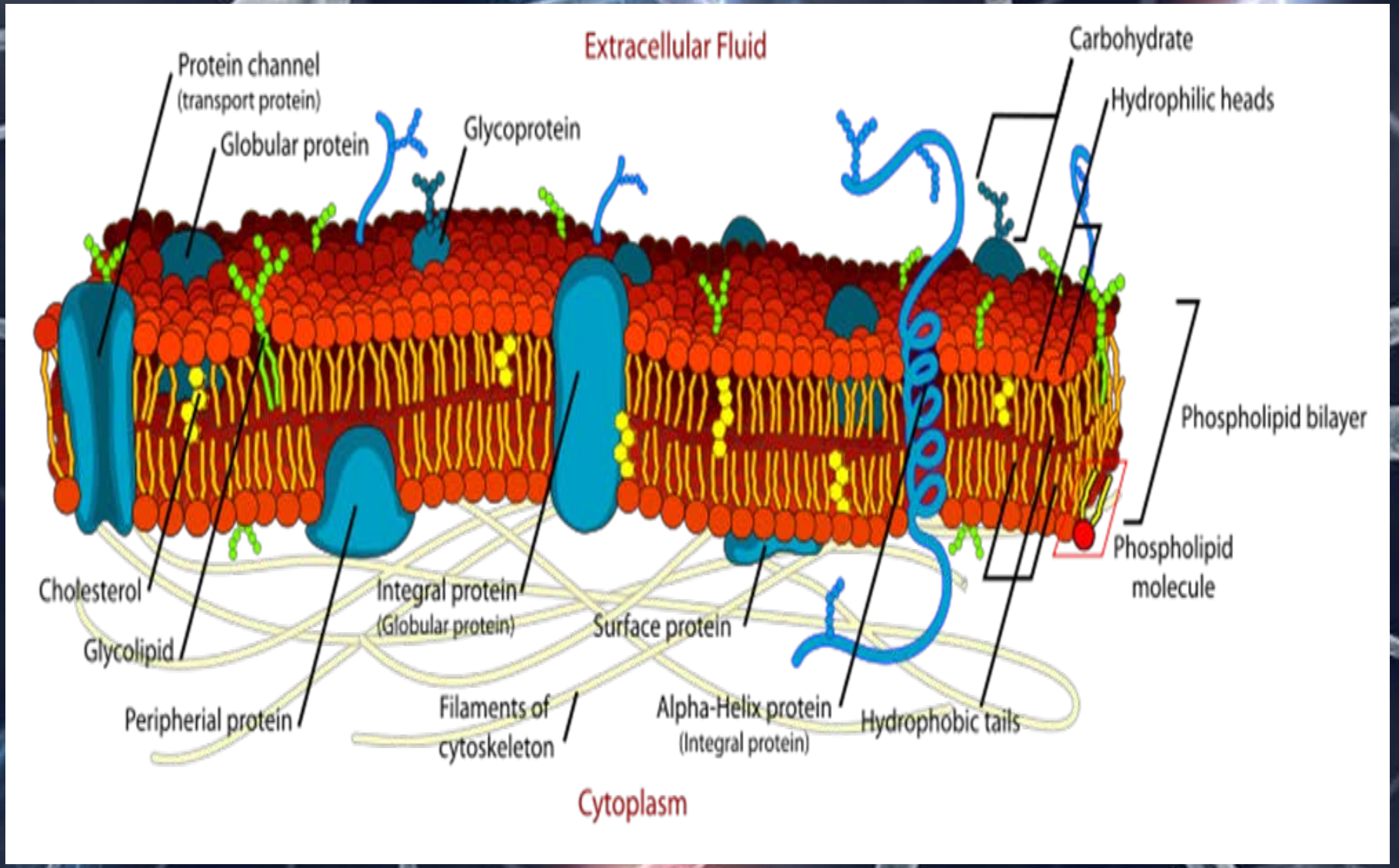
- Excitable cells
  - Exist in nervous, muscular and glandular tissue
  - Exhibit a resting potential and an action potential
  - Necessary for information transfer (e.g. sensory info in nervous system or coordination of blood pumping in the heart)



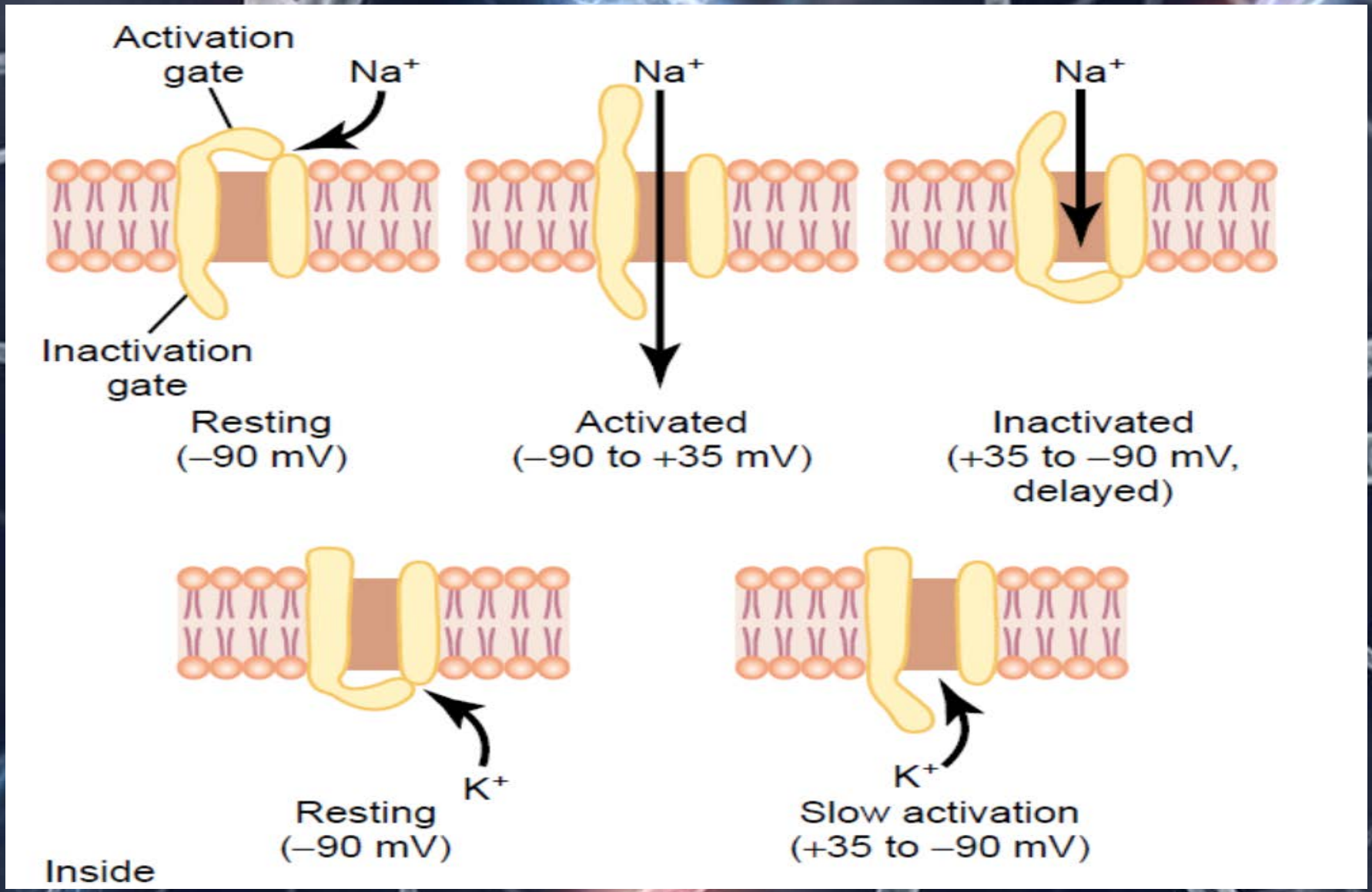
Structural organization of cell



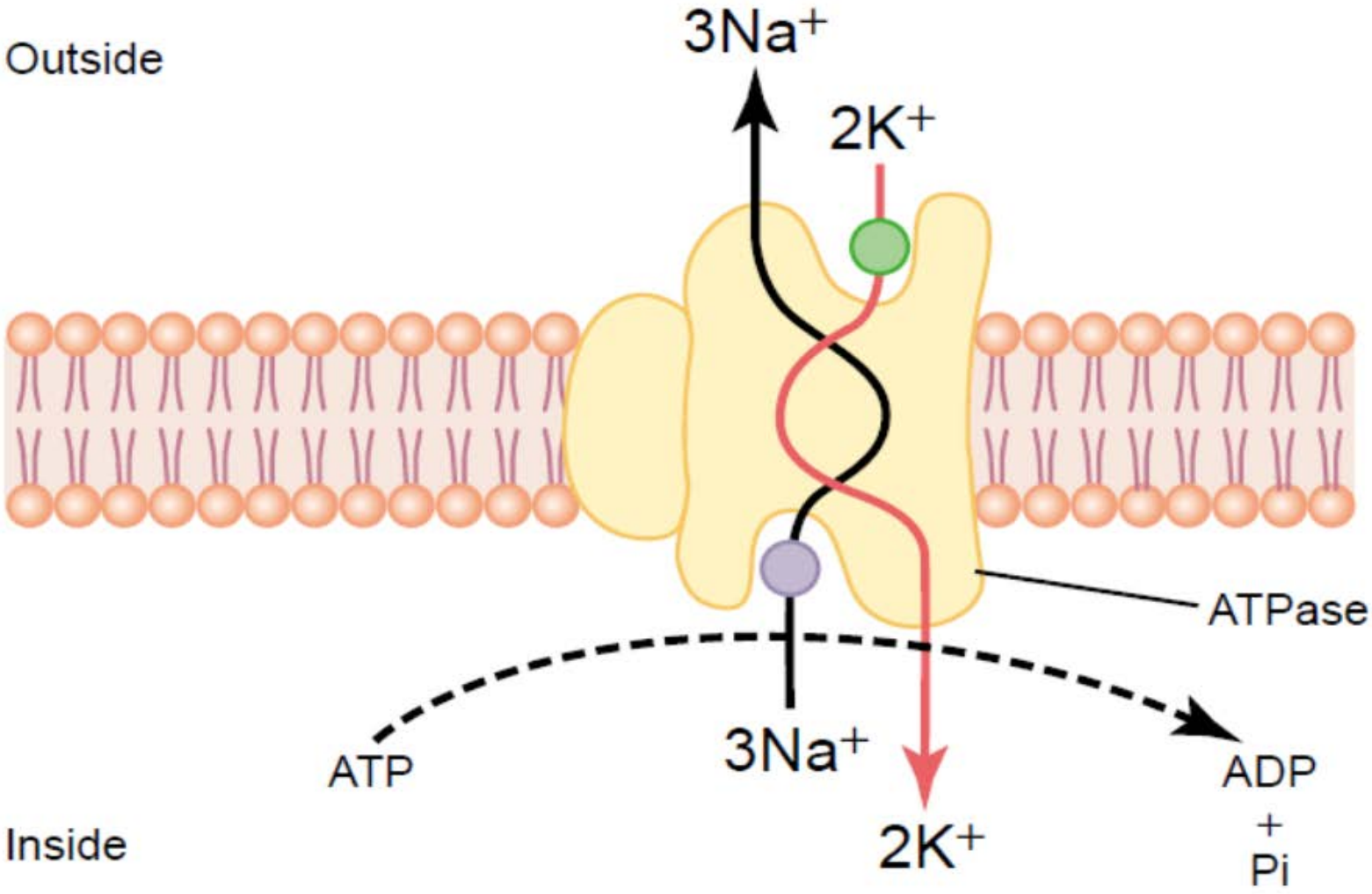
Structure of cell membrane



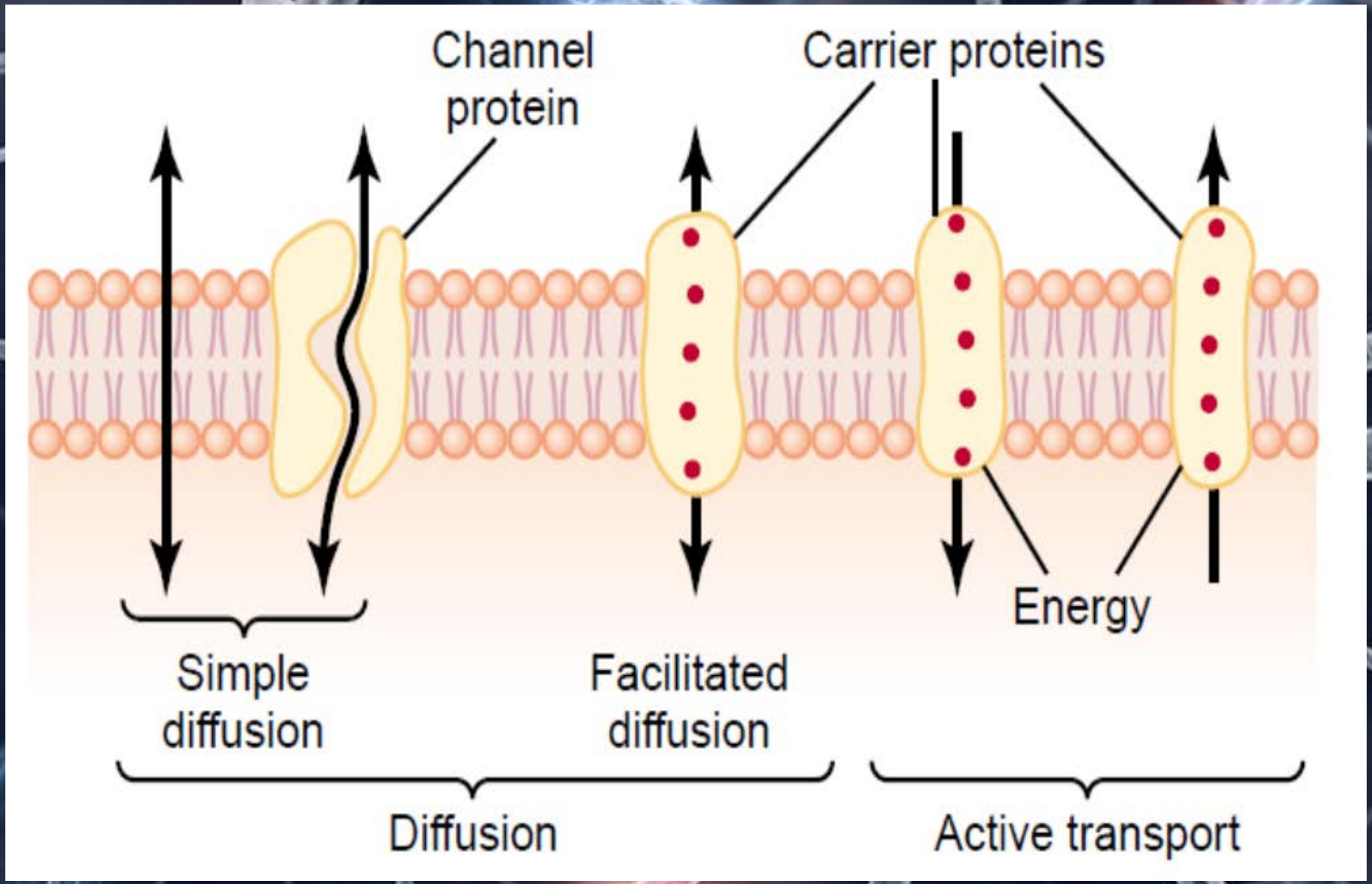
Mechanisms of ionic channels action



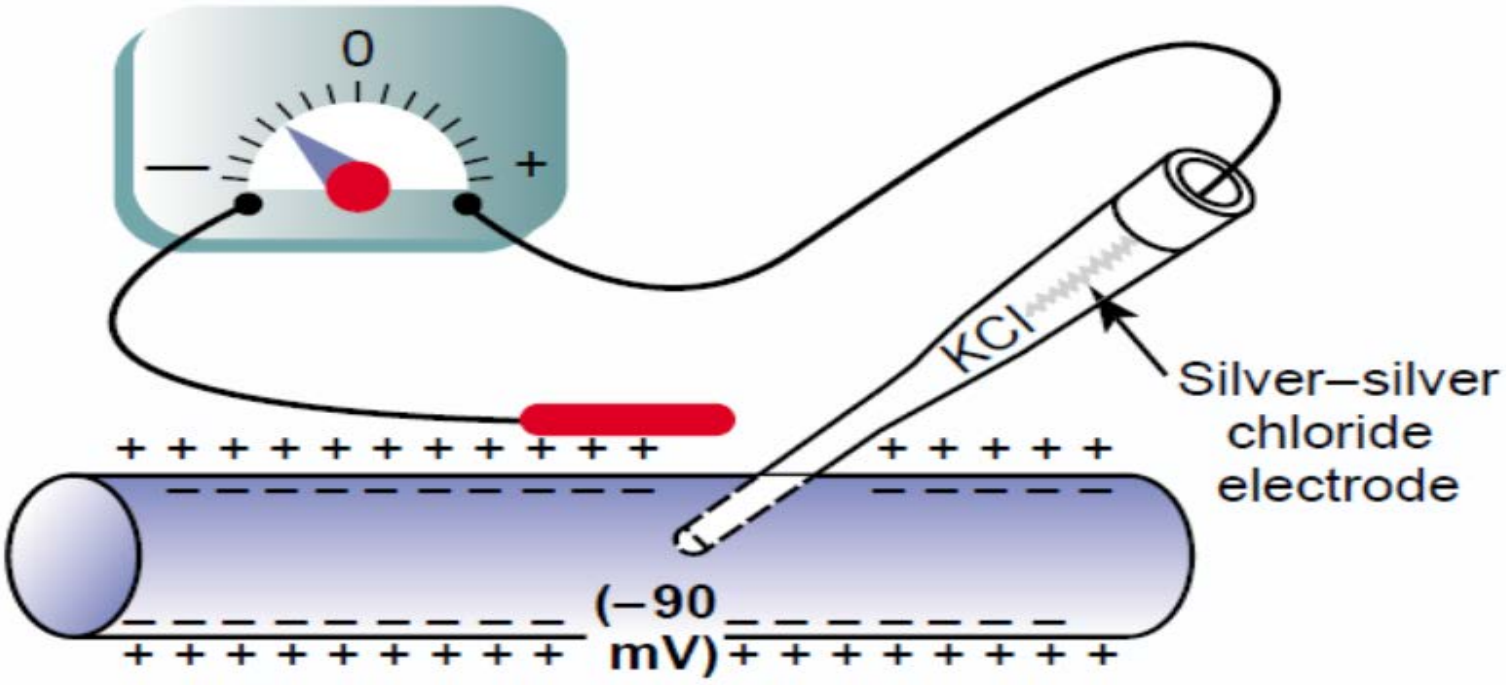
Mechanism of sodium-potassium pump action



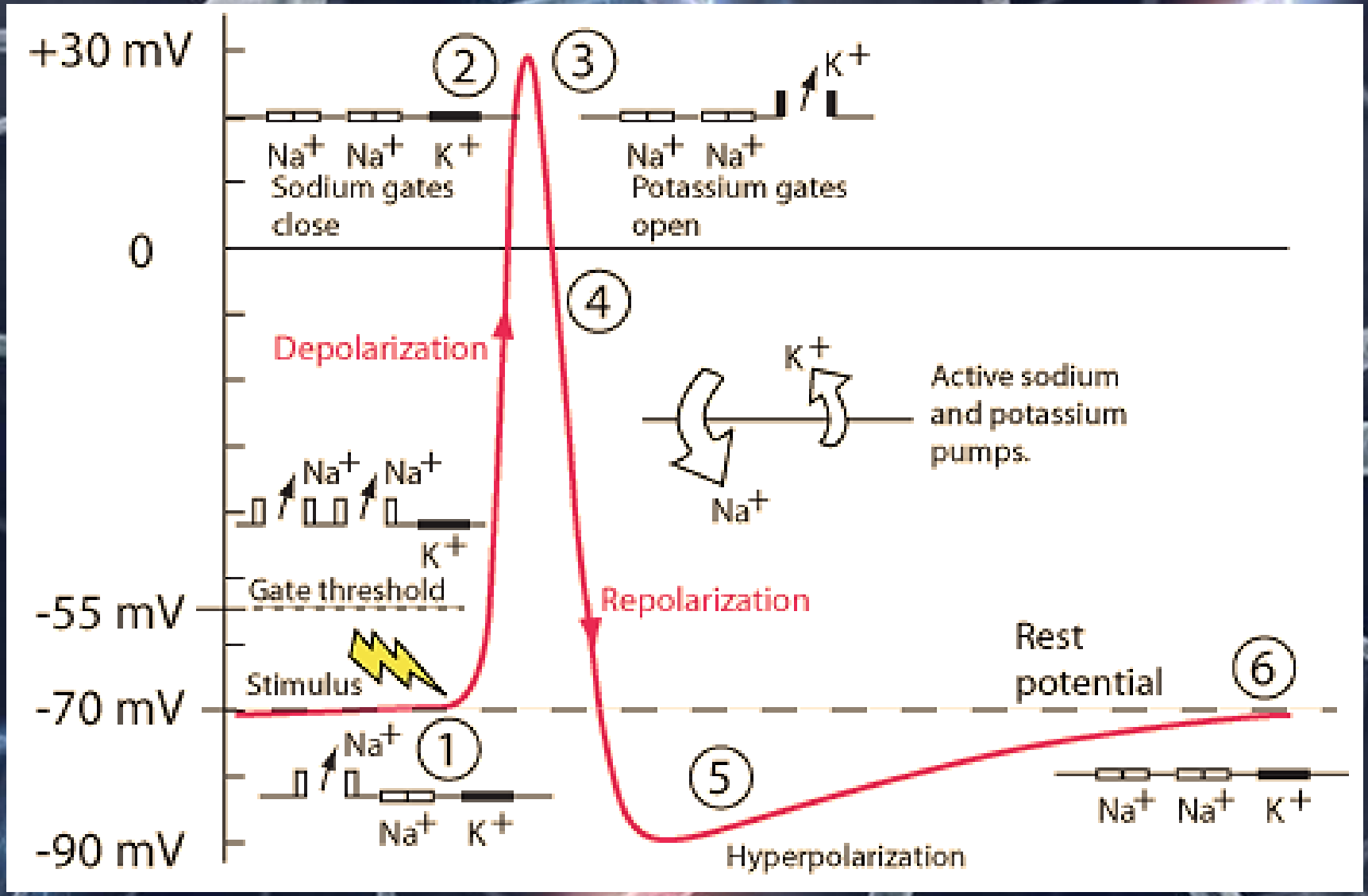
Transport pathways through the cell membrane



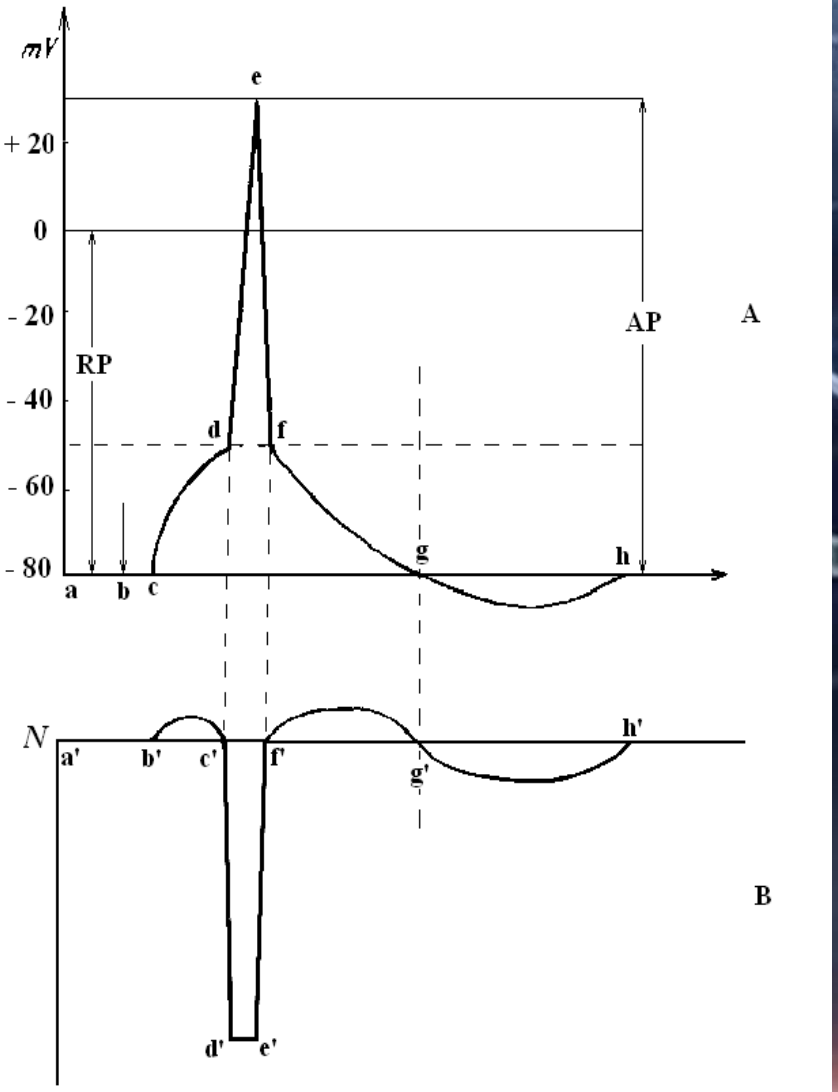
Membrane potentials registration



Graphic scheme of action potential



Dynamics of electrical conditions



Dynamics of electric conditions of the excitable tissue (A) and dynamics of excitability in the single cycle of excitation (B)

A: **ab** - rest condition (static polarization), rest potential;

bh – excitation (action potential);

bc – latent period;

ce – depolarization (**cd** – slow; **de** - rapid);

d – critical level of depolarization, threshold;

eg – repolarization (**ef** – rapid; **fg** – slow, negative after-potential);

gh – hyperpolarization, positive after-potential.

B: **a'b'** – normal excitability;

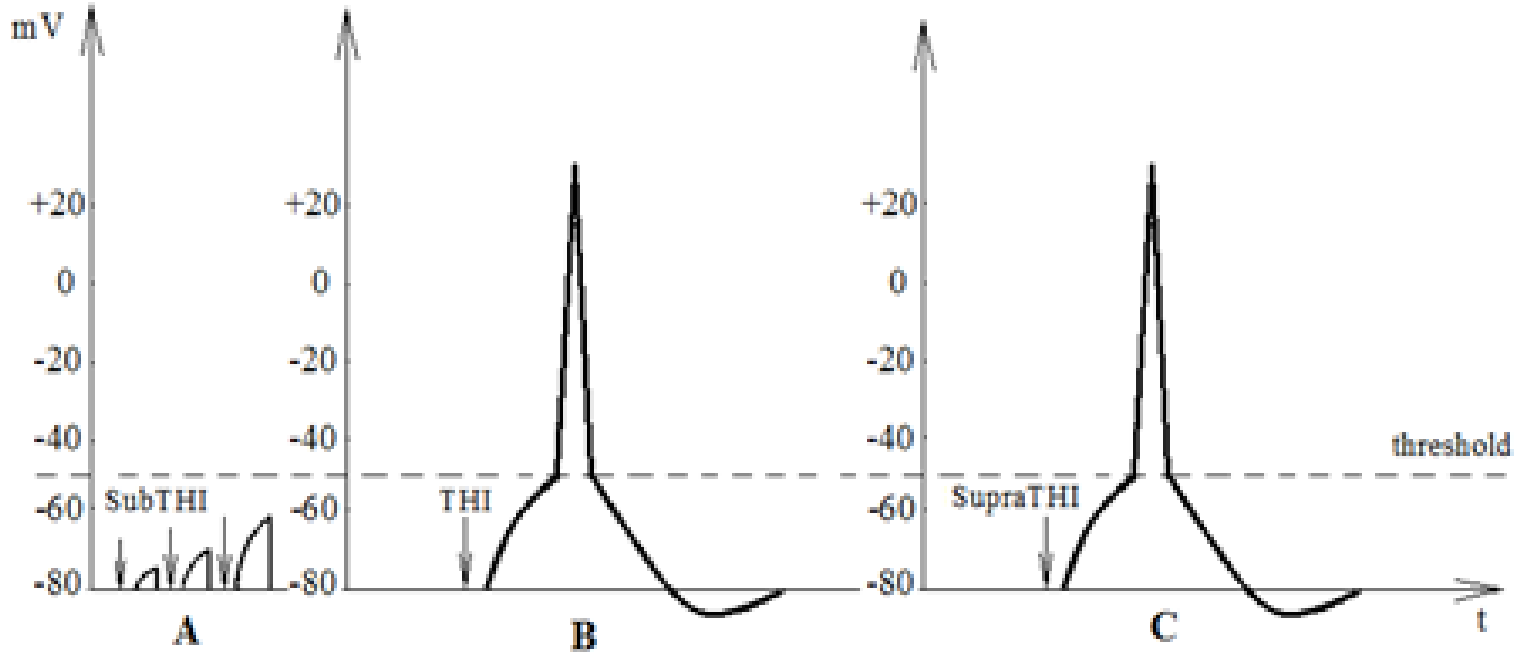
b'c'; **f'g'** –supernormal excitability;

c'd'; **e'f'** – relative refractory period;

d'e' - absolute refractory period;

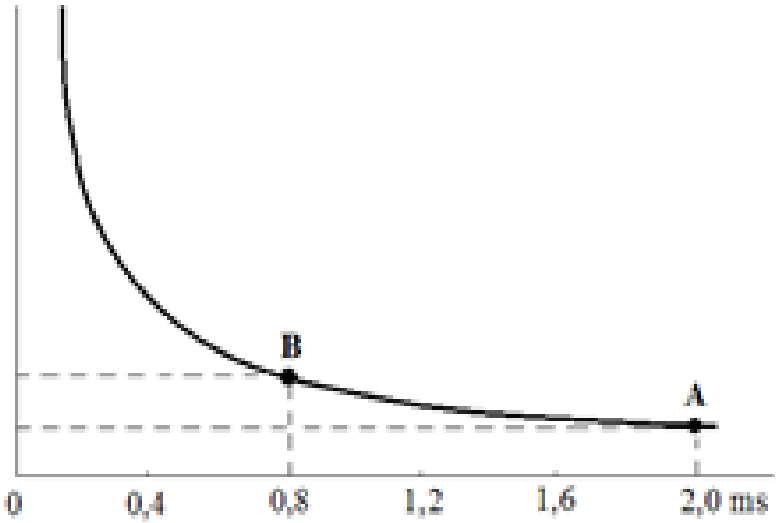
g'h' – supernormal excitability.

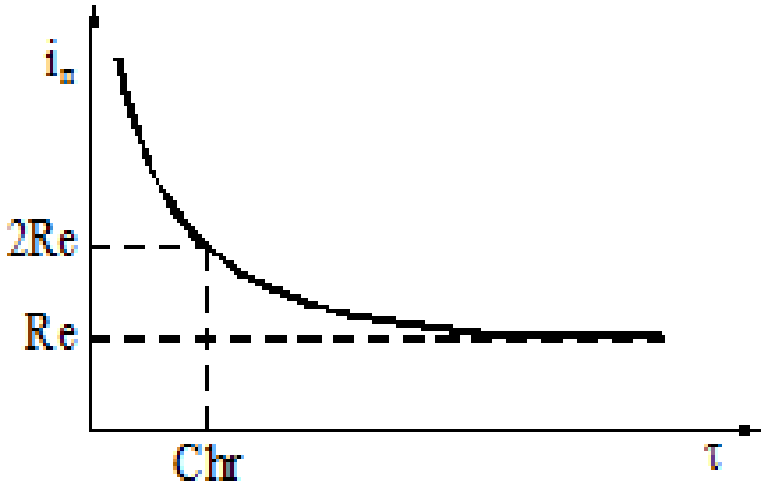
Stimulation of excitable membrane



*The electrographic characteristic of excitable membrane reactions at the action different strength of irritators: **A** - local response (action of the subthreshold irritator); **B** - action potential (action of the threshold irritator); **C** - action potential (action of the suprathreshold irritator).*

The curve “strength-duration”





*The curve "strength-duration": vertical axis - strength; horizontal axis - time of irritant action; point **A** - threshold force (rheobase) and threshold (useful) time; point **B** - double rheobase and chronaxie*

Comparison of AP and LR

Physiological process	*Action potential (AP)*	*Local response (LR)*
1. Conducting	1. AP spreads from the place of origin along all length of nerve or muscle fiber.	1. LR arises in the place of irritation. LR can't be conducted.
2. Spreading	2. AP spreads without extinguishing.	2. LR spreads with extinguishing.
3. Arising	3. AP arises with the action of threshold irritation.	3. LR arises with the action of subthreshold stimulus.
4.Strength of irritation	4. AP depends upon the strength of irritation according to "all-or-none" law: the amplitude of AP doesn't depend upon the irritation strength after the critical level of depolarization reaching.	4. LR depends upon the strength of irritation: at the increasing of strength subthreshold irritation the amplitude of LR will be increased.
5. Amplitude	5. 80-130 mV	5. 10-40 mV
6. Summation	6. AP can't be summated.	6. LR can be summated
7. Excitability	7. While AP formation the cell membrane has variable excitability.	7. LR accomplished with increased excitability.


THANK YOU
FOR
YOUR ATTENTION!