Surface Activity of Angiotensin

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Studies of the renin-angiotensin-aldosterone system are dictated by the rapidly growing incidence of cardiovascular diseases. This system plays a key role in metabolic reactions in various forms of cardiac insufficiency and regulates the general and renal circulation, water-electrolyte balance, arterial pressure, aldosterone level, etc. [7]. The most active component of this system is angiotensin-2; some authors [2,6,7] believe that, in binding with a receptor, it stimulates inositol triphosphate production, this being followed by a rise of the intracellular ionized calcium level and activation of proteinkinase C.

The primary mechanisms of angiotensin-2 binding with membranes are unknown, but oxytocin and substance P, which are similar to this peptide in structure, were recently discovered to bind with the lipid matrix of the membranes [3-5]; this prompted us to investigate the surface-active properties of angiotensin-2, one of the factors of peptide-membrane interaction.

MATERIALS AND METHODS

The surface activity of angiotensin-2 (Riga, Latvia) was examined in water-air or electrolite aqueous solution - air systems; the agent was added to the subphase so that its contact with the phase interface was ruled out absolutely. Subphase pH values were monitored by means of an I-102 ionometer. Peptide adsorption isotherms at the phase interface and the isochoric dependences of the interface potential differences in monolayers were analyzed as described previously [1,2].

RESULTS

The angiotensin-2 preparations were found to be characterized by a marked surface-active activity; when introduced into the subphase (twice distilled and deionized water, pH 6.2), they accumulated at

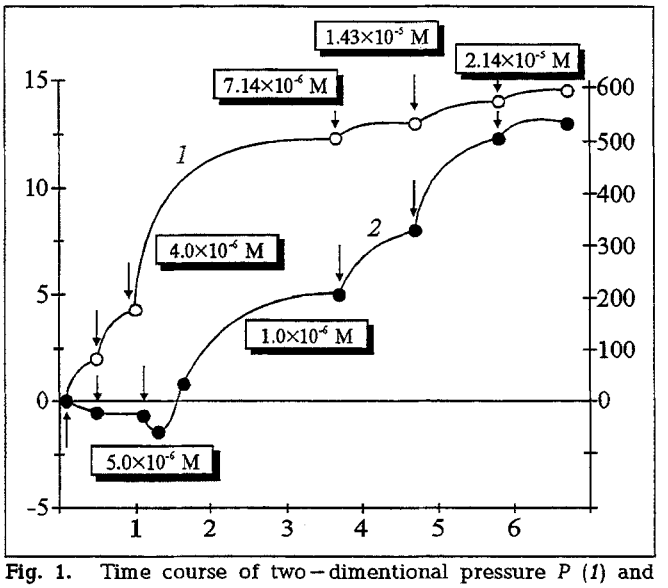

Fig. 1. Time course of two-dimentional pressure P (*1*) and interface potential differences ϕ (*2*) in monolayers of angiotensin-2 in the course of a stepwise increase of concentration (shown with arrows) in the subphase.

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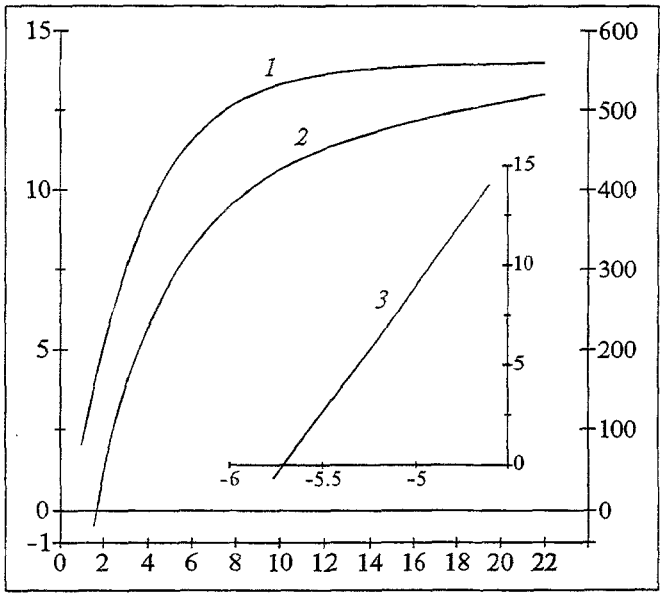

Fig. 2. Angiotensin−2 adsorption isotherms: relatioship between interface potential difference ϕ (1) and two−dimentional pressure P (2), on the one hand, and angiotensin−2 concentration in the subphase, on the other; relationship between two−dimentional pressure and log C peptide in the subphase (3).

the water-air interface. The time course of the changes in interface potential differences and in two-dimentional pressure for a stepwise increment of peptide concentrations in the subphase is shown in Fig. 1. Marked adsorption of angiotensin-2 at the water-air interface is seen to occur when the angiotensin concentrations in the subphase were higher than 5×10^{-7} M. The two-dimentional pressure in the system fell somewhat in this case, and the interface potential difference increased and was +90mV during 30 min. If the peptide concentration in the subphase increased twofold, the interface potential difference increased to +180 mV, but the surface tension was unchanged. When the angiotensin-2 volumic concentration was 4×10^{-6} M, a monolayer with a noticeable pressure (P=3.5 mN/m) formed, the interface potential difference in this case increased to +40 mV.

Peptide monolayer structures become condensed with angiotensin-2 volumic concentrations surpassing 10^{-5} M. The interface potential differences and two-dimentional pressure in such monolayers attain +520 mV and 13 mN/m, respectively.

Angiotensin-2 adsorption isotherms (P-C and ϕ-C relationships) are presented in Fig. 2. The curve is plotted in semilogarithmic P and C coordinates (Fig. 2, *3*) indicating a maximal adsorption, higher than with peptide volumic concentrations equal to 1.7×10^{-6} M. The adsorption isotherms were processed using Gibbs' equation:

$$G=1/RT\times dP/d\ln C,$$

where G is adsorption, R universal gas constant, and T absolute temperature, permitting estimation of G value and area per molecule in monolayer S_i ($S_i=1/G$). They are equal to 3.7×10^{-6} M/cm^2 and 0.45 nm^2, respectively. These data are in good correlation with the results of physical modeling of angiotensin monolayers, which indicate that at the water-air phase interface such monolayers should consist of vertically oriented molecules directed with their N terminal into the subphase. The cross section of the angiotensin-2 molecule is 0.42 nm^2, and its length is 3 nm.

Hence, angiotensin-2 is a surfactant and its adsorption from the subphase is associated with the formation of regularly arranged monomolecular films. It may be assumed that in nature such phenomena may also occur on the plasma membrane of cells, which are also characterized by surface activity at the phase interface. This fact may be significant in studies both of the primary mechanisms of peptide interactions with cell plasma membranes and of the molecular mechanisms of angiotensin-2 intracellular effects.

REFERENCES

1. V. S. Gevod, V. I. Karamushka, P. V. Pogrebnoi, *et al., Byull. Eksp. Biol.*, **96**, № 7, 552-556 (1983).
2. G. Yu. Grigoryan, *Progress in Science and Pechnology. Human and Animal Physiology Series* [in Russian], Vol. 38, Moscow (1989), pp. 61-88.
3. V. K. Rybal'chenko, G. V. Ostrovskaya, and N. E. Kucherenko, *Byull. Eksp. Biol.*, **105**, № 12, 681-683 (1990).
4. V. K. Rybal'chenko, *Dokl. Akad. Nauk SSSR*, **314**, № 4, 984-987 (1990).
5. V. K. Rybal'chenko and B. R. Mogilevich., *Dokl. Akad. Nauk SSSR*, Series B, № 10, 66-69 (1991).
6. J. G. F. Cleland, *Herz*, № 2, 68-81 (1991).
7. C. Tamm, U. Lang, and N. V. Vallotton, *Endocrinology*, № 2, 68-81 (1990).