

CHANGES IN THE SODIUM AND POTASSIUM IONS IN THE SMOOTH MUSCLE OF THE CHICK AMNION AT VARIOUS STAGES OF ITS RHYTHMIC ACTIVITY

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Previously it has been shown that between the 5th and 14th days of incubation of the chick embryo there is a change in the cholinesterase activity and acetylcholine content of the muscular tissue of the amnion [2]. In addition it has been suggested that there is a connection between the acetylcholine-cholinesterase system and the ions of sodium and potassium. It has been shown [3, 5, 6] that the injection of acetylcholine during excitation of the muscle increases the number of potassium ions leaving it, and VanderKloot [9] concluded from his experiments that the reduction of cholinesterase activity was related to loss of sodium ions.

Also, from numerous investigations the idea has developed that potassium and sodium ions take part in the processes of excitation and contraction of the muscles. Some authors [4, 10] relate muscular contraction to loss of potassium ions. McDowall and Munro [8] have shown that the strength of the contractions of cardiac muscle depends on an increase or decrease of sodium content. We have shown that in the development of the amniotic movements there is a change of the rapid and slow contractions [1].

The object of the present investigation has been to follow the changes in the potassium and sodium ions in the smooth muscle of the amnion at various stages of the development of its periods of rhythmic activity.

EXPERIMENTAL METHOD

To determine the amount of sodium and potassium ions in the muscle of the amnion between the 5th and 14th day of incubation we used the method of flame photometry. A weighed portion of 10-50 mg of tissue was heated in concentrated nitric acid and the solution obtained was diluted 50-250 times in twice-distilled water. The final result was taken from the mean content of sodium and potassium ions obtained from measurements made on the given day of incubation.

EXPERIMENTAL RESULTS

From Fig. 1 it can be seen that the content of potassium ions in the muscle increased on the 7th day of incubation, on the 8th day it fell to approximately the original value, and during subsequent development it underwent no particular change. On the 9th and 11th day of incubation the level of potassium ions in the amnion shows some increase.

The content of sodium ions in muscle tissue of the amnion during the same period of development suffered corresponding changes, i.e., on the 7th day there was a sharp rise, and on the 10th day it returned to the original level. On the 11th day of incubation the number of sodium ions in the amniotic tissue again increased, only to return to the original level on the 13th day.

As Fig. 2 shows there was a marked increase in the number of monovalent ions in the muscle tissue, which corresponded to a reduction in the activity of the cholinesterase between the 5th and 7th day of incubation; on the 8th day there was a considerable increase, while for the next two days the amount of cholinesterase remained approximately constant. By the 11th day, in addition to some increase in the amount of monovalent ions there was some increase of cholinesterase activity.

From the results obtained and from data which have been published it would appear that the entry of sodium and potassium ions into the muscle tissue of the amnion from the amniotic fluid is related to the cholinesterase activity;

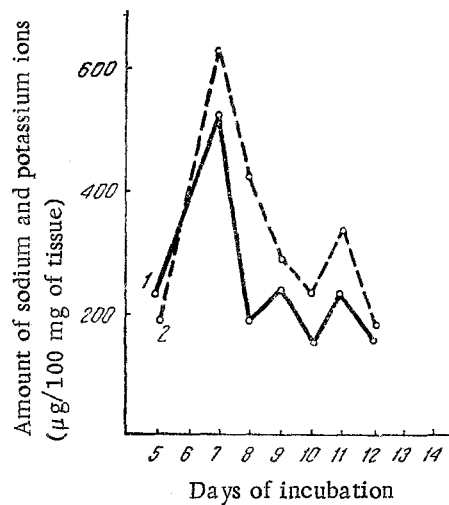


Fig. 1

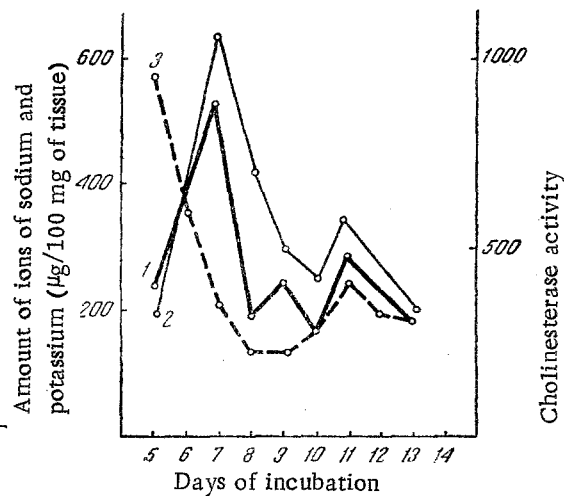


Fig. 2

Fig. 1. Change in the content of (1) potassium and (2) sodium ions in the smooth muscle tissue of the amnion during chick embryo development.

Fig. 2. Change in the content of (1) potassium and (2) sodium ions and (3) of the cholinesterase activity in the smooth muscle tissue of the amnion during the development of the chick embryo. Cholinesterase activity is expressed as μg of acetylcholine per 100 mg per hour.

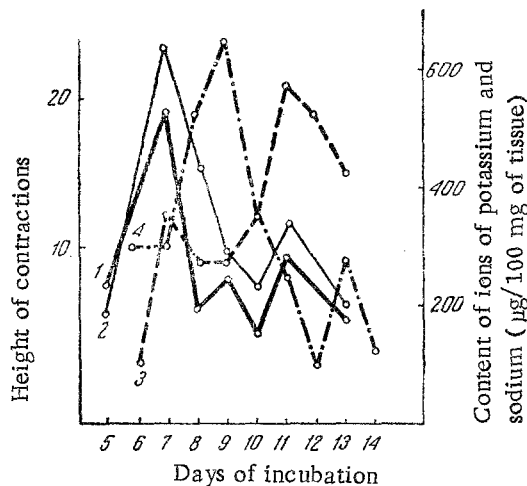


Fig. 3. Change in the content of (1) potassium and (2) sodium ions; (3) height of rapid and (4) height of slow contractions of the amnion of the chick embryo.

a considerable increase of ionic concentration inhibits and a small increase stimulates cholinesterase activity. The marked reduction in the amount of potassium ions in the tissue between the 7th and 8th day of incubation appears to be due to the great increase in the amount of acetylcholine present in the muscle tissue of the amnion at this period [3].

It is interesting to compare the change in the amount of sodium and potassium ions in the amnion occurring between the 5th and 14th day with the corresponding changes of muscular activity. Previously it was explained that the height of slow contractions of the amnion increased between the 5th and 9th days, and again fell on the 12th day. At the same time the height of the rapid amniotic contractions increased toward the 11th day, and fell again on the 14th.

Fig. 3 shows clearly that the increase of height of the slow contractions between the 7th and 8th days of incubation was associated with a reduction in the amount of potassium ions in the muscular tissue. The reduction in the amount of sodium ions at this time took place more slowly. The small increase in the amount of sodium and potassium ions on the 11th day of incubation

occurred together with an increase in the height of rapid contractions of the amnion, but the subsequent reduction of ionic concentration was associated with some small increase in the height of slow contractions.

Therefore from a comparison of the curves showing changes of the slow amniotic contractions and the potassium and sodium concentrations it would appear that superficially there is a resemblance and that the ionic tissue changes

precede changes in the height of the slow contractions. The resemblance in the appearance of the curves gives some reason to suppose that sodium and potassium ionic concentration changes influence the height of the slow amniotic contractions, and support for this view is provided by another report [7].

SUMMARY

Changes of the sodium and potassium ionic concentrations were observed during the development of rhythmic amniotic movements. A considerable increase of the ion content in muscular tissue occurred from the 5th to 7th day of incubation; from the 10th to 11th day there was a slight increase of the sodium and potassium content which reverted to normal values on the 13th day of incubation. These alterations may be associated with changes in cholinesterase activity and intensity in the amniotic contractions.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
