HIGH ACTIVITY OF ADENYL CYCLASE IN OLFACTORY AND GUSTATORY ORGANS

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SUMMARY

Bovine taste buds bearing papillae exhibit high adenyl cyclase activity comparable to the activity found in the brain, while the tongue epithelium without taste buds exhibits much lower activity than found in the taste buds bearing papillae. Rabbit olfactory epithelium also exhibits high adenyl cyclase activity. The results suggest that cyclic AMP may play an important role in the transducer process common to the sensory organs.

The initial event of olfactory and gustatory stimulation is estimated to be the adsorption of chemical stimuli by the receptor membranes (1-3), but the process by which the initial event on the receptor membranes is translated into a nerve impulse is utterly unknown.

Recently, Bitensky et al. (4) found that frog rod outer segments contain higher activity of adenyl cyclase than that found in brain, which was heretofore known as the tissue containing much higher adenyl cyclase activity than any of the other mammalian tissues (5), and that the adenyl cyclase was active in darkness and inactivated by light. This finding suggested that adenosine cyclic 3',5'-monophosphate (cyclic AMP) may play a role in translation of light stimuli into a nerve impulse.

Olfactory and gustatory organs may have the transducer

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system common to the visual organ. In the present study, adenyl cyclase activity in rabbit olfactory epithelium and bovine taste papillae was measured and it was found that both sensory organs exhibit high adenyl cyclase activity comparable to the activity found in the brain.

MATERIALS AND METHODS

Rabbit olfactory epithelium was shaved off gently with a spatula from the pigmented area of the olfactory tissues (6). Bovine fungiform papillae, circumvallate papillae or the surrounding epithelium including filiform papillae were cut off with a small scalpel from bovine tongue (7). Brain was obtained from adult rats. Samples from bovine tongue were homogenized with a motor driven glass homogenizer in 0.25 M sucrose and those from the olfactory epithelium and the brain were homogenized with a 'Teflon' homogenizer. The homogenates were centrifuged at 12,000 x g for 10 min. The sediments was washed with 100 mM Tris-HCl buffer (pH 7.5) and resuspended in the buffer. The resulting suspensions (washed particulate preparations) were used for assay of adenyl cyclase activity.

Adenyl cyclase activity was measured essentially according to Bär and Hechter (8). The components of reaction mixture in a total volume of 0.04 ml were ; 0.25 mM $\left[8\text{-}^{14}C\right]$ ATP (45 Ci/mol), 0.2 mM $KHCO_3$, 50 mM Tris-HCl (pH 7.4), 5 mM $MgCl_2$, 10 mM theophilline, 0.1 % bovine serum albumin, 10 mM sodium phosphocreatine, 16 μg creatine kinase and washed particulate preparations (0.1-3.0 mg/ml). The reaction mixture was incubated for 10 min at 37 °C. Reactions were stopped by boiling for 3 min, after addition of 0.05 ml 5 mM cyclic AMP and 5 mM ATP. The amount of cyclic AMP formed in the reaction was determined exactly according to Bär and Hechter (8).

Protein concentration was determined by the method of Lowry _et al_. (9).

RESULTS AND DISCUSSION

There are three types of papillae on bovine tongue surface, that is, fungiform, circumvallate and filiform papillae, Among these papillae, taste buds occur only in fungiform and circumvallate papillae. Table 1 shows that taste buds bearing papillae contain high activity of adenyl cyclase comparable to the activity found in rat brain, while the activity of the surrounding epithelium including filiform papillae is only one hundred-fold lower than the activity found in circumvallate papillae. High activity of adenyl cyclase was also found in

Table 1. Adenyl cyclase activity in the olfactory and gustatory organs

Source	Specific activity*
rat brain	3.5
rabbit olfactory epithelium	5.7
bovine fungiform papillae	3.7
bovine circumvallate papillae	5.6
bovine tongue epithelium without taste buds	0.05

* The specific activity of adenyl cyclase is expressed as nanomoles of cyclic AMP per mg of protein per 10 min.

the rabbit olfactory epithelium.

De Robertis _et al_. (10) reported that much of the adenyl cyclase in brain is contained in the nerve endings and synaptic fragments. Although taste cells contain nerve endings of the taste nerves (11), the relative amount of the nerve endings in the whole papillae is much less than that in brain. The olfactory nerves have no synapse during the course to the olfactory bulb (12). Therefore, the high activity of adenyl cyclase in the chemo-sensory organs seems to come from the receptor cells, probably the receptor cell membranes because the particulate preparations were used in the present study for assay of adenyl cyclase activity. Since rabbit olfactory epithelium and bovine taste papillae contain a fairly large amount of the cells except for the receptor cells, the specific activity of adenyl cyclase in the receptor cell membranes would be much higher than the activity measured in the present study. The present results, together with the fact that photoreceptors exhibit high activities of adenyl cyclase (4, 13) and cyclic nucleotide phosphodiesterase (14), suggest that cyclic AMP may play an important role in the transducer process common to the sensory organs.

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