tion was used as bath fluid and the presence of histamine was confirmed by mepyramine maleate, 0.2 ml, 2.5×10^{-6} M. Histamine concentration was calculated and expressed in µg per g of tissue.

Results. The result of the experiment is summarized in the table. It can be seen that daily intramuscular administration of 0.4 mg betamethasone over a period of 12 days leads to a highly significant reduction in gastric tissue histamine concentration in albino rats.

Discussion. It has been reported that about half of the whole-body histamine formation takes place in the stomach[17]. A strong positive correlation between mast cell population and tissue histamine concentration has been shown to exist[18]. We have reported earlier that following betamethasone injection the gastric mucosal mast cell population is greatly reduced, whereas bilateral adrenalectomy causes an increase in their number[14]. An increase in gastric tissue histamine concentration following bilateral adrenalectomy has also been observed in albino rats[19].

Therefore, in view of the above observations and in the light of the present findings, it appears that betamethasone injection leads to the liberation of histamine from the gastric mast cells and thereby reduces the gastric tissue histamine concentration.

1 This investigation was carried out as a part of a project supported by a research grant from Medical Research Centre, Bombay Hospital Trust, Bombay, India.
2 A.K. Ganguly, Experientia *25,* 1224 (1969).
3 A.K. Ganguly, S.K. Lal, S.D. Nishith and S.K. Sreepathi Rao, Indian J. med. Res. *57,* 295 (1969).
4 A.K. Ganguly and S.K. Lal, Indian J. Physiol. Pharmac. *14,* 121 (1970).
5 J.W. French, R.L. Longmire, R.W. Porter and H.J. Movius, Surgery *34,* 621 (1953).
6 R.W. Porter, H.J. Movius and J.D. French, Surgery *33,* 875 (1953).
7 H. Shay, D.C.M. Sun, B. Dlin and E. Weiss, J. appl. Physiol. *12,* 461 (1958).
8 A.K. Ganguly and O.P. Bhatnagar, Can. J. Physiol. Pharmac. *51,* 748 (1973).
9 A.K. Ganguly and S.K. Lal, Experientia *32,* 74 (1976).
10 A.K. Ganguly, S.S. Sathiamoorthy and O.P. Bhatnagar, abstr. Ass. Physiol. Pharmac. India *101,* 72 (1975).
11 A.K. Ganguly, S.S. Sathiamoorthy and O.P. Bhatnagar, Q. J. exp. Physiol. *63,* 89 (1978).
12 A.K. Ganguly and P. Gopinath, Experientia *35,* 54 (1979).
13 A.K. Ganguly and P. Gopinath, Q. J. exp. Physiol. *64,* 1 (1979).
14 S.S. Sathiamoorthy, A.K. Ganguly and O.P. Bhatnagar, Experientia *32,* 1300 (1976).
15 S.S. Sathiamoorthy, A.K. Ganguly and O.P. Bhatnagar, Experientia *35,* 508 (1979).
16 W. Feldberg and J. Talensik, J. Physiol. *120,* 550 (1953).
17 D.P. High, D.M. Shepherd and B.G. Woodcock, Life Sci. *4,* 787 (1965).
18 J.F. Riley and G.B. West, J. Physiol. *120,* 528 (1953).
19 A.K. Ganguly, K. Somasundaram, V.K. Chawla and R.H. Majithia, Indian J. Physiol. Pharmac. *23,* 406 (1979).

Taurine concentrations in the aqueous humor and plasma of anesthetized rabbits[1,2]

J.M. Rowland, D.E. Potter and J.B. Lombardini

Department of Pharmacology and Therapeutics, Texas Tech University Health Sciences Centers, Lubbock (Texas 79430, USA), 6 November 1979

Summary. Aqueous humor taurine concentrations were found to be significantly higher ($p < 0.01$) than that of the plasma in anesthetized rabbits. Topical application of 2 mg terbutaline lowered intraocular pressure ($p < 0.001$), but did not alter aqueous taurine content.

Taurine has become the subject of increasing interest in the visual sciences since its recognition as one of the amino acids classified as putative inhibitory neurotransmitters[3-5], and has been found in high concentrations in the lens and retina[3,4,6]. In rabbits the concentration of most amino acids is higher in the aqueous humor than in the plasma[7] however, the respective concentrations of taurine apparently have never been reported. Moreover, it has been reported that catecholamines can limit production and release of certain amino acids from striated muscle[8], apparently owing to stimulation of β-adrenergic receptors and adenylyl cyclase. It has further been shown that β_2 agonists are potent ocular hypotensive agents[9] and can increase cAMP content of aqueous humor[10]. Thus, it appears reasonable to determine whether a correlation exists between a β_2-mediated decrease in intraocular pressure (IOP) and changes in aqueous taurine levels. The purposes of this study were to determine the relative concentrations of taurine in the plasma and aqueous humor of anesthetized rabbits, and to describe the concomitant effects of β_2-selective terbutaline on IOP and aqueous taurine concentrations.

Materials and methods. IOP was measured in mm Hg with an Alcon applanation pneumatonograph and taurine was measured in nM/ml with a Beckman amino acid analyzer in 3-4 kg male albino New Zealand rabbits anesthetized with pentobarbital. About 300 µl aqueous humor was aspirated with a 25 gauge needle inserted through the cornea on a plane parallel with that of the iris. 3 ml blood obtained by cardiac puncture was immediately mixed with 300 µl EDTA solution (12 mg/ml), then centrifuged for 10 min at $1000 \times g$ to obtain plasma. Plasma and aqueous

Table 1. Taurine levels (nM/ml) in plasma and aqueous humor of 8 anesthetized rabbits

Plasma	57.7 ± 5.2 (8)
Aqueous	75.2 ± 3.3* (16)

Mean ± SE (n), * $p < 0.01$.

Table 2. Aqueous taurine levels (nM/ml) and IOP (mm Hg) 1 h after administration of 2 mg topical terbutaline or vehicle

	Taurine	IOP
Vehicle (bilateral)	93.1 ± 3.5 (4)	21.4 ± 0.7 (10)
Terbutaline treated eye	86.2 ± 8.9 (4)	16.6 ± 0.8* (7)
Terbutaline fellow eye	91.6 ± 8.5 (4)	23.0 ± 0.8 (7)

* $p < 0.001$.

samples were deproteinized with 5% perchloric acid and centrifuged for 10 min at 1000 × g. A total of 2 mg (base) terbutaline sulfate (Astra) dissolved in distilled water was applied topically in 2 50-µl doses given unilaterally 2 min apart. IOP was measured and aqueous humor withdrawn 1 h later. Student t-tests discriminated levels of probability.

Results. Aqueous humor taurine levels were found to be significantly higher than plasma taurine levels in anesthetized rabbits ($p < 0.01$) (table 1). 2 mg (base) terbutaline significantly reduced IOP ($p < 0.001$) 1 h after topical instillation in treated eyes, but not fellow eyes (table 2). Terbutaline failed, however to alter aqueous humor taurine levels in treated or fellow eyes ($p > 0.05$) (table 2).

Discussion. Our results indicate that, like most of the other amino acids[7], taurine exists in significantly higher concentrations in the aqueous humor than in the plasma of anesthetized rabbits. In general, amino acid levels have been found to be lower in the aqueous humor than in plasma of non-human primates, cats and rats[6]. Amino acid ratios of dogs slightly favor the aqueous humor[11]. Eyes of sheep[12], bovines[13], rabbits[7] and diseased eyes of humans[14–17] all show generally greater amino acid concentrations in the aqueous humor. However, of the species studied, rabbits alone have significantly higher aqueous than plasma taurine levels, which may imply the involvement of an active transport mechanism. In this study no correlation between an adrenergically mediated decrease in IOP and aqueous taurine content was found. In another study[18] however, while topical taurine had no effect on normal IOP in rabbits, subconjunctival injections of taurine apparently reduced the hypertensive effect of a subsequent injection of prostaglandins (PGE_2 and $PGF_{2\alpha}$).

1 Supported by National Eye Institute grants Nos EY05430 (JMR) and EY02156 (DEP).
2 Acknowledgments. We thank Dr J. Gintautas, this institution, for translating reference 18 and Dr S.Y. Schmidt, Massachusetts Eye and Ear Infirmary, for valuable advice.
3 H. Pasantes-Morales, J. Klethi, M. Ledig and P. Mandel, Brain Res. *41*, 494 (1972).
4 M.S. Starr and M.J. Voaden, Vision Res. *12*, 1261 (1972).
5 L.K. Kaczmarek and A.N. Davison, J. Neurochem. *19*, 2355 (1972).
6 D.V.N. Reddy, Invest. Ophthal. *6*, 478 (1967).
7 D.V.N. Reddy, C. Rosenberg and V.E. Kinsey, Expl. Eye Res. *1*, 175 (1961).
8 A.J. Garber, I.E. Karl and D.M. Kipnis, J. biol. Chem. *251*, 851 (1976).
9 D.E. Potter and J.M. Rowland, Expl. Eye Res. *27*, 615 (1978).
10 J.M. Rowland and D.E. Potter, Albrecht v. Graefes Arch. Ophthal. *212*, 65 (1979).
11 L.Z. Bito, H. Davson, E. Levin, M. Murray and N. Snider, Expl Eye Res. *4*, 374 (1965).
12 V.N. Reddy, M.R. Thompson and B. Chakrapani, Expl Eye Res. *25*, 555 (1977).
13 G. Kirsten and V. Dardene, Ber. Dt. Ophthal. Ges. *15*, 474 (1961).
14 G.W. Barber, Invest. Ophthal. *7*, 564 (1968).
15 J.C. Dickinson, G.D. Durham and P.B. Hamilton, Invest. Ophthal. *7*, 551 (1968).
16 F. Schonheyder, N. Ehlers and B. Hust, Acta Ophthal. *53*, 627 (1975).
17 F. Schonheyder, N. Ehlers and B. Hust, Ophthal Res. *8*, 64 (1976).
18 A.Y. Bunin, E.I. Yarstev, Y.A. Kolesnikov, V.N. Ermakova, A.A. Yakovlev, T.A. Bernikova and N.A. Komlev, Vest. Oftal. *1*, 22 (1978).

Activity of bulbar respiratory modulated neurons and restart of respiration after hypocapnic apnea in rabbits

M. Fallert and G. Böhmer

Department of Physiology, University of Mainz, Saarstrasse 21, D-6500 Mainz (Federal Republic of Germany), 19 November 1979

Summary. The activity of respiratory modulated neurons at the end of the apneic pause and during restart of respiration and the diaphragmatic mass activity were examined and both were compared to quiet respiration. Thresholds of mutual inhibition of neurons are unevenly distributed within various phase types of neurons.

In states of hypocapnic apnea following artificial hyperventilation, part of the respiratory modulated neurons (RMN) become silent while others discharge tonically at a low rate. Both types of responses have been found in phase-bound inspiratory (I neurons) and expiratory units (E neurons), as well as in phase-spanning inspiratory-expiratory (IE neurons) and expiratory-inspiratory cells (EI neurons)[1–3]. As apnea regresses, the spike density (spd) of the tonically discharging RMN and the tonic diaphragmatic activity steadily increase.

The first phasic movement terminating apnea is expiratory[4]. In rabbits it was found that respiratory movements started again when Pa_{CO2} averaged 28.3 mm Hg (30.3 during normal respiration) and pH_{art} 7.34 (control value 7.31).

The present study describes the discharge of RMN at the time when respiration restarts. In rabbits anesthetized with 1.1–1.3 g urethane/kg b.wt, the medulla oblongata was sounded stereotaxically from 2 mm rostrally to 4 mm caudally of the promontorium gliosum and 3 mm laterally from the midline. Extracellular recordings were made from RMN located near the solitary tract and in the neighbourhood of the nucleus ambiguus with 'floating' 25-µm platinum wire electrodes (for location of RMN, see Fallert and Wassermeyer[5]). The tracheal pressure, the excursions of a bellows-type spirometer and the electrogram of the diaphragm were recorded. The strength of diaphragmatic mass activity (dma) was estimated from light extinction of the original recording measured within a time 'window' of 250 msec duration with a lux-meter (Gossen). Both cervical vagal nerves were intact. Following artificial hyperventilation with a positive-negative-pressure respirator during 5 min, apnea of 10–20 sec duration occurred. After release from inflation, in rabbits vagally mediated tonic inspiratory activity occurs, the duration of which, however, hardly exceeds 3 sec[4]. The apnea examined in the present study may thus well be attributed to hypocapnia. Bursting activity of 5 EI, 16 I, 6 IE and 6 E neurons during normal respiration is shown on the left side of figure 1, A and B. Units which fired during one respiratory half cycle and during less than 15% of the other half cycle were denoted as I or E neurons; the remainder cells were labelled as IE or EI units. α- and β-classification was based on unit response to lung distension and collapse. Decrease of burst duration