

even higher potential values may exist. The spike amplitude, measured from the upper peak value to the peak value of the post-hyperpolarization, reached values of up to 75 mV. As demonstrated in the example given in Figure 2, the spike potentials show a similar variability in size and shape as do those in other smooth muscle preparations^{3,4}, and the half duration (duration of the spike at half height) of the largest and sharpest spikes lies at 8–12 msec, similar to taenia coli⁶.

The lower part of Figure 1 gives an example of another pattern where the activity is modulated by a slower 'minute-rhythm' (MR). This MR was regularly present in the isolated bile duct, either from the beginning of the experiment or, as in the example of Figure 1, developing during the first 1 or 2 h. The MR is combined with fluctuations in the basic membrane potential which lead to an inhibition of spike discharges in the phase of high polarization and stimulate spike discharges in the phase of depolarization. During the highest activity in the MR cycle, the spike frequency is increased over the preferred frequency of the SR – this again is similar to taenia coli. The period duration of 0.5 min of the MR in the bile duct is more similar to that of the portal vein than to that of taenia coli, where, under normal conditions, it is 1–3 min. But shorter period durations also occur in taenia during phases of depressed activity⁷.

Following the classification of smooth muscle rhythms recently described³, the smooth muscle of the bile duct is characterized by a spontaneous activity determined by the SR and the MR, both of which are the more general rhythms of the intestinal smooth muscle system. A pronounced 'basic organ specific rhythm' (BOR) is not usually found in the bile duct. Fluctuations with a frequency of 20–25/min, which were occasionally seen, have to be interpreted as an irradiation of the segmenta-

tion rhythm (BOR) of the duodenum to the bile duct. This assumption is supported by the fact that these fluctuations are particularly observed when the preparation of the common bile duct is extended in the distal direction into the biliary duodenal junction.

Finally, Figure 3 gives an example of augmented activity of the bile duct produced by application of cholecystokinin. A depolarization with accelerated spike discharges leads to an increase of tension under these conditions. The effect of acetylcholine is very similar.

Zusammenfassung. Im Rahmen vergleichender Untersuchungen an verschiedenen Typen spontan aktiver glatter Muskulatur wurde beim isolierten Ductus choledochus des Meerschweinchens durch intrazelluläre Messungen des Membranpotentials regelmässig eine mittelstarke Spontanaktivität, bestehend aus sekundenrhythmischen Oszillationen mit Spikes, moduliert durch langsamere Fluktuationen im Minuten-Rhythmus, gefunden.

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Relationship between Passive Permeability to Nonelectrolytes and Active Transport Activity in the Isolated Intestinal Wall¹

It is well known that sodium concentration in the bathing mucosal fluid strongly affects glucose and amino acid transport through the isolated intestinal barrier^{2–5}. This may be explained by supposing an influence of sodium on the entry of sugars⁶ and of amino acids into the epithelial cells^{6–7}. Actually there is a decrease in the unidirectional influx of L-alanine into the intestinal cells in the absence of sodium in the perfusing fluid⁸. According to CRANE⁹, the transported substance interacts with a binding site on a carrier and this interaction is enhanced by the binding of sodium with a second site present on the same carrier.

In a recent paper¹⁰, our aim was to investigate whether, besides the above-mentioned hypothetical specific mechanism of sodium effect, another unspecific effect occurred on the resistance of the intestinal barrier to the passage of non-actively transported molecules. From the results collected in that paper, there was some evidence that 'by lowering sodium concentration, the passive flux of acetamide or thiourea is decreased. To avoid criticism of our indirect method of evaluation of the test substance concentration in the intestinal sac, another set of experiments was performed using a continuous circulation of the perfusion fluid through an open and everted intestinal tract. Such a perfusion method provides a direct control of the inside and the outside concentrations of the substance tested throughout the period of the experiment¹¹.

Previous conclusions have been confirmed. The thermal diffusion of small molecules such as acetamide and thiourea across the intestinal barrier is reduced together with the active transport of D-glucose, when NaCl of the incubating medium is replaced by equimolar quantities of Tris Cl, Choline Cl or LiCl. Some evidence was also provided that the decrease in the passage of small molecules may be partially due to an increase in the resistance offered by the brush border. Furthermore,

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Intracellular water content of the jejunum epithelial cells, mobility of acetamide (ω) and glucose transport activities across the intestinal wall (Sprague-Dawley Albino male rats)

Incubation fluid	Intracellular water content ml g ⁻¹	ω $\mu\text{moles g}^{-1} \text{ h}^{-1}$ Atm ⁻¹	Glucose trans-epithelial transport $\mu\text{moles g}^{-1} \text{ h}^{-1}$	Fluid trans-epithelial transport ml g ⁻¹ h ⁻¹
Basic perfusion fluid	5.56 \pm 0.15 (9)	721 \pm 55 (14)	280 \pm 51 (14)	6.64 \pm 1.16 (14)
Phlorhizin added 10 ⁻⁴ M	4.50 \pm 0.17 (8)	634 \pm 57 (5)	-14 \pm 12 (5)	4.22 \pm 0.75 (5)
Tris Cl substituted isosmotically for NaCl	4.60 \pm 0.14 (12)	354 \pm 34 (9)	75 \pm 17 (9)	2.51 \pm 0.48 (9)

Mean values \pm S.E. referred to 1 g of dry tissue and 1 h are reported. The numbers of experiments are in parentheses.

Tris Cl substitution for NaCl in the bathing fluid was paralleled by a significant shrinkage of the epithelial cells.

This observation suggests the hypothesis that cellular swelling under normal perfusing conditions may result in a mechanical increase of the cellular surface and, therefore, of passive flow across the cell membranes. No glucose accumulation and swelling are detectable by perfusing at a lower sodium concentration, and the permeability of the epithelium decreases.

In order to check this hypothesis, experiments after phlorhizin poisoning have been performed.

All the experiments were carried out between November and April. Sprague-Dawley Albino male rats, initially weighing about 250 g, semistarved over a 15-day-period (final percent weight decrease 15–25%) were used^{12,13}.

A tract of small intestine 15 cm long was removed from the animal at about 10 cm from the pylorus, under barbituric narcosis. Each tract was everted according to the WILSON and WISEMAN technique¹⁴, and perfused at 28°C as in previous experiments¹¹. The basic perfusion fluid was Krebs-Henseleit bicarbonate solution added with acetamide 10 mM and glucose 13.89 mM.

At the end of the experiment, the emptied intestine was dried at 100°C overnight. The transepithelial mobility coefficients calculated by disregarding the drag effect¹¹ and the net glucose transport per g dry weight (from mucosa to serosa) were at first calculated for all the 10 or 20 min periods and then the mean values between all the single data belonging to 1 experiment (1 h) were obtained. Only these mean values constitute the pool of data for statistical treatment in the Table.

In another set of experiments we tried to determine the water content of the mucosal epithelial cells. In this case polyethylenglycol ¹⁴C (PEG) was added to the basic solution at the beginning of the experiment both to the serosal and mucosal fluids. The subsequent procedure was the same as in a previous paper¹¹.

These two kinds of experiments were repeated by replacing NaCl in the basic incubation fluid with Tris Cl in an isosmotic quantity, or by adding to the basic incubation fluid phlorhizin 10⁻⁴ M.

The results obtained are reported in the Table. The permeability of the phlorhizin-poisoned epithelium, where glucose transport is absent and cellular swelling is reduced to the same degree as in the intestines perfused with a Tris substituted perfusing fluid, is as high as in the cases of glucose transporting intestines.

Therefore the conclusion can be drawn that presumably the degree of swelling of the epithelial cell is not critical for the passive permeability to acetamide of the intestinal barrier. If we take into consideration the influence of the solvent drag, the above conclusion does not change. The substitution of sodium ion with Tris ion could directly affect the physico-chemical properties of cell membrane due, for instance, to the varied Na:Ca ratio of the perfusion medium.

Riassunto. La permeabilità all'acetamide dell'epitelio intestinale di digiuno di ratto non sembra influenzata dal grado di rigonfiamento delle cellule epiteliali.

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The Visual Response of the Purple Shore Crab, *Hemigrapsus nudus*, to Ionizing and Non-Ionizing Radiations¹

Physiological and behavioral responses to ionizing radiations, attributable to radiation effects on the visual system, have been known for over 70 years²⁻⁴. The nature of this action, however, is not completely understood, partly because of the difficulty in specifying the mechanisms through which high-energy quanta might act to stimulate the visual receptor system^{5,6}. A comparative study of the response to visible and near-visible light in the compound eye, followed by stimulation under the same conditions with X-rays and β -radiation, has made possible some inferences concerning the reception of ionizing radiations.

Methods. The isolated compound eye of the crab was used for this study. Electroretinographic (ERG) responses were detected by platinum microelectrodes and recorded on a Grass model 7 oscillograph after appropriate pre-amplification.

Visual stimuli from 250 to 700 nm were supplied by high intensity lamps in conjunction with a Bausch and Lomb diffraction grating monochromator. Light exposures were controlled by a leaf-type camera shutter and monitored by a photocell. X-ray exposures from a diagnostic unit (70 kVp, 0.54 mm Al HVL) were controlled with a solenoid-actuated, lead focal-plane shutter and monitored