1962 #26

MOVEMENT OF INULIN AND BICARBONATE ION ACROSS THE BLADDER OF AN AGLOMERULAR TELEOST, Lophius americanus

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Studies of renal function in aglomerular fish have contributed greatly to current concepts of modern renal physiology. Such studies have assumed that substances in the urine result solely from the activity of the kidney.

It is well known that the urinary bladder in a number of species is capable of modifying urinary composition. Recent studies reporting the excretion of carbohydrate substances like inulin and some pentoses by the aglomerular kidney have been disturbing.

In a study of the renal response to HCO_3^- infusion it was noted that both HCO_3^- and inulin appeared in bladder urine following intravascular infusion. In order to determine whether the urinary bladder was permeable to inulin and HCO_3^-, solutions of inulin and HCO_3^- were instilled into the bladder. Under these conditions inulin and increased HCO_3^- concentrations were found in plasma. This suggested that the inulin and HCO_3^- found in the urine may have resulted from direct penetration of the bladder without renal mediation.

To test this hypothesis, one ureter was cannulated to obtain renal urine and both ureters were ligated above the bladder. Previously collected goosefish urine was installed into the bladder. Inulin and HCO_3^- were given intravascularly. Under these conditions, inulin and bicarbonate appeared in the urine in the bladder, whereas the composition of renal urine was unchanged.

These data establish that the urinary bladder of Lophius is capable of profoundly altering the composition of urine and suggest that previous studies based on the assumption that the composition of the urine results solely from the function of the kidney require reevaluation.

This work was supported in part by a grant from the National Science Foundation and in part by a grant from the United States Public Health Service (HE-05059-04).

1962 #27

FACULTATIVE AEROBIOSIS IN A VERTEBRATE: ANAEROBIC METABOLISM IN THE FRESHWATER TURTLE, Pseudemys scripta elegans

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Molecular O_2 is generally considered essential for life in all animal species and the ability to survive without O_2 is limited to very brief periods of time.

It is well known that the freshwater turtle is able to remain submerged for days. It has been suggested that survival during diving is mediated through O_2 extraction from water by means of pharyngeal mucosa or by the lateral bladders.

Experiments have been performed which demonstrate that no significant O_2 extraction from water occurs during diving and that survival is possible because the turtle obtains energy from anaerobic sources.

Measurements of blood PO_2, PCO_2, pH, HCO_3^- concentrations and lactic and pyruvic acid concentrations were performed during diving; during the inhalation of 100% nitrogen and following the administration of massive doses of NaCN.

PO_2 falls during diving and N_2 administration, and rises following CN^- administration reflecting the fall in O_2 supply in the former cases and the decrease in intracellular O_2 utilization with CN^-. CO_2 tensions fall during N_2 and CN^- administration and increase during diving reflecting the net balance between CO_2 excretion by the lung and CO_2 generated by buffering during anaerobiosis. H^+ increases during diving and tends to fall during N_2 and CN^- administration reflecting the net balance between H^+ generated during anaerobiosis and H^+ equivalents lost by hyperventilation. Plasma HCO_3^- falls because of anaerobically generated H^+. Plasma lactic acid concentrations increase during all three procedures.

These studies establish that prolonged survival during complete anaerobiosis is based on the ability of the turtle to obtain sufficient energy for periods up to 5 days from glycolyses.

This work was supported by a grant from the United States Public Health Service (HE-05059 -04).

1962 #28

THE VENTILATORY RESPONSE TO CO_2 IN A DIVING MAMMAL, THE HARBOR SEAL, Phoca vitulina

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It has been suggested that one of the adaptive mechanisms which permits prolonged diving in the seal is a reduction in the sensitivity of respiratory centers to CO_2. However, data supporting this possibility are limited because of the technical problems associated with gas measurements. These data were extrapolated to suggest that the respiratory centers of the seal are unresponsive to concentrations of CO_2 in inspired air less than 10%.

The availability of a rapid acting infrared CO_2 analyzer has permitted an accurate quantitative estimation of the ventilatory response to CO_2 in the seal. The ventilatory response to the following mixtures of CO_2 in air (4%, 6%, 10%) was determined in 6 trained seals. For comparison similar data were obtained in 5 untrained humans (H. sapiens). CO_2 stimulus-response curves were constructed and the slopes of these curves $\frac{\Delta VE}{\Delta P_A CO_2}$ and the intercepts of these curves were compared in the 2 species.

The mean slope in the seals was 0.32 L/min/mm Hg as compared with 1.52 L/min/mm Hg in the humans. The threshold was higher in the seal.

These data are consistent with a lower respiratory center sensitivity to CO_2 in the seal as compared with the human and presumably explain the higher resting alveolar CO_2 tension found in this animal. These data establish that the seal does respond to increases in body fluid CO_2 tension, albeit sluggishly, but supports the hypothesis of diminished chemosensitivity as an adaptive mechanism during problonged diving.

This work was supported by a grant from the United States Public Health Service.