

## SIMILARITY IN THE EFFECTS OF POTASSIUM CYANIDE AND OF ETHER

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(WITH ONE FIGURE)

The writer has pointed out that typical anesthetics, such as ether, chloroform, and alcohol, produce a temporary decrease in permeability.<sup>1</sup> In view of the fact that anesthesia is looked upon by some as a form of asphyxiation, it seems desirable to investigate the manner in which permeability is affected by KCN, which not only acts as an anesthetic, but also inhibits oxidation to a remarkable degree.

The experiments here described were made in 1912, in connection with a series of experiments on anesthetics, of which a brief announcement has already appeared. Since then a paper by KREHAN<sup>2</sup> has been published which states that KCN produces a transitory increase of permeability which soon disappears. The writer is unable to confirm this statement, as will appear from the following account.

The experiments were made on tissues of *Laminaria Agardhii*. The permeability was measured by determining the electrical resistance in the manner described in previous publications.<sup>3</sup> The KCN employed was Kahlbaum's best, and the distilled water was prepared with especial care. A solution of KCN of the same conductivity as the sea water (about 0.381M) was prepared. This was added to the sea water and its effect on the tissues was observed. The following experiment will serve to illustrate the procedure.

A lot of tissue which had in sea water a resistance of 1140 ohms was placed in sea water to which had been added a solution of KCN 0.381M in sufficient quantity to make the concentration

<sup>1</sup> OSTERHOUT, W. J. V., The effect of anesthetics upon permeability. Science N.S. 37: 111-112. 1913.

<sup>2</sup> Internat. Zeit. f. Phys. Chem. Biol. 1: 189. 1914.

<sup>3</sup> OSTERHOUT, W. J. V., The permeability of protoplasm to ions and the theory of antagonism. Science N.S. 35: 112-115. 1912.



0.01M.<sup>4</sup> The resistance rose rapidly to 1170 ohms, where it remained for 10 minutes, after which it began to fall. The results are given in table I and fig. 1.

TABLE I  
ELECTRICAL RESISTANCE OF *Laminaria saccharina*

Time in minutes	In KCN 0.01M in sea water	In sea water
0.....	1140	1080
10.....	1160	0
20.....	1160	0
30.....	1150	1070
110.....	1010	0
200.....	910	0
300.....	810	0
400.....	710	1070

All readings were taken at 14° C. or corrected to this temperature.

The resistance of the apparatus was 250 ohms; hence the resistance of the tissue (the net resistance) at the start was 1140—

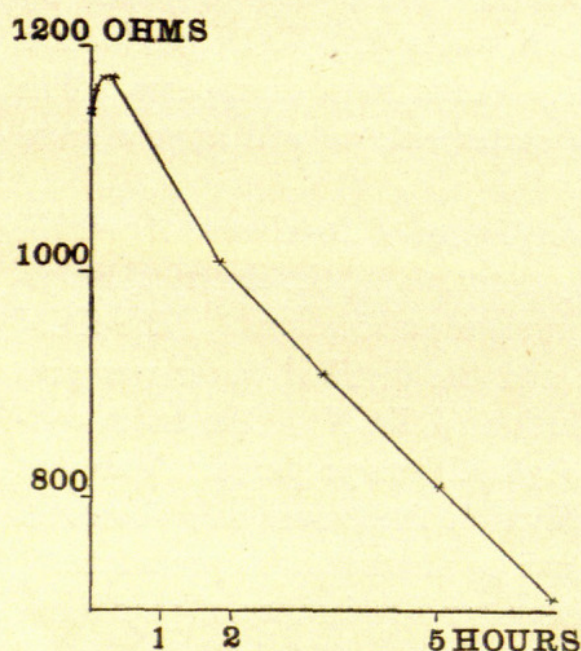


FIG. 1

250=890 ohms. We may put the permeability as equal to the conductivity, or, for convenience, as equal to the conductance; hence the permeability was  $1 \div 890 = 0.001124$ . The maximum net resistance was 1170—250=920 ohms, and the permeability was  $1 \div 920 = 0.001087$ . Hence the loss of permeability was  $(0.001124 - 0.001087) \div 0.001124 = 3.3$  per cent.

Similar experiments were made with other concentrations from 0.002M up to 0.381M (solution of KCN without sea water). The results were irregular, and it is not possible to say

<sup>4</sup>This mixture had the conductivity of sea water. The sea water after the addition of the KCN was slightly alkaline to litmus. The hydrogen ion concentration of 0.01M KCN in sea water was  $1.4 \times 10^{-10}$  as determined by the gas chain. The alkalinity tends to make the rise of resistance less pronounced.



without numerous additional experiments at exactly what concentration the maximum decrease of permeability occurs. It seems doubtful whether it amounts to much more than 3 or 4 per cent at any concentration.

In KCN  $0.381M^5$  (without sea water) there was in some cases a rise in resistance, followed by a rapid fall, and in other cases the resistance did not rise, but fell from the start. It is probable, however, that in these cases there was a transitory rise which disappeared before the end of the first minute, at which time the first measurement was taken.

The experiments demonstrate that there is a temporary decrease of permeability instead of a temporary increase as described by KREHAN. At no concentration was a temporary increase of permeability observed. Whenever the permeability began to increase, it continued to increase steadily until the tissue was dead. The concentrations employed ranged from  $0.002M$  to  $0.381M$ . It may be added that the method of plasmolysis, which was employed by KREHAN, cannot be relied upon to give as accurate measurements of permeability as the determination of electrical resistance.

If tissue be allowed to remain in KCN until the resistance has fallen about 100 ohms, it will often completely regain its original resistance on being transferred to sea water. But if the resistance be allowed to fall much beyond this, recovery is usually incomplete and the greater the fall of resistance (beyond the point where complete recovery is possible) the less the recovery.

The concentrations of KCN necessary to produce a decrease of permeability are very much smaller than the corresponding concentrations of ether, chloroform, and alcohol. This accords with the fact that it also takes less KCN to produce narcosis. The period of decreased permeability cannot be prolonged as much by means of KCN as by means of the other anesthetics mentioned. This agrees with the fact that organisms can be kept longer under

<sup>5</sup> The hydrogen ion concentration was  $7 \times 10^{-13}$  as measured by the gas chain. This is sufficiently alkaline to cause a considerable fall in resistance (cf. Jour. Biol. Chem. 19: 335. 1914). The concentration of KCN was determined by weighing out the requisite amount, but owing to the presence of alkali it was really less than  $0.381M$ .



narcosis without injury by means of ether, chloroform, and alcohol than by means of KCN.

The fact that KCN resembles typical anesthetics (such as ether and chloroform) in producing a temporary decrease in permeability does not, in the opinion of the writer, show that anesthesia is a form of asphyxiation. It seems quite probable that the decrease of permeability and the anesthesia produced by KCN have connection with its effect on oxidation.

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