The table shows that the colloid osmotic pressures of the body fluids of freshwater animals arrange themselves, as well as those of the marine animals, in the order of phylogenetic development. The parallelism between the two series of figures is striking. There is, however, a marked difference between the marine animals and those living in fresh-water: the values for the freshwater animals are 20–35 per cent lower than those given by the body fluids of the marine animals. This difference does not conflict with the hypothesis of a relation between the general organization of an animal and the colloid osmotic pressure of its body fluids, but even strengthens it. The freshwater fauna being considered as a regressive branch of the aquatic fauna in general, this regression expresses itself by a diminution of the colloid osmotic pressure of the body fluids of these animals.

There is one exception from this rule: the eel's serum exerts a colloid osmotic pressure varying from 19·9 to 27·2 cm. H_2O. This exception, however, does not in the least weaken the hypothesis; though passing a great part of its life in fresh-water, the eel must essentially be considered as a marine fish. The colloid osmotic pressure of its serum has indeed the same value as that of one of the most active marine Teleosteans, that is, *Labrax lupus*.

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[1] P. Meyer, NATURE, **136**, 757 (1935); *Compt. rend. Soc. Biol.*, **120**, 303, 305 (1935); *J. Physiol.*, **34**, 5 (1936).
[2] P. Meyer, NATURE, **137**, 401 (1936); *Compt. rend. Soc. Biol.*, **120**, 1004, 1005 (1935); *J. Physiol.*, **34**, 448 (1936).
[3] A. Keys and R. M. Hill (*J. Exper. Biol.*, **11**, 28; 1934) had already measured the colloid osmotic pressure of the serum of three freshwater teleosteans (*Tinca vulgaris*, *Esox lussius* and *Anguilla vulgaris*). The figures reported by these authors agree with the values recorded in this note.

Metabolism of Cartilage

IN reply to the letter of Dickens and Weil-Malherbe[1], a previous communication[2] on this subject was based, except where rabbit cartilage was specified, on more than one hundred experiments with cartilage from the carpo-metacarpal joints of the adult horse, to whose metabolism that of human cartilage is very similar.

As regards the rabbit, hyaline cartilage from the femur has an anærobic glycolysis of 1·0 for the first few hours, falling to an average of 0·6 over the 24 hours: the figures cited previously refer to meniscus (fibrocartilage) over a period of 24 hours in an experiment lasting fourteen days. A comparable figure is that for the first hour, 0·6.

Respiration measurements have not yet been made on rabbit material, but it is perhaps of interest:

(1) That the well vascularized epiphyseal cartilage of the fœtal rabbit has an anærobic glycolysis ten times as high as the adult, or, per cell, twice as high.

(2) That a human enchondroma showed a glycolysis thirty times that of normal cartilage and an oxygen uptake of 0·34.

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[1] Dickens and Weil-Malherbe, NATURE, **138**, 125 (1936).
[2] Bywaters, NATURE, **138**, 30 (1936).

Intermediate Metabolism of Carbohydrates

WE have found some new chemical reactions in living cells which represent steps in the breakdown of carbohydrates. Pyruvic acid, if added to animal tissues, disappears rapidly not only in the presence, but also in the absence of oxygen. In the presence of oxygen the end-products of the pyruvic acid metabolism are known to be carbon dioxide and water. We find that the primary steps of the oxidation proceed in the absence of molecular oxygen, and as products of the anærobic oxidation the following substances were identified: (1) acetic acid, (2) carbon dioxide, (3) succinic acid.

The reductive equivalent for the oxidation of pyruvic acid is the conversion of another fraction of pyruvic acid into lactic acid or the homologous reduction of another ketonic acid. The quantitative data suggest that pyruvic acid is metabolized by the following intermolecular oxido-reductions: The first step is a dismutation of pyruvic acid according to the reaction:

(1) 2 pyruvic acid + water → acetic acid + carbon dioxide + lactic acid.

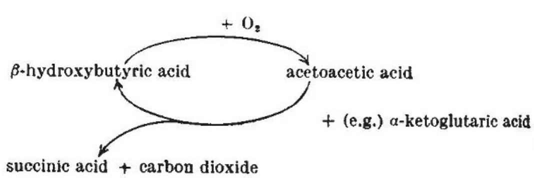
The evidence for the occurrence of this reaction in the tissues which metabolize carbohydrates is conclusive. The subsequent reactions which lead to the formation of succinic acid may be tentatively formulated in the following way:

(2) acetic acid + pyruvic acid + 'ketonic acid' → α-ketoglutaric acid + 'hydroxy acid'.

(3) α-ketoglutaric acid + 'ketonic acid' + water → succinic acid + carbon dioxide + 'hydroxy acid'.

According to (2) α-ketoglutaric acid is formed by the oxidative condensation of pyruvic and acetic acids, a ketonic acid acting as hydrogen acceptor. According to (3), α-ketoglutaric acid is oxidatively decarboxylated by dismutation. Reaction (3) is analogous to (1).

The experiments suggest that different 'ketonic acids', such as pyruvic acid, acetoacetic acid, oxalacetic acid[1], or their homologues may be concerned in reactions (2) and (3), and may possibly take the place of pyruvic acid in (1). It seems that acetoacetic acid reacts preferentially in (3), and it is therefore of great interest that we find in tissues which metabolize carbohydrates a specific system which catalyzes the oxidation of β-hydroxybutyric to acetoacetic acid by molecular oxygen[2]; β-hydroxybutyric acid may thus act as a carrier for molecular oxygen according to the scheme (4).

(4)


As is indicated in (4), α-ketoglutaric acid is not directly oxidized by molecular oxygen, but through the intermediation of another ketonic acid. It has long been known that there are links between carbohydrate breakdown and 'ketone bodies', and it is now possible to describe this link, or at least one of the links, in chemical terms.

The oxidative formation of succinic acid from pyruvic acid has been discussed by previous workers.