

The Degradation of Pyrimidines for Tracer Work. Bicarbonate as a Precursor for Ribonucleic Acid Pyrimidines

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The degradation of uric acid for tracer work by Buchanan *et al.*¹ revealed many interesting facts concerning the synthesis of this substance in the organism. It was thus thought that a similar degradation of pyrimidines would be of great interest. A method for the isolation of nitrogen 1 and 3 from pyrimidineribosides as methylamine and ammonia respectively has already been elaborated by the author². The present paper deals with the isolation from pyrimidines of carbon atom 2 as urea, and carbon atoms 5 and 6 as oxalic acid, and with experiments using radioactive bicarbonate as a precursor for pyrimidines in the rat. The radioactivity of carbon atom 4 was obtained by difference.

The degradation method has been worked out for uracil using an amount of about 20 mg. It may also of course be applied to cytosine as this substance can easily be converted into uracil by deamination.

materials, has been proven by isolation by paper chromatography. When run side by side with a synthetic preparation², it gives identical R_F values in phenol, *m*-cresol, butanol-acetic acid, collidine, and pyridine-amylalcohol. Spots, which do not appear after hydrolysis and thus indicate peptides, have been found in malt, unboiled and boiled wort, but not in beer. In yeast no less than 9 such peptides have been found. During the first fermentation, asparagine, aspartic acid and threonine

Uracil was converted into 5-nitro-uracil according to Johnson³ and this substance was degraded with KMnO_4 in neutral solution as described by Offe⁴. After hydrolysing with alkali the oxalic acid formed was precipitated as calcium oxalate, dissolved in dilute sulfuric acid and treated with KMnO_4 to liberate CO_2 which was precipitated as BaCO_3 .

The urea formed during the degradation was extracted with boiling absolute alcohol and treated with urease to liberate CO_2 .

Offe⁴ has shown in his work on the degradation of 4-methyluracil and its derivatives with KMnO_4 in neutral solution that the oxalic acid formed is derived from carbon 5 and 6. After degradation of 4-methyluracil in the cold he was able to isolate acetylurea and oxalic acid in good yields.

The experiments made by Offe make it reasonable to suppose that the oxalic acid formed during degradation of 5-nitrouracil with KMnO_4 in neutral solution, is entirely derived from carbon atoms 5 and 6.

Experiments with C^{14} -bicarbonate. C^{14} -bicarbonate was administered subcutaneously to partially hepatectomized rats at 30 minutes intervals. Each rat received 12 doses and the animals were sacrificed 30 minutes after the last dose. Samples of the respiratory CO_2 were analyzed for

disappeared, and a distinct decrease was observed in all basic amino acids and serine. After the second fermentation, the basic amino acids had completely disappeared together with serine, leucine, isoleucine, phenylalanine and tyrosine.

A more detailed account of this work will appear elsewhere.

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Force Constants in the Hydrogen Halides and Ionic Radii

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Let us make the rather bold assumption that the bond in the hydrogen halides is suddenly disrupted when the hydrogen atom is removed to a certain distance r_2 from the centre of the halide atom. Outside this limiting distance we then have the bond order 0 while inside we reckon with a bond order 1¹. We further assume that the interatomic force is quasi-elastic so that the increase in potential energy on moving the proton from the equilibrium distance r_1 to $r_2 = r_1 + \Delta$ is approximately $E = \frac{1}{2}C\Delta^2$ where C is the force constant. (Outside r_2 C is 0). Identifying E with the dissociation energy ϵ of the

molecule (— for dissociation into atoms —) we get approximately

$$\Delta = \sqrt{\frac{2\epsilon}{C}}$$

or when ϵ is in e. v., r_1 in Å, C in 10⁵ c. g. s. units and Δ in Å:

$$\Delta = 0.566 \sqrt{\frac{\epsilon}{C}}$$

Hence we can easily calculate the "limiting distance" from the halide centre: $r_2 = r_1 + \Delta$ because r_1 and C are known from the infrared spectra¹ and ϵ is also known².

It is remarkable that these "limiting distances" come out nearly identical with the van der Waals or ionic radii of the halides as seen from the table below. (As Pauling has shown the ionic and van der Waals radii are nearly identical³).

their radioactivity in the Geiger-Müller counter.

Uracil was isolated from the PNA of the regenerating liver according to methods worked out at this laboratory⁵. The uracil was probably contaminated with cytosine that had undergone deamination to uracil during the preparation.

After the degradation procedure described above the samples obtained were analyzed in the Geiger-Müller counter. The results are given in Table 1.

Table 1.

	counts/min
Precursor	28 000
Mean value of respiratory CO ₂	2 880
Uracil	35
Carbon atom 2	62
Carbon atoms 5 and 6	9
Carbon atom 4	60

These results indicate that in regenerating liver the carbon from bicarbonate enters positions 2 and 4 in the pyrimidine ring to the same degree. Wilson has previously found that bicarbonate enters position 2 (personal communication to professor Hammarsten) and his findings are confirmed by this investigation.

A more detailed report of the method and the experiment with C¹⁴-bicarbonate will be published later.

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