under proper adjustments. The accompanying graph gives the results of a typical set of observations on an oscillator using 6*SK*7 valves; a 6*C*5 valve was used as the modulator. The entire system was very carefully designed, and the voltages to the anode and screen grid were stabilized with voltage regulators. The frequency of the resistance-capacity oscillator was measured by 'beating' it with a conventional quartz-controlled oscillator; it was varied to bring the beat frequency within the audio range, and the variation of this audio-frequency with modulator grid voltage was studied.

It will be seen from the graph that a linear variation of more than 3·0 kc./s. is easily effected. The standard variation for wide-band frequency modulation being ± 75 kc./s. over a carrier frequency generally lying between 40 and 50 megacycles/sec., it would require a linear variation of about ± 1,500 c./s. on a 1-megacycle carrier. The present arrangement accordingly gives quite faithful modulation for the wide-band system. The graph also shows the variation of output voltage of oscillator with frequency. The recorded variation in amplitude over the entire range of linearity is quite small—only 1·5 per cent.

The frequency stability of the resistance-capacity oscillator has been quite satisfactory, and further experiments are in progress to stabilize the central carrier with the help of a discriminator circuit acting in conjunction with a quartz-controlled oscillator.

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Studies on Human Dentine

A detailed study of the hydrolysates of human dentine has been carried out here during the last twelve months, using the paper chromatogram technique.

The protein studies on a large series of hydrolysates of sound dentine reveal the consistent absence of either cystine or methionine. Hydrolysates of both sound and carious dentine show a qualitative similarity; but quantitative studies, after water extraction, reveal a definite decrease in the amounts of aspartic and glutamic acids in carious dentine relative to sound dentine. Cold aqueous extracts of sound dentine reveal no amino-acid content, whereas those of carious dentine contain both aspartic and glutamic acids. Neither aspartic nor glutamic acid has been noted in chromatograms of saliva. It has been observed that both aspartic and glutamic acids at low concentrations readily decalcify normal dentine and enamel.

It can therefore be postulated that the carious process may well be a liberation of aspartic and glutamic acids from the protein of the enamel fissure by proteolysing organisms. The acid so formed decalcifies further enamel and dentine, thus freeing more protein. Carbohydrate studies on the chromatogram have so far failed to reveal the presence of either chondroitin sulphate or chondrosamine (although the hydrolyses were carried out in conformity with the studies of Dewar and Percival[1] on the hydrolysis of chondroitin sulphate). The foregoing views are, therefore, contrary to those of Pincus[2,3].

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[3] Pincus, P., *Nature*, **162**, 48 (1948).

Mutations by Photodynamic Action in *Bacterium prodigiosum*

In a previous paper[1] it was shown that dwarf-growth mutants in *Bacterium prodigiosum* (*Serratia marcescens*) can be produced by ultra-violet radiation apparently in a one-hit mechanism, and that the most active wave-lengths lie below 3,000 A. If the killing of bacteria by a light-quantum hit is a process happening in the genetical system, one might suppose that also the energy of quanta of visible light may be capable of producing vital genetic variants, for Liechti *et al.*[2] had observed the killing of vital-stained bacteria by such longer wave-lengths.

Experimental work in this direction seemed interesting because it may be possible in future to determine the threshold energy for a mutation by seeking the superior spectral limit of the mutating light action. In *Bacterium prodigiosum* the potency of visible light in production of dwarf-growth mutants could be demonstrated. Since the bacterial cell evidently does not absorb visible light sufficiently to produce an obvious mutative or killing effect, vital staining with photodynamic active dye (erythrosine) was necessary.

Resting cells were irradiated after staining by projecting the glowing spiral of a 5-volt Osram lamp into the suspension, which was stirred in order to spread the energy homogeneously to all cells. Heat radiation was absorbed by a special glass filter that simultaneously reflected a part of the light at right angles on to a calibrated photo-cell element measuring the radiation energy. After 5, 10, 15, . . . min. of irradiation, 0·5 cm.^{3} of suspension was diluted in 1/10 steps and one drop plated on a glycerol–citrate–ammonium phosphate agar. After 48 hours of incubation, the total colonies and the dwarf-colony mutants were counted.

The transformed hereditary character of the dwarf-colonies is manifested in later plate-passages only when colonies grow densely enough. If the colony separation is too large, especially at the periphery of the plate, no difference in dimension between normal and mutant colonies can be seen; but often dwarf mutant colonies have a brighter or darker colour. While the survival curve is a straight line in semi-logarithmic co-ordinates, the dose mutation-rate curve has a 'two-hit' character. The ratio of the probability for a killing hit to that for a mutation hit is only 3 : 1, whereas the same fraction for ultra-violet radiation is nearly 150 : 1. Thus visible light is essentially more effective in producing mutations than ultra-violet.

The cause of the different influence of short and long wave-lengths may be a difference in the structure between the vital 'genes' and the units for inhibition of cell-fission. A similar λ-relation in lethal and vital