original must bear against the emulsion of the paper. Expose approximately the same length of time as a normal negative. Develop and dry the paper.

(3) Make the negative transparent. Repeat processes outlined in (1).

(4) Make any number of the desired prints. Print the transparent negative as in (2). The prints are made on any desired surface of paper. Greatest definition is secured by the use of glossy paper. A good glossy print is as detailed as was the original.

(5) Recover the original drawing. Wash the original print or drawing in xylol, and dry. It returns to its original opaque condition and is none the worse for the processes through which it has passed.

This method is used for reproducing drawings made on stock of as great thickness as an ordinary index-card.

For many kinds of scientific work, the negative secured in (2) is more effective than is the positive secured in (4), due to the reversal of the colors.

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SPECIAL ARTICLES

THE PARATHYROID GLANDS AS INFLUENCED BY SELECTIVE SOLAR RADIATON

SINCE hyperplasia of the parathyroid glands occurs in animals kept upon a diet deficient in calcium, and since calcium metabolism is dependent upon vitamin D, present either in the diet or in the lesser wave-lengths of sunlight, an experiment was tried to determine the effect of selective solar radiation upon the parathyroid glands of chicks maintained upon diets in which the content of calcium was adequate.

Four convenient pens were constructed and screened upon their southern exposure by amber, blue, ordinary and vitaglass filters, transmitting variable portions of the sun's spectrum. Each of these four pens was divided by a median partition, so that four pairs of compartments, each pair illumined through a single filter, were thus arranged. The basic diet employed throughout the experiment was the Wisconsin ration, Bulletin 371, Agr. Exp. Station, Madison, Wis. This ration, without the cod-liver oil, was provided the chicks in one compartment of each filter; while the cod-liver oil was added to the diet in the other compartment of each filter. The chicks were placed in he filters on April 22, 1927, and the experiment was discontinued October 25, six months later. Certain chicks in each pen were killed after two, three, four, eight and twelve weeks of experimental observation. The thyroids and parathyroids were fixed in Bouin's fluid, sectioned and stained for histological study. Differential blood counts, serum calcium and phosphorus were determined at frequent intervals throughout the study.

The normal parathyroid tissue in the chick is massed into a pair of small glands which lie at the caudal angle of each thyroid lobe. Each gland is an epithelial structure, surrounded by a thin capsule which continues within the gland as the stroma. The cells comprising the gland are arranged into irregular groups or cords, sometimes alveolar or tubular in organization. The cells are usually large and contain elliptical nuclei with numerous nucleoli. Mitotic figures are frequently seen.

After three weeks of observation a differential growth in these glands under the various filters is manifest. Hyperplasia is more apparent in the glands of those chicks grown under the blue and amber filters on a diet devoid of cod-liver oil. In the chicks kept under these filters and fed the cod-liver oil the glands are smaller than those without the oil, but are larger than the parathyroids of chickens grown in the compartments having vitaglass or ordinary window-glass. Vitamin D, present in the cod-liver oil, appears to compensate partially for the absence of direct sunlight, at least in so far as the size of the parathyroids is concerned.

In the absence of the optimal wave-lengths of sunlight the chicks immediately evidence an increase in the number of parathyroid cells, apparently normal and of entirely functional significance. Chickens taken from compartments with blue or amber filters and maintained upon a diet without the cod-liver oil have parathyroids at the end of one month nine times the size of the gland in a chick grown under the vitaglass filter on the same diet.

Progressive changes within the hyperplastic glands become manifest about the end of the first month. Such regression is first manifest by an increase in the extent of the connective tissue stroma followed by a destruction of the normal cords and columns of cells. Hyperemia is also characteristic of such regression. Two distinct types of cystic degeneration occur within these hyperplastic glands. These cysts appear to be composed of extensive mucoid deposits walled off, in one case, by a high columnar epithelium and in the other case by a series of pavement cells concentrically arranged. The columnar cells of the first type appear to be formed by parathyroid cells of the normal columns, which break away to wall off the developing cyst from the adjacent parathyroid tissue. The origin of the concentric pavement cells is not clear, although those cells appear to arise in connec-

tion with the hyperplasia of the connective tissue stroma. Giant cells are frequently found associated with these cysts.

Light of certain wave-lengths appears to bear a definite relationship to the physiology of the parathyroid glands. In the absence of the optimal light factors, an attempt is made by the organism to compensate for this loss by an increase in the total functional activity of the gland. Hyperplasia ensues in the absence of the lesser wave-lengths of sunlight but such hyperplasia is partially obviated by the addition to the diet of a small portion of cod-liver oil. These experiments indicate that normal development of the parathyroids will best maintain in the presence of both the lesser and the greater wave-lengths of sunlight.

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A NEW TYPE OF ACID CARBOHYDRATE FROM SEAWEED

NATURALLY occurring acidic materials, essentially carbohydrate in nature, have been known for many years, though they have been investigated comparatively little from the standpoint of structural chemistry. We know little more about the chemistry of gums than was known by the chemists of thirty years ago. Many gums occur in nature as inorganic salts of complex organic acids, which on hydrolysis break down to mixtures of both pentoses and hexoses, and form also acidic products of unknown composition. That these acidic substances are *uronic* acids or polymers or derivatives of such acids is indicated by the fact that they liberate CO_2 when boiled with 12 per cent. HCl and that they give the naphtho-resorcin test.[1] That conjugated *uronic* acids are constituents of many polysaccharides found in plants is indicated by the work of various investigators, among them Nanji and others,[2] Erich Schmidt and coworkers,[3] Schwalbe and Feldtman,[4] and also by unpublished observations of the present writers.

Of late certain substances of this general class, namely, the pectins and the soluble specific substances produced by various types of pneumococcus have been submitted to careful study with interesting results. Ehrlich[5] and his coworkers have found that digalacturonic acid is formed by hydrolysis of pectin, along with sugars—mainly arabinose and galactose—and that this acid or polymers of it constitute a considerable proportion of the pectin molecule. Very recent work by Heidelberger and Goebel[6] shows an aldobionic acid—glucoso-glucuronic—to be the fundamental building stone of the polysaccharide derived from Type III pneumococcus and to be an important constituent in that from Friedlander's bacillus.

We are now able to report, in a preliminary way, a new type of carbohydrate material which apparently is made up completely of *polyuronic* acid. Quantitatively, at least, this material bears the same relation to *uronic* acid that starch does to glucose.

A sample of seaweed, gathered at Woods Hole, Massachusetts, in April and classified as *laminaria agardhii*, was extracted with cold dilute Na_2CO_3. After filtering, the so-called alginic acid was precipitated by addition of HCl and freed from salt by washing and dialysis. It was dried over P_2O_5 to constant weight and analyzed. The results of analysis indicate the formula $(C_6H_8O_6)n$, which is also closely checked by titration with standard alkali. The compound loses 24.5 per cent. of its weight as CO_2 on boiling with dilute HCl. This indicates that the molecule is at least 98 per cent. *uronic* anhydride, probably even more, as the loss of CO_2 from a *uronic* acid is said to be not quite quantitative.[7]

We have also isolated alginic acid from *macrocystis pyrifera*—the giant kelp of the Pacific coast. Our work to date indicates that this material is also a polyuronic anhydride to the extent of at least 98.6 per cent.

But little study, beyond the determination of the analytical data, has been made of the alginic acid from *laminaria agardhii*. Enough work has been done, however, with that from the *macrocystis pyrifera* to indicate that it is a very interesting substance, worthy of careful investigation. The pure acid does not reduce Fehling's solution, but becomes reducing if dried at 100° or if boiled with distilled water for a short time. By the action of heat in the presence of water, the substance loses CO_2. Because of these facts, it is our opinion that the analytical data and physical constants, obtained by previous investigators[8] working with this material, may be inaccurate. Changes were undoubtedly brought about in the substance, before it was analyzed, on drying at 100°.

Schmidt and Vocke[9] have recently isolated what they considered to be a mixture of polyglucuronic acids from *fucus serratus*. These acids, as they found them in the plant, were bound with varying amounts of other carbohydrates. They obtained, on hydrolysis of this material, an acid whose cinchonine salt

[1] Tollens, *Ber.*, 41, 1788, 1908.
[2] *J. Soc. Chem. Ind.*, 44, 253T, 1925.
[3] *Ber.*, 58, 1394, 1925.
[4] *Ber.*, 58, 1534, 1925.
[5] *Biochem. Z.*, 168, 263, 1926; *ibid.*, 169, 13, 1926.
[6] *J. Biol. Chem.*, 74, 613, 1927; *ibid.*, 74, 619.
[7] Nanji, Paton and Ling, *loc. cit.*
[8] Hoagland and Lieb, *J. Biol. Chem.*, 23, 287, 1915.
[9] *Ber.*, 59, 1585, 1926.