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## THE CONSTITUTION OF PROTOPLASM<sup>1</sup>

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AMONG the variety of elements which partake in the constitution of the cell, the nucleus is the largest single body and the one which has lent itself to the most successful investigation. The nucleus was seen as early as 1781 by Fontana, but it was not until the principles of the cell theory were established by Schwann, Remak and Virchow that its role in cell economy could take its full significance. With Flemming, Strasburger and van Beneden began a series of brilliant investigations on the nucleus, which culminated in the discovery of the phenomenon of mitosis and the demonstration of the unique role which the chromosomes assume in heredity. The success met with in the study of the nucleus was undoubtedly due to the circumstance that its structures were able to withstand the action of the fixatives which

had come into use during the nineteenth century. This typical resistance of the nucleus to these agents and the nuclear affinity for basic dyes can in turn be traced to a substance present in abundance in all nuclei and segregated in the chromosomes during division, namely, thymonucleic acid.

The usual fixatives which had proved eminently suitable for the preservation of the nuclear framework destroyed the cytoplasmic structures, an effect due chiefly to the high concentration of acids and of alcohol which they contained. The artefacts so produced gave rise to erroneous views on the organization of protoplasm, such as the reticular and the froth theories. The outstanding advance in the study of cytoplasm came with the work of Altmann and his followers, who recognized the destructive action of acids and introduced bichromate as a fixative. This improve-

<sup>1</sup> Paper presented at the Gibson Island Conferences of the American Association for the Advancement of Science, Gibson Island, August 21, 1942.

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