The Interaction of Biological Macromolecules in Coacervate Systems

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INTRODUCTION

A variety of polymer molecules (*e.g.*, polylysine + polyadenilic acid) may be used to prepare hydrophilic coacervate systems (1, 2). More than 200 coacervate systems are known and they may consist of two or more different molecules. They may be divided by their chemical composition into ten large groups. Most coacervates have been obtained from biological macromolecules which exist in protoplasm. There are coacervate drops in protoplasm of living cells (2). Thus, coacervate systems are of some interest for solving a number of biological items (9).

Forces of attraction take part in the interaction of biological macromolecules in coacervate systems. It is possible to measure the velocity of electrophoresis of macromolecules in solution at various pH values to establish optimum pH and difference of charges for the formation of coacervate systems. For example, histon molecules carry a positive charge and DNA a negative charge at pH 6.0. Gelatin is positively charged and gum arabic negatively charged at pH 3.4. The common property of any coacervate system is the cooperation of molecules in the coacervate drops (1) which occupy 0.1–0.5 of the volume of the system. Only a few polymer molecules exist in the equilibrium liquid. Coacervate drops may absorb other molecules from the equilibrium liquid (2) and these properties (1–6) of drops are used in practice (11). The purpose of this paper is to show how the cooperation of molecules in a coacervate affects the size and chemical composition of the individual coacervate drops.

EXPERIMENTAL

The size of individual coacervate drops was measured by an AB-analyzer of particles. More than 1000 drops were measured in every system. The error was 3% of the value found (4, 7, 8). The dry weight and solids content of 0.5 to 200 μ diameter coacervate drops (per unit volume) were determined by interference microscopy. The measurements were made with monochromatic light, $\lambda = 545$ nm. The limit of measuring the solids weight was 10^{-14} gm; the error is 2%–5% of the dry weight found (2). The nucleic acid and quinone contents of individual drops were found by means of a recording Cytospectrophotometer MUV4-5. The limit of the analyses was 10^{-13} to 10^{-15} gm. Details of the optical methods and calculations for homogeneous and heterogeneous drops have been reported (2, 5, 6).

RESULTS AND DISCUSSION

Coacervate systems were obtained from aqueous solutions (0.1% to 0.5%) of acid and basic proteins, RNA, DNA, carbohydrates, enzymes (phosphorylase, polyphenoloxidase, etc.) and their substrates. Some low molecular weight substances took part in these systems. Twenty different systems were studied (2); most existed at the pH 5–7.5 characteristic of protoplasm. Results are illustrated in Figs. 1–5 and Tables I and II.

The size distribution of coacervate drops