class of tumors is obvious, for the hypothesis of such an agent depended entirely upon the freedom from living cell of the desiccated, glycerinated or filtered tissue, by which these sarcomas can be transmitted. These materials had been inferred to be free from viable cells on the basis of the impossibility of transmitting mammalian tumors by the similarly treated material, thus giving rise to the belief in the existence in avian sarcomas of some entity which is separable from sarcoma cells. It would seem not impossible that some fundamental differences which might exist between the cells of the peculiar avian sarcomas and the cells of mammalian neoplasms might well account for the differences in their transmissibility, yet this point has scarcely been considered.

The purpose of this note is to show that the last of the three evidences, namely, the filterability, is also of no essential value in supporting the hypothesis of the causative agent. For a detailed description of the experiments the reader is referred to my article in *Gann*, vol. XX, No. 2, June, 1926, the journal of the Japanese Society of Cancer Research.

At first sight it would seem quite impossible that a cell of a higher animal should pass through a bacteria-tight filter. It must be admitted, however, that a soft, jelly-like cell, even much larger than bacteria, might readily "stream" through the pores of the filter when filtered under negative pressures, as is usually done. It was felt that such might indeed be the case with the Rous sarcoma No. 1, because of the frequent occurrence in this tumor of very minute cells, measuring 1.5 x 1.5 to 2.5 micra in sections fixed in formalin. Filtration experiments showed that a similar type of minute cells *do* pass through Berkefeld filters, V and N.

The usual method of filtration was followed, using, however, distilled water instead of physiological solution for suspending the mashed tumor tissue. Berkefeld filters were proved to be bacteria-tight by previous or simultaneous tests with *Bacillus prodigiosus*. About 10 cc of the clear filtrate was centrifugated at a high speed for half-an-hour, smear preparations were made of the bottom portion of the fluid and the stained smears were then carefully examined. Some minute but intact cells were demonstrated in this manner in three out of five different tumor filtrates through Berkefeld V candle, and in three out of seven filtrates through the N candle.

The cells found in the smears of filtrates measured on an average about 2.5 x 3 micra. They have round or oblong, well-stained nuclei, which are often surrounded by a small halo. The cytoplasm stains pale blue with Giemsa solution and usually shows what appear to be minute ameboid processes.

As the consequence of the invalidation of all the experimental foundations upon which the hypothetical causative agent is based, the chicken sarcoma can now be considered on a level with the true neoplasms of mammals. The retention of the identical histological characteristics by the avian tumors through their various processes of transmission (by desiccated material, by filtrates, etc.) can now be most satisfactorily explained as being due to the actual transplantation of sarcoma cells.

The recent work of Gye and Andrews[2] demonstrates that the filterability of the Rous sarcoma No. 1 varies from generation to generation during transplantation, filterable tumors giving rise to non-filterable ones, and *vice versa*. This observation, as the British authors state, must bring about a serious consequence on the filterable agent as the essential cause of the growth. From the recognition of the filterable cell, the variation in the filterability can be readily explained on the basis of the well-known cellular polymorphism of the Rous sarcoma.

CONCLUSION

The demonstration of filterable cells which frequently occur in the Rous sarcoma No. 1 renders it impossible to accept Berkefeld filtrates as being cell-free. This fact, taken together with the extraordinary resistance of sarcoma cells to desiccation and glycerination previously reported, may be regarded as removing completely the necessity for assuming the existence of the so-called filterable causative agent.

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GLASS AS A FOURTH STATE OF MATTER

IN the past a glass has been generally considered to be simply a super-cooled liquid. As a consequence, the transition between the glassy and liquid states has been imagined as gradual and continuous. This is by no means the case, however, as recent studies on both inorganic and organic glasses[1] have demonstrated. With n-propyl alcohol, for instance, the softening or "melting" of the glass takes place rather sharply within the temperature interval 90°–102° K.

[2] Gye, W. E., and Andrews, C. N., *Brit. J. Exp. Path.*, 1926, VII, 81.

[1] A number of inorganic glasses have been studied qualitatively by Tool and Volasek, U. S. Bureau of Standards Scientific Papers, *15*, 537 (1919). In the case of several organic glasses the specific heat-temperature curve has been worked out quantitatively: n-propyl alcohol by Gibson, Parks and Latimer, *J. Am. Chem. Soc.*, *42*, 1547 (1920), and more recently by the present authors in an unpublished investigation; glycerol by Gibson and Giauque, *J. Am. Chem. Soc.*, *45*, 94 (1923), and ethyl alcohol by Parks, *ibid.*, *47*, 338 (1925).

and there is an abrupt 80 per cent. increase in heat capacity during the process, as the accompanying figure shows. In fact, the heat capacity reaches a maximum in this softening region and then falls off slightly as the substance becomes distinctly liquid at higher temperatures. Qualitative observations which we have made indicate that the volume of the alcohol also increases sharply in the transition process and it seems almost certain that other properties will likewise exhibit discontinuities in this region.

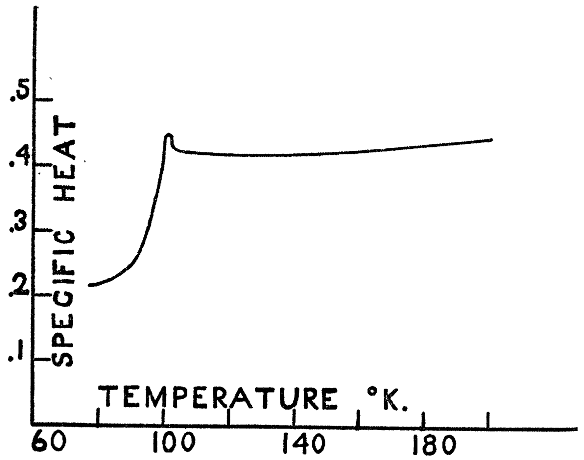

Fig. 1

In view of these considerations, it would seem reasonable to regard glass as a fourth state of matter, distinct from the liquid and crystalline states, and yet showing to some extent characteristics of both these states. A liquid is characterized by a random, haphazard arrangement of its component molecules or units and by the existence of variable, mobile bonds between these units; while a crystal possesses a definite, orderly structure and is held together by tight, rigid bonds. A glass, like a liquid, possesses a random arrangement of its units; on the other hand, like a crystalline substance, it is held together by a fixed, rigid bonding between these component particles. Because they are alike in this latter respect, the glass and crystalline states have nearly the same heat capacity. Furthermore, the comparatively large heat absorption in the case of the glass during the softening process is analogous to the heat of fusion in the melting of a crystalline material; in both cases the energy is required for breaking fixed, rigid bonds. On the other hand, because of its irregular, random structure these bonds in the case of a glass vary in strength and therefore do not all lose rigidity at exactly the same temperature; hence the "melting" of a glass is not sharp and invariable as in the case of a crystal.

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THE DIVISION OF CHEMICAL EDUCATION OF THE AMERICAN CHEMICAL SOCIETY

The opening session at the Philadelphia meeting was devoted to a symposium on International Chemical Education. Professor Ernst Cohen outlined the system of graduate study in European universities and called attention to some points in which improvement may be made in the American practice. Dr. P. E. Verkade explained the system of education in Holland by which students are trained for graduate work in the universities. Dr. Neil E. Gordon gave an illustrated review of the graduate work done in various countries of Europe. He urged the adoption of a number of international exchange fellowships, from which great benefit should result on both sides of the Atlantic. Dr. Harry N. Holmes called attention to the necessity of knowing French and German and gave many interesting personal touches in his recent study of chemical education in Europe.

A half day of miscellaneous papers presented many helpful suggestions to the teacher of chemistry. The most outstanding factor in this group was a series of four papers on various types of visual education. These were illustrated by charts, drawings, lantern slides and motion pictures. Another very helpful paper gave many suggestions on the proper way for chemists to cooperate in securing publicity for their own work and for the science itself.

One session was devoted to a joint discussion with the Division of Industrial and Engineering Chemistry and the Committee on Chemical Engineering Education on the topic "What is Chemical Engineering?" Dr. E. R. Weidlein presided and the discussion was led by Dr. Charles L. Reese and Dr. Harry A. Curtis. At the conclusion a resolution was adopted calling for a continuation of the study, with an extension to include the general curricula to be represented by the term "chemical engineer."

The concluding session contained papers especially designed to interest teachers of chemistry in secondary schools. Papers were read on a cooperative plan between high schools and sections of the American Chemical Society; on the vocabulary employed in high school textbooks of chemistry; on laboratory instruction in chemistry; and on vocational guidance in secondary schools as a training for a career in chemical industries.

The following officers were elected for the ensuing year: Chairman, B. S. Hopkins; vice-chairman, G. W. Sears; secretary, Ross A. Baker; members of the executive committee, Wilhelm Segerblom, W. D. Engle and M. V. McGill. The term of the treasurer-business manager, E. M. Billings, did not expire at this time.

B. S. Hopkins,
Secretary