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A cholesterol–isopropanol gel

In the course of measuring solubilities of cholesterol in pure and mixed solvents we have observed the formation of a transparent gel in the cholesterol+isopropanol system. Because of the historical importance of liquid crystals of cholesteryl esters[1] and the biological importance of cholesterol, we are reporting here some observations on the properties of this gel. Liquid crystals of cholesterol with fatty alkanols (C_{12}–C_{18}) are known[2,3], but have not been reported for smaller alcohols. The transparent gel of cholesterol and isopropanol seems to be stable at 4 °C for concentrations of 4.6–5.3% (w/w) cholesterol. At higher concentrations and temperatures (up to 10.2% at 22 °C), the transparent gel can be observed for a day or more, then white 'snowflakes' appear throughout the gel and grow slowly into a translucent or opaque mass. On warming, the transparent gels liquify, and the translucent gels seem to go directly to the liquid state. The transparent gel is unstable to vigorous shaking; samples with less than 5.5% cholesterol liquify then return to the transparent gel state on standing at 4 °C. Samples with larger concentrations form the translucent or opaque state on shaking and do not return to the transparent state over a period of several weeks. Observations of the transparent gel under a polarising microscope at room temperature showed the sample to be mostly isotropic with some small points of optical activity.

Cholesterol (Fisher Certified Reagent Grade) originally with a melting point of 147–148 °C. After several recrystallisations from ethanol the melting point was 148–149 °C. Isopropanol (Matheson, Coleman and Bell Spectroquality) was stored over molecular sieves and twice distilled, retaining the middle one-third each time. In all of the measurements reported here, these purified materials were used, but very similar results were obtained with untreated materials. Samples were prepared by weight, sealed in glass ampoules under reduced pressure, warmed to dissolve the solid, and then allowed to stand without shaking in four different environments ranging from −10–22 °C, all with observed temperature fluctuations of about 1 °C. Four physical states were observed: liquid, transparent crystalline plates, transparent gel, and the while material which seems to be an amorphous solid dispersed throughout the gel. Our observations are shown in Table 1.

After initial preparation, the gel took 2–3 d to form. If the gel was broken by shaking or slight warming, it reformed in a matter of minutes to hours, but if warmed excessively gel formation required several days. The upper surface of the gel was always coated with a small amount of liquid, presumably due to temperature fluctuations and handling. In one case, however, (4.62% cholesterol at 4 °C) substantial amounts of the liquid and gel phases can coexist.

Table 1 Coexisting states in the cholesterol–isopropanol system

% Cholesterol (w/w)	−10 °C	4 °C	18 °C	22 °C
4.03	L+P	L	L	L
4.16	L+P	L	L	L
4.62	L+P	L+P+G	L	L
5.29	L+P	P+G		L
5.49	L+P	P+G+W*		L
6.69	W	W	W	L
7.61	W	W	W	W
11.66	W	W	W	W†

L, Liquid; P, crystalline plates; G, transparent gel; W, white mass.
*Small flakes of white appeared in the transparent gel after approximately one week, and seemed to be slowly increasing in size.
†This sample liquified at 43 °C.

Samples with 6.69% or more cholesterol form the white mass at −10 °C, but it is unlikely that this is an equilibrium state. There seems to be kinetic competition between formation of the white material and formation of the crystalline plates. Samples of 5.49% and 6.69% cholesterol were allowed to gel at 4 °C, both with a small amount of white 'snowflakes'; the 5.49% sample also contained some transparent plates. When these samples were moved to the −10 °C environment, the less concentrated sample formed plates with liquid, and the more concentrated sample formed the white mass, possibly containing some crystallites.

To find out more about the white materials we have observed, we have begun measurements of the weight gain of cholesterol on exposure to isopropanol vapours. We have observed a gain corresponding to 1.9 molecules of isopropanol per molecule of cholesterol above pure liquid isopropanol, and some of our measurements indicate that the ratio of 0.5 isopropanol molecules per cholesterol molecule may be a stable configuration.

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Errata

In the letter 'Upper limits for the radio pulse emission from exploding black holes' by W. P. S. Meikle, *Nature* **269**, p. 41, in paragraph 3, line 15, for t_p read t_D; in paragraph 3, line 17, for t, read t_p; in paragraph 4, line 10, for $\upsilon \simeq 200$ MH$_z$, read $\upsilon \lesssim 200$ MH$_z$; in paragraph 4, equation (II) for $R_m \simeq 5 \times 510^{21}$, read $R_m \simeq 5 \times 10^{21}$; references 6 and 7 should read [6] Colgate, S. A. & Noerdlinger, P. D. *Astrophys J.* **165**, 509–521 (1971) and [7] Colgate, S. A. *Astrophys. J.* **198**, 439–445 (1975).

In the letter 'Electrical stimulation of denervated muscle reduces incorporation of methionine into the ACh receptor' by C. G. Reiness & Z. W. Hall, *Nature* **276**, p. 655, the correct order of authors' name was transposed.

Corrigenda

In the letter 'Aflatoxin B-oxide generated by chemical or enzymic oxidation of aflatoxin B_1 causes guanine substitution in nucleic acids' by C. N. Martin & R. C. Garner, *Nature* **267**, p. 865, the legend to Fig. 1, line 14 should read . . . To this two-phase system was added 1.25 mg 3-chloro-perbenzoic acid (4 molar excess) and the whole stirred for 25 h at room temperature in the dark in a stoppered flask.

In the letter 'On the optical identifications of five X-ray sources' by H. V. Bradt *et al.*, *Nature*, **269**, p. 21, the last line of the abstract should read . . . suggested class of Be-star X-ray emitters.