of organized science to insist on a proper solution, one cannot help but be concerned about the situation. There is ample evidence at hand that the services will not take the necessary action of their own volition. This leaves but one course of action—organized science must reawaken its interest in the military problem. The medical profession, having failed to take similar action in the face of a parallel and long-standing problem, are now faced with a draft. Will a similar crisis be required to stimulate scientists?

In answer to the question, "What can be done?" I make the following suggestions:

1. Committees can be organized within scientific societies to make a thorough investigation of the role of the scientist and science in the armed forces.

2. The services of these committees can be offered to the Secretary of National Defense to investigate the problem and to make necessary recommendations.

3. Standing committees can be established to provide periodic resurveys and to assist in (or to insist upon) the correction of obvious defects.

4. A mechanism can be established whereby scientific societies and academic institutions may assist the armed forces in obtaining necessary scientific personnel of sufficiently high caliber to meet the needs.

5. A plan for determining the supply of scientific man power in the United States and for using it in time of national emergency can be developed and presented to the President of the United States.

These suggestions are only a few of the many that could be made. Unless scientists take action on these or other suggestions which will aid in resolving this important problem, they will have failed to discharge a public duty and to exercise an important right of citizenship. The costs of such failure will be made clear in the event of a national emergency—a time for implementation of plans, not their preparation, and for use of weapons, not their development.

Infrared Spectra of Tissues

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THE INFRARED SPECTRA of many substances such as proteins (*1, 5, 8*), amino acids (*7, 9*), and nucleic acids (*2, 3*) extractable from tissue have been determined. The purpose of the present investigation is to examine the infrared transmission of whole tissue sections of various types with a view toward comparing the data. In this paper we are reporting some measurements of the infrared spectra of tissue sections and blood smears.

The technique used for determination of the spectra consists of mounting the tissue sections (4 to 50 μ thick) directly on thin (0.060-in.) disks of silver chloride without the use of cover slips. If paraffin sections are used, the paraffin is removed by immersion in xylene and washing two or three times in absolute alcohol. A drop of oil is then placed on the section and spread as evenly as possible over it before measuring the spectrum. The use of such a liquid is desirable in order to reduce scattering by the tissue, especially at wavelengths shorter than about 5 μ. A high molecular weight liquid fluorocarbon[3] has been found useful for wavelengths between 1 and 7.3 μ, since thin layers of it are completely transparent in this region. For the portion of the spectrum between 7.3 and 15 μ a hydrocarbon (mineral) oil is satisfactory in spite of its slight absorption at 13.8 μ. In all measurements a comparison silver chloride disk coated with approximately the same thickness of oil is used. The tissue section adheres strongly to the silver chloride through these manipulations, and is then ready for measurement in the spectrometer. We use a Perkin-Elmer instrument (model 12A) and place the sample close to the slit. Because the sample is not placed directly at the slit, it is desirable that the tissue area selected for measurement be approximately 17 by 5 mm (slightly larger than the slit size).

In all the spectra shown in Figs. 1–5 there are several strong absorption bands which may be correlated with those of known chemical groupings, viz., 3.04 μ (3290 cm^{-1}), N-H stretching; 3.4 μ (2940 cm^{-1}),

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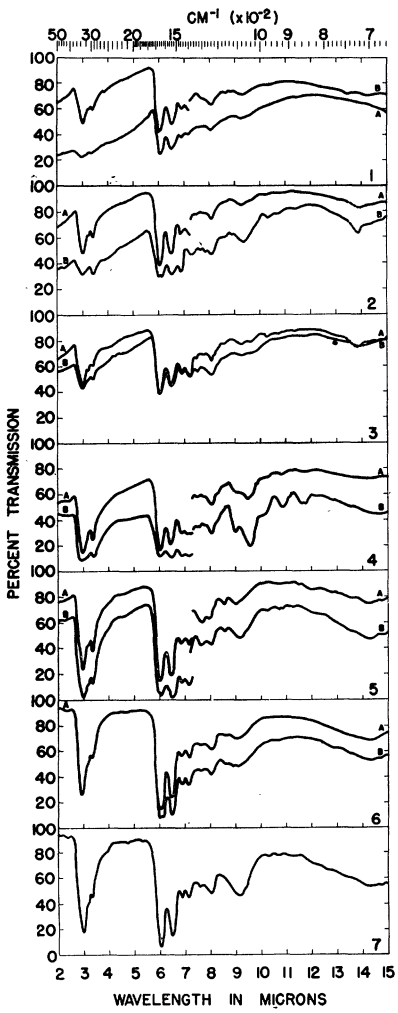
[3] Perfluoro lube oil (E. I. du Pont de Nemours & Co.), bp 130–150° C/10 mm, n_D^{20} 1.335. The relatively low refractive index is a disadvantage.



FIGS. 1–7. Infrared spectra of tissues. 1—Carcinoma of bladder, 18-μ section, formalin-fixed paraffin-imbedded. Curve A, section with the paraffin removed; curve B, section obtained with the addition of a drop or two of the proper oil. The reduction in scattered light with consequent better definition of the absorption bands, especially at short wavelengths, is apparent. 2—Human mammary carcinoma, formalin-fixed. Curve A, 10-μ section; curve B, 50-μ section. 3—Curve A, human mammary fibroadenoma, formalin-fixed, 20-μ section; curve B, normal human breast, formalin-fixed, 20-μ section. 4—Human mammary carcinoma, fresh frozen, dehydrated tissue. Curve A, 20-μ section; curve B, 50-μ section. 5—Human peripheral blood smears, air-dried. Curve A, normal; curve B, acute leukemia. 6—Histone. Continuous film on silver chloride. 7—Ribonuclease. Continuous film on silver chloride.

C-H stretching; 6.00 μ (1670 cm^{-1}), C-O stretching; 6.52 μ (1535 cm^{-1}), amide bending; and 6.88 μ (1450 cm^{-1}, C-H bending. The consistent appearance, except in the frozen, dehydrated sections, of a slight inflection point at 3.26 μ (3070 cm^{-1}) indicates that it may be the N-H band recently pointed out by Sutherland (*1*) in certain polypeptides. In addition a band at 8.06 μ (1241 cm^{-1}) to which a definite assignment has not been made, is apparent in all the spectra. The presence of these bands suggests, that the main absorbing constituent is protein in nature; and comparison of the spectra of the tissue sections with that of a histone film (Fig. 6) and a film of ribonuclease (Fig. 7) shows correspondence of the strong bands. The infrared spectra of other proteins from animal and fish sources show similarity in the bands at wavelengths shorter than 6.6 μ, but divergence at longer wavelengths.

In general it is at wavelengths longer than 7 μ that differences due to composition, and to different proportions or arrangements of component groups, should appear. For example, the band at 9.20–9.35 μ seen in all the fixed tissue sections does not appear in the blood smears, whereas two bands apparent in the blood spectra at 8.55 and 9.05–9.15 μ are absent from the tissue curves. Whether the shift of the 9.05-μ band in the normal blood smear to 9.15 μ in the leukemic blood smear is significant is not known at present. Another point that is worthy of note in the spectra is the increased intensity of the 9.3-μ band in the cancerous mammary tissue in Fig. 2 (out of proportion to thickness) as compared with the normal breast tissue (Fig. 3). This band lies at the same position as one of the strong ones in the nucleic acid spectra (*3*), and it is probable that this increase in absorption is due to an increased amount of nucleic acids in the rapidly proliferating and more cellular carcinoma. Of particular interest is a comparison of the infrared spectra of fixed (lipid-extracted) tissue with fresh frozen, dehydrated tissue. This comparison is perhaps best made between curves 2B and 4B, which are spectra of 50-μ sections of human breast carcinoma. Several absorption bands which appear in the frozen section at 9.00 μ (1111 cm^{-1}), 10.85 μ (922 cm^{-1}), and a doublet at 11.60–11.75 μ (862–851 cm^{-1}) do not seem to have counterparts in the fixed tissue spectra. Also the strong band at 9.55 μ (1047 cm^{-1}) in curve 4B appears to be shifted toward longer wavelengths, if indeed it is the same band (9.20–9.35 μ) seen in the fixed tissue sections.

It is hoped that with the increasing availability of reflecting microscope lenses of the Burch (*4*) and Grey (*6*) types, the infrared study of tissues can be extended to cells and portions of cells. Whether infrared techniques will allow an exact differentiation and identification of tissues must await further work.

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