LETTERS

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Autoradiography: Terminology and Definition

D. L. Joftes and S. Warren [*Science* **124**, 1155 (1956)] recommend the term *radioautography* in preference to *autoradiography* [W. N. Tauxe, A. H. Moser, and G. A. Boyd, *Science* **120**, 149 (1954); G. A. Boyd, *Autoradiography in Biology and Medicine* (Academic Press, New York, 1955)]. Joftes defines this technique, in part, as a method by which an image is obtained in which the image "corresponds to the distribution of a radioisotope *within* an object"; the image is "the result of radiation from the *contained* isotope and does not necessarily correspond to the interior structure."

I am convinced that the prefix *auto* should be used in the prime position (thus, *autoradiography*) for etymological reasons and beg the indulgence of Joftes and Warren in such use in this communication. The primary purpose of this letter is not to comment on semantic and etymological merits of the two terms but rather to point up the need either for new terms for certain techniques that are identical to, or very closely akin to, *autoradiography*, or for revision of the foregoing definition of the technique. The definition attributed to Joftes and Warren limits the autoradiogram to an image corresponding to radioisotope distribution "within" an object. Such a concept does not recognize the broad implications of the technique in physics, metallurgy, chemistry, and geology, beyond the classical histological applications. Where such a definition is accepted, then certain instances of work could not be defined as *autoradiography* although the method seems best identified by this term. Two examples follow:

1) This is a technique in which a surface is selectively covered with a radioactive isotope in very thin film form [L. E. Preuss, *Nucleonics* **12**, No. 8, (1954)], and the intimate detail of that surface is reproduced through latent photographic image production, by the conventional gross apposition technique, in which an appropriate photographic emulsion is used. This may be generally categorized within the technique under discussion except for the fact that the radioisotope is not imbedded *within* the object.

2) This is a system by which a radioisotope is laid down on a uniform substrate to form a pattern not related to the substrate (L. E. Preuss, in a paper presented before the National Vacuum Symposium, Chicago, Ill., 11 Oct. 1956). This pattern is duplicated again by the gross apposition technique on an autoradiographic emulsion. However, this does not fall into the category of Joftes' "radioautography," since the isotope is on a surface and not in an object. To go farther afield for another example, Erik Odeblad [*Acta Radiol.* **43**, 145 (1955)] discusses a method of radioisotope self-photography and terms it "pin-hole autoradiography." Here, the source is *removed* from the emulsion during the latent image production.

Perusal of the foregoing techniques, the classical histological applications, and the host of other modifications of autoradiography, too numerous to mention, discloses two obvious features that are common to them all, throughout. The first essential is a radioisotope in a particular *pattern* or *array*. The second is the *photographic impression* of that pattern by radiation-stimulated latent image production.

The first two examples outlined seem to fill the general conception of autoradiography, yet the radioisotope is not "within the object." Shall these be called "autoradiography," but with modifying terms to give specific meaning, such as "surface detail autoradiography by gross apposition," for the first example? Such a system is pedantic. The logical alternative is to alter Joftes' definition to one which is more inclusive. It becomes apparent, as time goes on, that multitudinous variations will be played on the theme of the original technique by scientists in every realm of investigation. Thus, a general definition which is not restricted by the limitation within one discipline seems logical.

I submit that autoradiography consists of two essentials: (i) The presence of a radioisotope in some significant array (not necessarily within a matrix); and, (ii) the reproduction of this array through photographic latent image production by the attendant radiation.

Therefore, I propose the following as a more general alternative definition: "Autoradiography is that method in which a photographic response precisely reproduces the significant array of a radioisotope. The isotope may or may not exist within or on some supporting structure or substrate, the latent image production being attributable to the isotopic radiation."

Such a general definition will satisfy the conditions for use of the term by the chemist, geologist, physicist, histologist, and other workers. It may be emphasized that autoradiography is not

only applicable to location studies of isotopes in tissues but in the investigation of surface layers as well as self-supporting structures of the isotopes themselves. Thus, the limitation, by definition, that the isotope must be contained within the matrix of some structure is not logical. It is my conviction that this method has now become so common and unrestricted in application to all phases of science that such a definition is contrary to the generally accepted meaning of the term.

LUTHER E. PREUSS
Edsel B. Ford Institute for Medical Research, Detroit, Michigan

Preuss' criticism is based on the erroneous assumption that we were attempting to promulgate the definitive definition of *radioautography*. Actually, ours was simply a working definition, used to describe the basic conditions of radioautography. The fact remains that in all radioautographic techniques, including those of Preuss, there is no external source of radiation which penetrates the object and therefore there is no radiography—auto or otherwise. *Autoradiography* is a self-contradictory term.

As for defining terms, any definition, including that of Preuss, is open to criticism for the reason advanced by Preuss himself—namely, lack of sufficient generality to encompass all the permutations to which the technique is susceptible. For instance, Boyd suggests that the use of photographic emulsions (which Preuss makes a condition of his "general" definition) do not have to be the sole method of registering the image. Other materials that are sensitive to radiation and can be caused to yield a visual image may be used. This kind of hairsplitting is futile and will serve us ill in the long run.

Preuss' definition would be acceptable if it were amended as follows: "Radioautography is a method by which an image is obtained which reproduces the array of a radioisotope or isotopes during exposure of a radiation-sensitive material. The isotope(s) may exist within, on, or near the structure or substrate under investigation, the image obtained being attributable to the radiation emanating from the isotope." Doubtless even this definition is not broad enough.

I hope that my acceptance of all the main elements of his definition will induce a similar attitude of conciliation in Pruess and that he will accept the basic point of the original comment and use the term *radioautography* for the ingenious methods which he has developed.

DAVID L. JOFTES
Cancer Research Institute, Boston, Massachusetts