

Hunter W M & Greenwood F C. Preparation of iodine-131 labelled human growth hormone of high specific activity. *Nature* 194:495-6, 1962.
 [Division of Chemistry and Biochemistry, Imperial Cancer Research Fund, Lincoln's Inn Fields, London, England]

Once a peptide hormone was purified, two other reagents were needed in order to develop a radioimmunoassay for the peptide hormone in biological fluids: an antiserum to the peptide hormone to confer specificity and a radiolabeled peptide hormone for sensitivity. The paper described a deceptively simple protocol for the latter. [The *SCI*[®] indicates that this paper has been cited in over 6,355 publications.]

Longevity of Immunochemical Methods That Work

Frederick C. Greenwood
 Pacific Biomedical Research Center
 University of Hawaii
 Honolulu, HI 96822

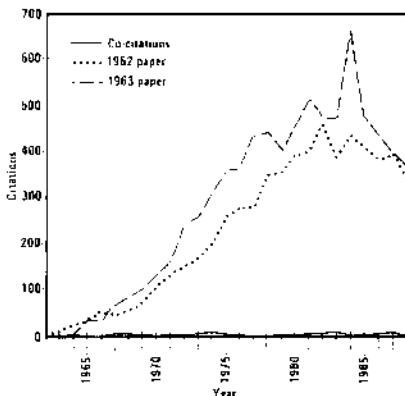
February 27, 1989

By being both young and pushy, I was able to attend a very invited colloquium on "Detection and Assay of Hormones by Immunochemical Means" held at the Ciba Foundation in London in July 1961.¹ I used a question by Roger Unger to show slides on the radioiodination method that we had developed for human growth hormone and its use in developing a standard curve for a radioimmunoassay. The protocol was freely shared with anyone who was interested in the method, which was, alas, never patented, and we were subsequently asked for a reference to a publication. Bill Hunter's PhD thesis work was still under way, but it would not be compromised by a preliminary communication—hence, this paper. The 1962 publication was but a protocol for radioiodination, whereas the full paper, published in 1963 in the *Biochemical Journal*,² was appropriately turgid with data and proving experiments. It also included J. Stewart Glover's name: he had suggested to us the use of chloramine-T as a possible oxidizing agent.

It is interesting to speculate why researchers cited one paper or the other. Parenthetically, it would seem surprising that either of the two papers are still referenced since, in some instances, I have seen them omitted and replaced by the phrase "the chloramine-T method was used"³—surely the proper fate of all good methodology papers. However, I would add that Dr. Solomon Bersson's regard for scholarly references

helped tremendously in the initial years. He insisted that the original reference be given despite the introduction of minor modifications in almost every lab. The two reports had different strengths: the *Nature* paper may have been nonthreatening to those who preferred to work with a protocol of proven authenticity but who were singularly uninterested or unimpressed by the theoretical basis of the reactions involved or in our lack of knowledge of the same, as inferred in the comprehensive *Biochemical Journal* paper.

Writing references out meticulously by hand for a typist to copy in the days before word processors, and so on, might have applied a selection pressure for the *Nature* paper rather than the triple authorship in the 1963 paper. On the other hand, there would be a selection pressure for graduate students, postdocs, and others, to cite the most scholarly reference, the 1963 paper, implying that they had indeed read the original full paper. In any event, I am bemused that either paper is still cited 25 years after publication, but I choose to take it as a nod from research workers grateful that a method worked as published and that a single successful radioiodination could produce a plethora of results from a number of subsequent radioimmunoassays. I am grateful in turn to the Institute for Scientific Information[®] for their unique service to the scientific community and its contemporary history.



Year-by-year citation performance for the Greenwood/Hunter superstar papers. Also shown is the low co-citation rate, the number of papers in which both are cited together.

- Greenwood F C. Discussion on growth hormone. (Wolstenholme G E W & Cameron M P, eds.) *Ciba Foundation colloquia on endocrinology. Volume 14. immunoassay of hormones*. Boston, MA: Little, Brown, 1962. p. 138.
- Greenwood F C, Hunter W M & Glover J S. The preparation of ¹²⁵I-labelled human growth hormone of high specific radioactivity. *Biochemical J.* 89:114-23, 1963. (Cited 7,695 times.) [See also: Greenwood F C. Citation Classics. (Barrett J T, ed.) *Contemporary classics in the life sciences. Volume 1: cell biology*. Philadelphia: ISI Press, 1986. p. 95.]