## Cancer treatment will become so advanced that today's chemotherapy will seem like "applying leeches"

467-481) reporting the discovery of CEA.

It is because of these papers that Gold and Freedman are on the list of the thousand most-cited scientists. But their work did not, then, attract much attention. Virtually no one noticed it — at first.

Then Gold, Freedman and their co-workers found a clinical application.

After writing his Ph.D. thesis, Gold completed his medical training. Freedman, meanwhile, was assembling a team to do research at the laboratories of the Montreal General Hospital, and to practise medicine in its Allergy and Clinical Immunology Department, of which he was the head. The focus of the research was to be Gold's carcinoembryonic antigen (CEA). They worked well together: Gold's enthusiasm, excited by the merest inkling of a promising result or new idea, was balanced by Freedman's desire to see the "hard data" that followed.

"I found a textbook called *Purification Techniques by Chemical Processes,*" Phil Gold recalls. "Talk about cookbook techniques! Anyway, we used our immunological probes and these techniques to isolate CEA and look at its composition. We found we had a big monster of a molecule (a glycoprotein, or combination of carbohydrate and protein) with a coiled head and a long, branched tail. Then we found that it sits on the surface of the cell. One day we realized that it might slough off the cell surface. So we decided to look for it in the blood. Our objective was to ask biological questions, not to set up a test for cancer. I got the surprise of my life."

In California, one of the Montreal team had learned the radioimmune assay technique — a powerful new way to measure extremely small quantities of protein, and a means of measuring CEA in the blood.

After some encouraging preliminary results, they sought confirmation with fresh blood samples from cancer patients. Of 36 patients with tumors of the colon or rectum, 35 had detectable levels of CEA in their blood; there was only one false negative. They could find no CEA in patients whose colon tumors had apparently been successfully removed, but they could detect it in all the 15 patients in whom tumor recur-

