PHYSICS

Exploding Atoms

May aid the study of cancer, explain how the green leaf synthesizes food and fuel, and explain just what happens in some of the major industrial processes.

By WATSON DAVIS

➤ EXPLODING atoms, by-products of the atomic bomb, promise to discover some of the world's major scientific secrets. These include how the green leaf synthesizes food and fuel, what makes cancer cells run wild, how the minute cells at the very beginning of a human life know what to do, just what happens in some of the major industrial processes such as cracking oil to obtain gasoline.

The atom bomb is revolutionary and world shaking. The use of artificial radioactive isotopes for tracer and atom tagging experiments in chemistry, physics, biochemistry, and medicine, may be even more world shaking. The new tools which are being used are varieties of chemical elements called isotopes. Carbon 14, a radioactive isotope of the ordinary carbon which composes so much of the world we live in, is now to be had as a by-product of the atomic bomb research. It is made by transmutation of nitrogen 14 bombarded by neutrons.

"A whole vista of opportunity is opened up as the result of the availability of the C-14 isotope," according to Dr. Glenn T. Seaborg, co-discoverer of the bomb element, plutonium, and the newer elements known to chemists as numbers 95 and 96. Professor of chemistry at the University of California, Dr. Seaborg is engaged in atomic research at the Metallurgical Laboratories at the University of Chicago.

"Organic chemists, biochemists, physiologists and the men of medicine," Dr. Seaborg reported to the American Chemical Society meeting at Pittsburgh, "have dreamed for years of the day when a radioactive isotope of carbon suitable for tracer investigation should become available."

The first and most obvious application in organic chemistry for C-14 would, in Dr. Seaborg's opinion, be a study of the rearrangements that take place in organic molecules. "There are a number of reactions," he says, "in which carbon atoms or groups of carbon atoms move from one part of a molecule to another. The question of just how this migration is accomplished has been a subject for discussion among organic chemists for many years. By labelling the migrating groups in certain positions," by introducing radioactive carbon atoms into the molecule, it should be possible to determine the precise sequence of events in such a reaction.

Has Other Isotopes

Carbon, whose normal atomic weight is 12, has other isotopes as well. There is a heavy, stable variety, C-13, which can be detected in compounds by its greater weight. C-13 can also be used to replace C-12, and its ultimate place in the new compound determined.

"Actually these isotopes complement each other," says Dr. Seaborg, "and it is very fortunate that both are available. There now exists the interesting possibility of tagging each of two different carbon atoms in a molecule or system, and then simultaneously observing the course of each."

Still a fourth variety of carbon is known, C-11, which is radioactive but has a very short period of activity, so that its travels cannot be followed over as long a period as can those of C-14. Nevertheless, Dr. Martin D. Kamen and the late Dr. Samuel Ruben of the University of California, and Prof. William Z. Hassid, formerly of the University of California and now at Washington University, St. Louis, were able to use radioactive C-11 in a study of photosynthesis in which considerable progress was made.

"Radioactive carbon dioxide," states Dr. Seaborg, "was fed to the unicellular green alga Chlorella and also to higher plants under various controlled conditions in the light as well as in the dark. The results obtained so far have been rather surprising. The higher plants and the algae reduce carbon dioxide in the dark. This process takes place concurrently with the release of carbon dioxide by respiration, so that the net effect is an evolution of carbon dioxide."

The part of the plant to which the radioactive carbon atoms travelled was examined to try to find the chemical compound into which it had been built in the process of photosynthesis.

"Attempts to identify the radioactive substances formed in the dark and in the light have been thus far unsuccessful. It is of considerable interest to note that formaldehyde, which has played a prominent role in many proposed mechanisms, was not identified from the radioactive carbon dioxide introduced. Experiments with the ultra-centrifuge and diffusion methods indicate the average molecular weight of the radioactive molecules to be about 1,000, which explains the failure to identify chemically these molecules with any small molecules."

Radioactive isotopes of all the chemical elements are now known, and those of several besides carbon are contributing to our newer knowledge of life processes. Hydrogen 3, for example, may be introduced into many organic molecules, and followed through a series of shifts in much the same way as carbon 14, except that it is somewhat more difficult to detect.

"Radiophosphorus has been the most widely used of all the artificially prepared radioelements as a tracer for metabolic studies in biological systems," says Dr. Seaborg. "The distribution of administered phosphorus in human and animal tissues has been extensively studied."

A single dose of disodium phosphate tagged with radiophosphorus has been found to accumulate to the greatest extent in the bones, next in the muscle and so on in decreasing order in liver, stomach and small intestines, blood, kidneys, heart and least of all in the brain. However, other experiments showed that in cases of leukemia the abnormal tissues accumulated unusual amounts of radiophosphorus. This opens the possibility that cancer may be treated by radioactive elements which concentrate and give out their beneficial rays in the very tissues which the rays are planned to treat.

Concentration of a certain element in one part of the body is well known in the case of iodine, which is absorbed to a large extent by the thyroid gland, even though the absolute amounts of iodine used by the body are extremely minute. Radioactive iodine in an appropriate combination may be swallowed by a patient who has placed a Geiger counter, which detects radioactive rays, near his throat.

The arrival of the jagged atoms of iodine in his thyroid will promptly make itself known on the instrument. The differences in metabolism rate for the various types of thyroid activity characteristic of patients with different thyroid activity are easy to determine by this simple and direct method of measurement.

"An interesting piece of work to the comparative biologist," comments Dr. Seaborg, "was done by Dr. Aubrey Gorbman, of Wayne University, who found in certain invertebrates having no thyroid gland, that iodine is nevertheless concentrated in a marked fashion in a part of the organism whose function was not previously known. It is, therefore, this primitive organ that is probably the predecessor of the thyroid gland in higher animals."

From the utilization of tagged atoms in every-day life processes, the next step is to the migrations of atoms in newly forming embryos. "It is not difficult," says Dr. Seaborg, "to imagine ways in which the use of radioactive tracers will contribute to the solution of fundamental problems in the field of genetics, although some of the concepts are vague at the present time as to the actual planning of the experiments.

"It is evident, for example, that some causal relation must exist between the gene (or genes) for brown eyes, let us say, and the actual deposition of pigment in the cells of the iris. This problem has already been attacked by Dr. George W. Beadle of Stanford University and his associates by classical methods, but the availability of radioactive isotopes should make the solution of the problem much easier.

"Not unrelated to this problem, but in the field of embryology, is the problem of the 'organizer,' the substance or substances responsible for guiding the course of cellular differentiation in the developing embryo. The nature of this substance or substances is only incompletely understood, and its detailed method of action unknown. Here again radioactive tracers may be expected to facilitate the investigation of this problem.

"Radioactive isotopes will also contribute to future advances in investigations dealing with such fundamental problems as the mechanism for the transformation of chemical energy to mechanical movement in living things. Thus, today, no one knows quite what brings about a constriction of a muscle fiber, or even what mechanism is responsible for the movement of an amoeba.

"A possibility, which may sound quite startling, is that of tagging bacteria with radioactive C-14. This does appear to be feasible and to open great possibilities in the study of disease. In fact Prof. Israel Chaikoff and Dr. Alexander Kaplan of the University of California have made a beginning by tagging the tuberculosis bacillus with radioactive phosphorus in some experiments which have not yet been brought to completion.

"Many more possibilities for the use of radioactive isotopes in bio-chemical and physiological work might be suggested, but those given above suggest typical possibilities. Obviously, many of these problems are of profound significance in terms of human welfare."

But the biological field, full of possibilities as it is, is not the only one where the new techniques can bring valuable new information. "With respect to chemical problems of direct interest to industries," says Dr. Seaborg, "many examples could be cited. Among these may be mentioned studies, with C-14, of the mechanism of catalytic cracking, isomerization and alkylation of hydrocarbons which are of profound interest to the oil industry.

"The future," Dr. Seaborg concludes, "seems to hold unlimited possibilities for the application of radioactive tracers to scientific problems. It is certain that the applications of radioactive tracers which have been made so far are just the beginning of what is going to become an extremely large and successful field of research."

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CHEMISTRY

Waterproof Felt Hats Retain Shape and Size

➤ NOW MEN can have waterproof felt hats that retain their shape and size permanently. They look like ordinary felts, but the material is a combination of wool with a plastic fiber that keeps the hat in proper shape and makes it shed water.

The plastic is a vinyon fiber, which is a polyvinyl chloride-acetate made from vinyl resin dissolved in acetone. In the hat-making procedure, it is "set" by a special heat-treatment, and becomes fused with the wool fibers.

While water-repellent under most circumstances, it can be wetted through by thorough soaking, but even then does not lose shape or shrink, it is claimed. It is unaffected in dimensions by the ordinary commercial dry cleaning, steaming and pressing methods.

Science News Letter, May 4, 1946

America has now at least 300 companies packing *frozen foods,* 40,000 stores selling them, and 2,000,000 families using these fresh fruits, vegetables and other articles of diet.