somes "must range mostly between 0.25 and 0.8 μ if their density is low (1.10) or between 0.13 and 0.4 μ if their density is high (1.30)." They soon concluded that their density was high. From the latency of all five hydrolases they reasoned that the organelles were "surrounded by a semipermeable membrane." From measurement of the nitrogen content of the L fraction, they inferred that the lysosomes "must be very few" in number, accounting for "4 percent or less of the cells' nitrogen." Subsequently, in a collaborative effort with de Duve and Henri Beaufay in Louvain, Albert Claude in Brussels, and Wilhelm Bernhard in Villejuif, outside Paris, I did indeed find by electron microscopic examination of the L fraction an organelle about 0.4 micrometer in diameter and surrounded by a tripartite membrane. The organelle resembled the "pericanalicular dense bodies" described in rat hepatocytes by Charles Rouiller in 1954. Acid phosphatase cytochemical studies by Stanley Holt and Marian Hicks in London, and by others, soon confirmed our tentative identification of the dense bodies as the hepatocyte lysosomes. Sagacious deduction from biochemical data by de Duve was thus confirmed by morphologic findings—a startling reversal of the usual course of events.

A flood of publications followed, including studies with electron microscope cytochemistry. Lysosomes were found to be ubiquitous in animal cells. They were shown to exist in several different cytologic forms. In symposiums held in 1959 at the Marine Biological Laboratory, Woods Hole, and in 1963 at the Ciba Foundation, London, de Duve discussed a wide variety of possible functional roles for lysosomes. The two-volume work, *Lysosomes in Biology and Pathology*,* edited by John T. Dingle and Dame Honor B. Fell, summarized the status of the field in 1969.

De Duve's remarkable mind is reflected in his hesitation to assign urate oxidase to the same cytoplasmic particle that houses the acid hydrolases. In the initial experiments this oxidative enzyme activity sedimented with those of the hydrolases, but some minor differences in its behavior made de Duve consider that this nonhydrolase might be localized in yet another cytoplasmic organelle. Urate oxidase (and two other enzymes related to the production and breakdown of hydrogen peroxide) were later shown by de Duve, Pierre Baudhuin, and others in the Louvain group to be localized in a different organelle, the "peroxisome." The preparation of

* North-Holland, Amsterdam and London.

Laser Fusion Secrecy Lifted: Microballoons Are the Trick

For the first time, at a conference in Albuquerque, New Mexico, last week, scientists without security clearances were able to learn most of the intimate details about the government's $66 million research program aimed at producing power by laser fusion.

The laser fusion program was almost totally classified in the early stages, apparently because of its potential for development of nuclear weapons and for simulation of weapons effects, cited in official Atomic Energy Commission (AEC) statements. Other scientists have hinted that laser fusion was classified not so much for its military usefulness as for the similarity of certain laser fusion calculations to the design studies for an H-bomb. Several well-known physicists, including Edward Teller, at the Lawrence Livermore Laboratories of the AEC, and George Trigg, editor of the *Physical Review Letters*, have argued that classification of laser fusion was unnecessary and detrimental to efficient research on the subject.

Guidelines for public information were relaxed slightly in 1971. But most of the research, particularly the details of the fuel pellet, remained secret. The big change occurred on 28 August after a thorough review of the classification guidelines during the past summer.

Laser fusion is based on the idea that a very high powered laser focused on a very small spot could heat a pellet of fuel above the 10^7 degree minimum temperature needed for fusion to occur. Before the disclosure of the implosion concept in 1971, no way was known to achieve the required conditions without an impossibly large laser. Public reports and conversations with scientists in private suggested that the design of the fuel pellet was crucial to the success of the implosion scheme. It was hinted that the laser target was perhaps a liquid droplet, a solid frozen pellet, or a hollow sphere. The new information shows that all suppositions were wrong.

Laser fusion researchers in the government and in private industry have been firing their lasers, or planning to fire them, at tiny hollow glass spheres called microballoons which enclose the fuel. Produced by commercial glass manufacturers in lots of at least 2 million to the kilogram, these small spherules provide a casing that keeps the fuel from leaking out as the whole assembly undergoes compression. The actual fuel, which is a mixture of equal parts of deuterium and tritium, is introduced into the microballoons as a gas in sufficient quantities to reach a pressure of 50 to 100 atmospheres.

In order to introduce the gaseous fuel into the glass balloons, which are only 50 micrometers in diameter, the glass spherules are placed in an oven and heated to 500°C. At that temperature gas diffuses easily through glass, and so the isotopes of hydrogen that make up fusion fuel rapidly migrate inside and are trapped there when the microballoons are quickly cooled. Millions of glass balls are tested and sorted in order to find those without imperfections, and even so the shelf life of microballoon targets is limited because the gas fuel tends to diffuse out.

Different variations on the microballoon targets are undoubtedly used at different laboratories, but generally some sort of outer layer is added. Some material is needed around the microballoon to absorb the energy of the laser pulse and ablate, driving the glass sphere and its trapped fuel inward as the ablating material expands outward. The microballoon must have a fairly high atomic number, relative to hydrogen, to trap the gaseous fuel, but the outer material must have a low atomic number to be a good thermal conduction medium. Microballoons may be coated with plastic, which has a satisfactorily low atomic number, or they may be mounted on a backing of some other low-*Z* material.

—William D. Metz