and carries its fine adjustments G 1, 2, 3 as in the standard form. The cones of the fine adjustments for the transverse and vertical movements H, have, however, steeper pitches which increase their rapidity of action threefold. The speed of control in the axial line is also increased threefold by change of the actuating screw I. Long use has shown that these changes give the additional speed needed for pure culture work with no sacrifice of accuracy.

The adoption of felt linings for the adjustable guides of moving parts insures sufficient friction to maintain the parts in any desired position without special clamping, yet permits by its smooth resistance accurately controlled movement. The parts are thus always ready for the instant response required by this type of work. All jamming and uncertainty of control are eliminated. So smooth and accurate is the control that, for low powers, the coarse adjustments frequently suffice.

A special form of pipette holder J, which makes possible the quick change of pipettes, has been designed for this instrument. The pipette is held between two jaws. One is movable, is opened by lever K and is automatically closed by an adjustable spring. The other jaw is fixed but can be adjusted by means of a clamp to receive pipettes varying in diameter from 2 mm to 10 mm. The pipette holder is adjustably clamped to the end of the MM shaft; it can therefore be inclined from the horizontal to any desired angle.

The grouping of all controls, as in my standard MM, has been adhered to throughout. The direct correlation between the control movement and the apparent movement of the operating point in the field of the microscope, as well as the bilateral symmetry between the right- and left-hand instruments of the double assembly, are also that of the standard form. Reports from the instrument in use show that this convenience of construction and arrangement makes it possible to prepare and put away a mount of ten culture selections in 5 to 6 minutes. Of this time 2 minutes are required for the spreading of the cells.

A total weight of less than nine pounds for the double micro-manipulator, inclusive of its mahogany base, insures easy portability, even in a suitcase.

For valuable assistance in the clear definition of the requirements exacted by pure culture and microchemical work and in the testing out of the working models submitted by me I acknowledge my indebtedness to Dr. Morton C. Kahn, of the Cornell Medical Center, and to Mr. F. R. Swift, of the Fleischmann Laboratories, New York City.

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SPECIAL ARTICLES

ARTIFICIAL PRODUCTION OF RADIOACTIVE SUBSTANCES

CURIE and Joliot[1] have recently observed the emission of positive electrons from boron, magnesium and aluminum, for a considerable length of time after exposure to α particle bombardment. They suppose that in the case of boron, the boron nucleus captures the α particle and emits a neutron, leaving as the product nitrogen 13, which is radioactive, and subsequently emits a positive electron, becoming carbon 13. They suggest analogous processes for magnesium and aluminum, and point out that, if the process is of this nature, it should be possible to produce the unstable nitrogen 13 by bombarding carbon with deutons.

In order to investigate carbon and other elements under deuton bombardment, we constructed a disk, around which was fixed targets of a number of substances. The disk could be rotated inside the vacuum by means of a shaft so that it was possible to bring any one of the targets first into the ion beam for bombardment, and then into view of a Geiger counter having a thin window for recording the delayed emission of particles or gamma rays. Targets of LiF, Be, H_3BO_3, C, Mg and Al were subjected to bombardment, each for about 15 minutes with 5 microamperes deuton current, at 900,000 volts, and immediately rotated into view of the Geiger counter. In the case of boron and carbon, a large number of counts was recorded during the first few minutes after bombardment. Carbon gave the largest effect; several hundred counts per second (calculated for the total solid angle) and decreased at a rate corresponding to a half life of about 10 minutes. The effect from boron was somewhat less intense, and the half life was about 20 minutes. Other substances bombarded gave effects which were appreciable, but which might have been caused by carbon contamination on the surface of the targets. In the case of these small effects an investigation of the rates of decay will decide whether or not they are to be attributed to carbon.

To determine the nature of this delayed activity Dr. Carl D. Anderson and Seth H. Neddermyer placed a piece of freshly bombarded carbon in a Wilson cloud chamber and took a series of photographs, extending over a period of about two hours after bombardment. During the first hour each expansion revealed a number of electron tracks, nearly all of which were of positive polarity. In addition, a few short tracks ap-

[1] *Comptes Rendus*, 198, 254 (1934).

peared, which originated in the gas, indicating the presence of gamma rays.

The electrons ejected from the carbon appeared to have energies which were distributed from about 700,000 electron volts downward. It does not seem that the loss of energy of the electrons in getting out of the target can account for such a large proportion of low energy tracks. The carbon is essentially a thin target, since the depth to which it can be activated by the deutons is very small compared to the range of the ejected electrons. If it can be established, with certainty, that the energy spectrum of positive electrons emitted from nuclei is continuous, it will be of profound theoretical importance in dealing with the problem of the continuous negative beta ray emission.

Both the decay period (14 minutes) and the maximum energy of the electrons from carbon indicate that the active isotope here concerned is the same as in the case of boron bombarded with α particles, as reported by Curie and Joliot. A calculation on the basis of the length of time of bombardment and the half life indicates that one radioactive atom is produced for about 10^{10} deutons incident on the target.

We have previously shown that carbon bombarded with deutons emits gamma rays of hardness corresponding to about 3×10^6 volts, during the time of bombardment. This we associate with the emission of protons and the formation of C^{13}. Three gamma ray quanta are emitted in this process for about 10^8 deutons at 900,000 volts. It seems, therefore, that when carbon is bombarded with deutons, not more than 1 per cent. of the transformations give as a product the radioactive N^{13}, while the remaining 99 per cent. give C^{13}.

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THE PORTAL OF ENTRY AND TRANSMISSION OF THE VIRUS OF POLIOMYELITIS[1]

BOTH human and experimental poliomyelitis evince considerable evidence toward the belief that the virus of poliomyelitis enters the nasopharynx rather than the gastro-intestinal tract.

In acute cases the virus has been demonstrated in the nasal secretions or nasopharyngeal mucosa, where it may persist for some time. The nasal secretions of abortive cases, of healthy carriers and, on one occasion, the dust of the sick room, have been shown to contain the virus. In one instance, virus was found in the nasopharyngeal washings of a patient five days prior to the onset of symptoms. On the other hand, with the exception of one unconfirmed report, the virus has not been demonstrated in the feces of human cases. These facts and the epidemiology of the disease recently reviewed[2] suggest that the virus enters the upper respiratory tract and is spread by its droplets rather than by the excretions of the gastro-intestinal tract.

There is considerable experimental evidence to confirm these findings. In *Macacus rhesus* monkeys introduction of a virus-soaked tampon high up in the nares, injection of virus into the nasopharyngeal mucosa, application of the virus to the scarified mucosa or spraying the virus into the nose have all proved infective. Recently, several workers have reported consistent infection by the administration of multiple intranasal inoculations. We ourselves have a strain of "nasal" virus which gives uniform infectivity upon the administration of 0.2 cc of a 10 per cent. suspension into each of the upper nares. On the other hand, only three of the many who have fed the virus to monkeys have reported positive results. As yet the virus has not been recovered from the feces of poliomyelitis infected animals. Yet in such animals, it can easily be demonstrated in the nasal mucosa or nasal secretions, where it persists for a considerable length of time.

The propagation of the virus from its portal of entry to and through the central nervous system has not been studied extensively. There is evidence indicating that it may travel along the olfactory nerves to the brain. Virus has been demonstrated in the olfactory bulbs during the incubation period following the intranasal inoculation of virus in monkeys by Flexner and Clarke and Faber and Gebhardt. However, the latter authors were unable to follow the distribution of the virus throughout the rhinencephalon. Therefore, the transmission of the virus to the brain is in need of further study and, despite the evidence favoring the nasopharynx as the portal of entry, the small number of carriers and the low incidence of direct contact infections make additional proof desirable. From recent and careful review of the subject, the following is quoted:[2] "Although the pathological anatomy of poliomyelitis has received intensive study for a period extending over more than a hundred years, investigators have not reached an agreement with regard to the atrium of infection or the path of transmission of the virus within the organism. It is to be hoped that research will be continued along these lines until sufficient evidence has been obtained to permit of an authoritative statement."

In order to determine whether or not the virus

[1] From the Department of Bacteriology of New York University and Bellevue Medical School and the Department of Neuro-Surgery, McGill University, Montreal, Canada.

[2] "Poliomyelitis," International Committee. Williams and Wilkins, Baltimore, Md.