who is working in the Highpolymer Research Bureau of the Polytechnic Institute of Brooklyn. He is in this country as a representative of the Ministry of Education of the Chinese Government. After the war the new institute will be in Shanghai, since it is considered advisable to have it near a seaport. Dr. Shen plans to take an ultracentrifuge back with him and is now purchasing basic equipment which is being shipped out as rapidly as possible. The first project will be an investigation of the nutritional status of Chinese children with a view to improving the content of foods with essential minerals and vitamins. Since going to the Polytechnic Institute this year, Dr. Shen has been collaborating with Dr. Kurt G. Stern, who is working with Dr. Herman F. Mark, director of the bureau, under a grant from the Carrie S. Scheuer Foundation of New York, on the application of the ultracentrifuge to highpolymer chemistry.

DISCUSSION

ANTHONY ASKHAM, THE AUTHOR OF THE VOYNICH MANUSCRIPT

IN 1912, in an Italian monastery, the late Wilfred M. Voynich found a manuscript which some of the world's best cryptographers have called undecipherable. Recently I have found the key and some of the details, including the name of the author and the language used, which are here presented for the first time.

The dating of the Voynich manuscript beyond 1493 by O'Neill,[1] restricts considerably the search for the key to the cipher. This determination of a date is based upon the inclusion in "the most mysterious manuscript in the world" (Manly[2]) of the common sunflower, *Helianthus annuus* L., and the pepper plant *Capsicum*, two plants, native to the Americas, which were unknown to Europeans before the return of Columbus from his second voyage. Recently, this key has been determined and some of the biological material contained in cipher has been decoded. Due, however, to present war conditions, it seems undesirable to publish, at this time, the details of the key.

The peculiar use of a double system of arithmetical progressions of a multiple alphabet indicates that the author of the Voynich manuscript was familiar with the ciphers discussed by Trithemius,[3] Porta[4] and Selenius.[5] It is not wise to date a manuscript based upon the dates of these published works, since the material is known to have been circulated in manuscript for many years. The format and use of certain peculiar symbols (mirror images of the Italian d or di and el, respectively) are evidences that the author was probably familiar with the manuscript of Leonardo da Vinci's "Anatomy"[6] (written about 1510). The symbols used in the Voynich indicate, however, origins from many and unknown sources. The text, so far decoded, is in Medieval English and deals with (1) the effects of plants on physiological processes in health and disease, especially, the diseases of women, and (2) a conception of pre-Harveian[7] generation and parturition. As an illustration, the following description of the birth of an infant was decoded from folio 78: "When skuge uf tun'e-bag rip, seo oogon kum sli of se mosure-issue ped-stans sku-bent, stokked kimbo-elbow crawknot." That is, put into modern English this passage becomes, "when the contents of the womb rip (or tear the membranes), the child comes slyly from the mother-issuing with the leg-stance scewed and bent while the arms, bent at the elbow, are knotted (above the head) like the legs of a crawfish." Among the many examples of the effects of plants on human beings, several references to the use of antibiotics have been determined from the decoded material. From folio 93, was decoded, as the author of the manuscript, the name of Dr. Askham. On several previous occasions the opinion has been expressed that the manuscript was written in Latin by Roger Bacon.

According to the "Dictionary of National Biography," Anthony Ascham (older spelling Askham), fl 1553, astrologer) studied at Cambridge, became M.B. in 1540, and in 1553 was presented by Edward VI to the vicarage of Burneston, Yorkshire. He is probably to be identified with Anthony, the brother of Roger Ascham.[8] Anthony Ascham wrote several almanacs, a "Treastise on Astronomy" and more especially "A Little Herbal, etc.," 1550. The author has been unable to study the herbal yet. Larkey and Pyles,[9] however, state that in comparison with other writers of herbals published about this time (Banckes, 1525, etc.), Ascham refers to a very large number of the diseases of women.

[1] Hugh O'Neill, *Speculum*, 19: 126, 1944.
[2] John Matthews Manly, *Speculum*, 6: 345, 1921.
[3] Johannes Trithemius, Steganographia, 1551 (?); Polygraphia, 1518.
[4] Joan Baptista Porta, De Furtivis notis vulgo. De Ziferus Libri IIII. 1563.
[5] Gustavi Seleni, Cryptomenytices et Cryptographiae Libri IX. 1624.
[6] T. Sebachnikoff, "I Manoscritti di Leonardo da Vinci della reale Biblioteca di Windsor"; "Dell' Anatomia." Parigi. Rouverge Fogli A. Torino. Viarengo. Fogli B. 1898 and 1901.
[7] Wm. Harvey, "Exercitationes de generatione animalium." London: W. Dugard. 1651.
[8] Grant, Vita Aschami in Ascham's works et Giles IV, 307.
[9] S. V. Larkey and T. Pyles, "An Herbal" [1525], 1941, footnote p. xix.

In view of the facts (1) that the Voynich manuscript deals in part, at least, with the history of medical thought of the sixteenth century and (2) that the key already determined gives a consistent and connected sequence of decoded material based upon the rules of mathematics, the hope is expressed that the complete manuscript (or a photostatic copy of same) may be made available to the author for present use (thus making inappropriate any attempt at accusing an honest decoder of the use of "a learned and ingenious subconsciousness").[2]

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THE GENETIC ASPECTS OF THE ENZYME-VIRUS THEORY OF CANCER

WHEN investigators in widely separated fields arrive at substantially the same conclusions regarding a common point,[1,2] it is not only a significant event but also a time to pause and inquire whether the departmental barriers—evidenced by terminology—may not have outlived their usefulness. At the very least it is necessary to inquire whether the various specialists may not be coining words which designate the same entities.

To trace the parallel advances which have been taking place in cytology, virology, enzymology and genetics prior to the actual application of these findings to the cancer problem would be a task to which the writer does not pretend to be equal. These developments reach common ground, however, in the fundamental work of Claude,[3] who showed that certain particulate components in cytoplasm, called mitochondria and microsomes, are ribonucleoproteins. The writer has for some time been developing methods for the extracellular study of these particles as enzymes,[2,4] that is, in terms of the chemical reactions which they promote. These techniques have been employed by Claude[5] to show enzyme activity in the collected particles, and attempts have been made to see whether the enzymes are to be identified with the particles.[6]

Meanwhile momentous advances in the field of genetics provide an explanation for non-Mendelian inheritance in terms of extra-nuclear entities[7,8,9,10,11,12] which are variously referred to as plasmones, plasmagenes, plastogenes, factors, influences or enzymes. Darlington[13] and Haddow[14] have recently brought together the many observations in the field of genetics and virology which suggest the possible identity of some of these particles. Indeed, these writers, who are in substantial agreement, regard a "virus" as a "plastogene" in the wrong place. This recalls the writer's view that a virus is an "outlaw" enzyme[15] and that "life began when a small group of enzymes became organized for mutual benefit."[16] The writer's enzyme-virus theory of cancer[1,2] proposed that cancer was mainly the result of competition between two autosynthetic proteins: a normal enzyme protein *vs.* a cancer protein lacking certain specific catalytic properties possessed by the competing normal protein. The cancer protein could be the end result of a variety of processes: it could arise spontaneously as a result of a mutation or be produced by the action of carcinogenic chemicals, or be introduced preformed as a virus. By assuming that the cancer protein, regardless of how it was formed, was the bearer of the changed enzymatic activities which the writer observed in cancer tissue as contrasted to normal tissue, it was possible to construct a theory which would integrate most of the important facts about cancer, as well as to formulate the stages of cancer development.[17] It is now of interest to find that both Darlington and Haddow, evidently without having access to the writer's contributions from the enzyme side, have come forward with a concept of cancer which is based upon the idea of cancer proteins of diverse origins but characteristic properties, *viz.*, "These viruses [referring to the Rous tumor virus and the Bittner milk agent] are distinguished from plasmagenes not by their origin or action but only by their transmission. There is therefore nothing surprising in the fact that reproductive particles can suddenly appear in the cytoplasm by the action either of the mutafacient nucleus or of external carcinogens, nor again that such particles may either be transmissible or only transplantable."[13]

It is noteworthy that while the above view was not based upon enzyme studies, neither was the writer aware of the wealth of data which the English writers presented. The illuminating discussions by Darlington and by Haddow contain nothing which weakens the enzyme-virus theory and much which strengthens it. Conversely, the enzyme-virus theory may provide

1 V. R. Potter, *Cancer Research*, 3: 358, 1943.
2 *Idem, Advances in Enzymology*, 4: 201, 1944.
3 A. Claude, SCIENCE, 91: 77, 1940.
4 V. R. Potter, *Jour. Biol. Chem.*, 141: 775, 1941.
5 A. Claude, *J. Exp. Med.*, 80: 19, 1944.
6 V. R. Potter and H. G. Albaum, *Jour. Gen. Physiol.*, 26: 443, 1943.
7 J. J. Bittner, SCIENCE, 84: 162, 1936.
8 M. Rhoades, *Proc. Nat. Acad. Sci.*, 29: 327, 1943.
9 T. R. Sonneborn, *Proc. Nat. Acad. Sci.*, 29: 329, 1943.
10 *Idem, Proc. Nat. Acad. Sci.*, 29: 338, 1943.
11 S. Spiegelman, C. C. Lindegren and G. Lindegren, *Proc. Nat. Acad. Sci.*, 31: 95, 1945.
12 S. Spiegelman, *Ann. Missouri Bot. Garden*, 32: 139, 1945.
13 C. D. Darlington, *Nature*, 154: 164, 1944.
14 A. Haddow, *Nature*, 154: 194, 1944.
15 V. R. Potter, *Jour. Am. Diet. Asn.*, 19: 488, 1943.
16 *Idem, Jour. Am. Diet. Asn.* 18: 359, 1942.
17 *Idem*, SCIENCE, 101: 105, 1945.