stration of an antagonism between norleucine and leucine in mammals.

The mechanism of norleucine toxicity and its reversal by leucine cannot be explained at present. The growth inhibition caused by the inclusion of amino acid analogs in the diet has been frequently explained as resulting from the inhibition of protein synthesis; more recently it has been attributed to the formation of "foreign" protein, in which the particular amino acid is replaced by its analog. Indirect evidence for the latter possibility in our system is given by the recent finding that the administration, by intravenous injection, of DL-norleucine-3-C^{14} to cows resulted in the incorporation of this amino acid into casein (*6*). Norleucine does not seem to be a natural constituent of casein or of other proteins that have been investigated to date.

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Low-Angle X-ray Diffraction of Fibrous Polyethylene

The low-angle x-ray diffraction of a crystalline and highly oriented fiber of linear polyethylene has been studied (*1*). The high axial orientation possessed by these fibers is shown by the wide-angle diffraction pattern, which is similar to that of a well-developed single crystal with rotational symmetry about the fiber axis. The amorphous scatter was weak in this fiber, and the unit cell was verified to be orthorhombic with dimensions identical with those given by Bunn (*2*). Furthermore, the *c* axis—that is, the chain direction—is coincident with the fiber axis. It was also noted that, when a fiber is heated above its melting temperature and then cooled to room temperature, an axial contraction of about 40-fold occurred. This observation is a further indication of the high orientation in the sample. It is doubtful whether the properties of a synthetic macromolecule possessing this degree of axial orientation have been studied heretofore.

The low-angle camera, described elsewhere (*3*) was capable of resolving spacings up to 800 A. The specimen consisted of a fiber bundle of optimum thickness for CuK_α radiation. A well-defined, low-angle pattern, limited to meridional reflections, was observed (Fig. 1). The first-, second-, and fourth-order reflections of a long period corresponding to $d = 410 \pm 20$ A are clearly resolved. A photometry trace showing the resolution between the first two orders is shown in Fig. 2. The second-order reflection is of greater intensity than the first order, and the third-order reflection is missing.

Since equatorial and other non-meridional reflections were absent, experiments were undertaken to determine whether the fiber acted as a one-dimensional diffractor. These experiments involved the tilting of the fiber axis relative to the x-ray beam. Although diffraction persisted with angles of tilt up to 40°, the diffraction orders were poorly defined, thus making any quantitative deductions from these experiments difficult. Nevertheless, one can conclude that this highly oriented polyethylene fiber acts as a one-dimensional diffractor, its reciprocal lattice consisting of discs of large diameter which increase with the order of the diffraction.

Low-angle diffraction patterns have been observed previously in both the fibrous proteins (*4*) and in mechanically oriented synthetic polymers (*5, 6*). The fibrous proteins usually exhibit a series of meridional low-angle reflections, as many as 30 orders having been reported for native collagen (*4*). However, the synthetic fibers previously studied displayed only a single diffuse diffraction maximum corresponding to a much smaller spacing than that reported above. Our observation that several meridional diffraction orders can be obtained from a highly oriented fiber with a principal spacing of 410 A indicates that a well-defined periodicity along the chain direction can also be developed in these substances.

In the case of collagen the low-angle diffraction pattern can be accounted for by a cylindrical band and interband model (*4, 7*). As was suggested by Hess and Kiessig (*5*) a similar interpretation for the periodicity of the fibrous polyethylene can be made. The crystalline regions correspond to the interband and the amorphous regions to the band, with the high orientation causing these regions to approach colinearity. The amorphous regions in polyethylene occur as a consequence of the kinetic difficulties of completely crystallizing a long-chain molecule even though it may be composed of identical repeating units. On the other hand, in the fibrous proteins the chain repeating units (that is, amino acid residues) are not all identical so that a periodicity can also be developed as a consequence of chemical and structural differences along the chain. For synthetic polymers a high degree of orientation must be developed if more than one diffraction maximum is to be observed at low angles.

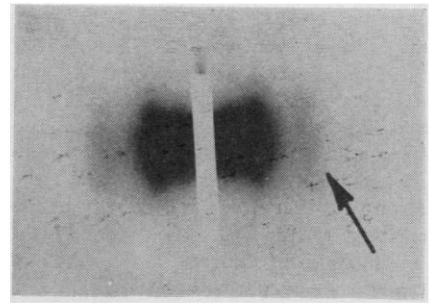

Fig. 1. Low-angle diffraction pattern of polyethylene. Copper K_α, nickel-filtered radiation; specimen-to-film distance, 22.5 cm. The arrow indicates the position of the fourth order of reflection.

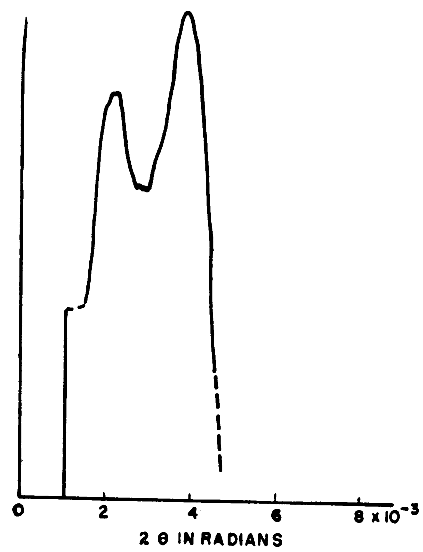

Fig. 2. Photometer trace of low-angle pattern of polyethylene (less exposure time than in the example shown in Fig. 1).

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