changes in culture media which are characteristic of bacteria of ordinary type. In other words, it appears that morphological reversion runs very much ahead of physiological transformation. This has been noted by other workers. It apparently was the case in the excellent work of Smith and Jordan[6] on the diphtheria organism. Dr. Hadley informs us (personal correspondence) that it has been true in all the work which he has done on this subject. Kendall,[7] in his recent important contribution to this field of study, reports the same observation. In their exceptionally complete work on the Shiga bacillus, Hadley, Delves and Klimek[4] succeeded in accomplishing a total physiological transformation of the organism through its various stages to the "adult" form of the laboratory culture with which the experiments were started. In this connection we wish to report that some of our cultures which have been obtained from the filtrates of various substances, after several months' culture in the laboratory, ferment sugar broths and give physiological tests in other media simulating those obtained with ordinary bacteria.

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DIAMAGNETISM IN METAL CRYSTALS

ONE of the fundamental problems in the study of the constitution of solid metals is to find the cause of the magnetic susceptibility due to crystalline state, which property is for most crystals very different from the atomic susceptibility of the metal. As an example tin (Sn) may be mentioned, which is diamagnetic in the liquid state, paramagnetic in the "white" (tetragonal), and diamagnetic in the "gray" (hexagonal) modification. Hence, one must conclude that the magnetic properties of a metal crystal depend mostly on an action caused by the coexistence of a number of molecules (atoms) in a given geometric configuration.

One fashion to approach this problem in a way which gives reliable measurements is the study of the magnetic susceptibility in anisotropic metal single crystals in different directions with regard to the crystal. After the magnetic constants of a pure crystal are known, a small number of atoms of another metal are added to the original substance, and a new single crystal of the same orientation is produced. For most of the measurements bismuth (Bi) was used, since its crystalline susceptibility is 15 to 20 times larger than its atomic magnetism; it is, furthermore, one of the most diamagnetic substances known.

The results obtained concerning the influence of foreign atoms on the magnetic properties of the crystal are the following:

(1) The presence of foreign atoms affects the magnetic properties of the crystal only if the atom goes into a solid solution. Inclosures or occlusion of heterogeneous substances do not affect the susceptibility. Thus, all metals which can not be dissolved in f. i. bismuth do not change its magnetic properties appreciably.

(2) If a soluble metal (Sn, Pb) is added in a quantity below the limit of saturation (which is very low—0.5 per cent. to 3 per cent.—for different enantiomorphous metals) the effect on the susceptibility is very large. Beyond the saturation the effect due to enclosures of eutectic mixtures is negligible.

(3) The effect of dissolved foreign atoms is surprisingly large and affects the crystal differently in different directions. (An atomic concentration of 1:10,000 alone changes the susceptibility several per-cent.)

(4) The influence calculated per added atom within the solubility limits in the crystal depends on their number, *i.e.*, the first few atoms have an effect which may be 100 fold larger than the atomic effect for larger concentrations.

(5) The dependence of the susceptibility of the crystal on the temperature is changed very much by foreign atoms such as to cause a large decrease with decreasing temperature. The decrease is different in different directions.

The effect mentioned under (3) works in all cases investigated as to *increase* the anisotropy of the crystal, *i.e.*, the ratio of the susceptibilities normal and parallel to the axis becomes larger due to the fact that the diamagnetism parallel to the axis decreases. This change is more distinct at lower temperatures, and it is thus possible *to obtain a crystal saturated with 3 per cent. Sn which is below 270° K. paramagnetic parallel to the axis and diamagnetic normal to it.* Since the x-ray analysis of such crystals does not show any difference from the normal Bi-crystal, it is evident that the atomic complexes within the lattice responsible for the diamagnetism must be of much larger sizes than the wave-lengths of the x-rays used.

To account for the exceedingly small amount of foreign atoms sufficient to influence the crystal diamagnetism it seems necessary to accept one of the two alternative conclusions:

(1) The distortion due to a foreign atom dissolved within the crystal lattice reaches very far (somewhat like 25 crystal-atoms in each direction.

(2) The foreign atoms are absorbed in discrete layers within the crystal, the total effect thus being due to an internal surface phenomenon.

The former assumption, of far-reaching influence in

[6] *Jour. Bact.*, 20, 25, 1930.
[7] SCIENCE, 74, 129 and 196, 1931.

dissolved atoms, can not be reconciled with the fact that no change in the lattice parameter can be detected by x-rays. It also contradicts the observation that the atomic influence decreases with increasing concentration of foreign atoms.

The latter conclusion seems to be more probable, since the formation of block-like complexes within a crystal produces large additional surfaces which absorb foreign atoms and thus form potential thresholds preventing the development of large free paths of electrons necessary for the crystal diamagnetism. It is obvious that the amount of foreign atoms necessary to form absorbed layers is many times smaller than the amount necessary for any volume-distortion. Furthermore, the change in internal surface conditions would scarcely be detectable by x-rays.

The size of these complexes calculated from the influence of foreign atoms comes out to be of the order of 1 micron (10^{-4} cm) and is in good agreement with the size observed microscopically by Goetz and is also in qualitative agreement with the theory of Zwicky of the secondary structure of crystals.

This picture of a crystal leads to certain predictions:

(1) The crystal diamagnetism should decrease as soon as the size of the crystal is less than the size of a crystal complex (secondary unit). (It was observed recently, first by Vaidyanathan, that colloidal particles of diamagnetic metals show smaller susceptibilities below a size of 1 micron.)

(2) The crystal diamagnetism should be influenced by any other change of the internal surface in the crystal. (The dependence of the diamagnetism of Cu on irreversible deformation was observed by Bitter, Lowance and Constant.)

(3) The electric conductivity—depending as well on the electric "transparency" of the crystal—should be affected the same way as the crystal diamagnetism. This was found true by Honda and his collaborators for the average susceptibilities on polycrystalline material.

It seems that the experiments described allow an insight into the constitution of a solid metal from a new angle; they also tie the crystal diamagnetism—a hithertofore isolated phenomenon—on to known electric qualities.

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Certain factors determining the direction of growth of nerve fibers: H. S. BURR (introduced by R. G. Harrison). A problem which has baffled students of the nervous system for many years is the determination of the factors which direct the growth of nerve cell processes and fix their termination. We do not know why olfactory nerves always end in olfactory centers. We do not know that motor neurones from the brain always end at the proper level of the spinal cord for the innervation of specific groups of muscles. These have been generally assumed. If they are true we need to know what factors in the nervous system and its environment bring them about. Several years ago while studying a related problem an amazing result appeared in a number of experimental conditions. Transplantation in Amblystoma of an additional olfactory organ adjacent to that of the host resulted in the outgrowth of an olfactory nerve from the transplant, which, instead of joining the olfactory nerve of the host, grew into the wall of the brain a considerable distance behind its normal termination. Not all olfactory fibers followed this course: some did run with those of the host into the forebrain, some followed the branches of nearby nerves to the skin, still others wandered blindly in the environing mesenchyme. These latter conditions can be explained partially on the basis of known facts, but the problem in which a new connection is established with the brain is not so easily solved. It is of fundamental importance that an adequate answer be reached, for the inherent implications are far-reaching. In the experimental condition we have a specific nerve establishing a new, different, one might almost say wrong connection in the brain. If such a thing is possible under experimental conditions it implies that the factors which bring it about are fundamental to the organization of the nervous system. Further, it implies that in given conditions neurones, instead of having their connections established according to a fixed pattern determined by the genetic history of the individual and its interplay with environment, may make contacts that are different and new. If this be true, then environmental circumstances, if they are of the proper sort, may alter the pattern of organization of the nervous system and thus profoundly affect behavior. What, then, are the environmental changes that bring about this new pathway of growth in olfactory neurones? An analysis of 175 experiments shows that conditions are right for the new connection in 29 cases. Of these 17 occurred after operations at one particular stage of development (Harrison stage 32). Furthermore, though outgrowth of olfactory fibers does not begin until five days after the stage of operation, at that time the wall of the brain is full of mitotic figures confined, however, to the relatively restricted area to which the nerve fibers eventually reach. Rapid cell division has been shown to be an index of high metabolic activity and the latter to be the head of a physiological gradient. In all probability this gradient, acting through the medium of a bioelectric field, attracts the growing olfactory nerves. These reach the area and, as has been shown elsewhere, stimulate the contained cells to continued cell division. An augmentation of the