TABLE III.
Oral Immunization of Rabbits Against Type III Pneumococcus Pneumonia and Septicemia. Intratracheal Inoculation.

Vaccines	No. Immunized	Survived	Died	% Survivals
Acid-killed	12	100	0	100
Bile-dissolved	6	100	0	100
Milk-heated	6	4	2	66
Controls (10)	0	6	4	60

duced the most encouraging and consistent results and our present experiments are being conducted only with this particular kind. Furthermore, we believe that the results require further study employing monkeys, in view of the fact that the induced pneumonia bears a closer resemblance to pneumococcus lobar pneumonia of human beings as shown by Cecil and his associates.

Summary. 1. It has been found possible to actively immunize rabbits against Type I pneumococcus pneumonia and septicemia produced by the intratracheal injection of virulent culture, by the oral administration of 7 doses of vaccines at daily intervals. 2. Of the 3 "acid-killed", "bile-dissolved" and "milk-heated" vaccines employed, the first mentioned appeared to engender the most immunity. 3. The induced immunity has been found to persist for at least 4 months and possibly longer. 4. Oral administration of similar vaccines of Types II and III pneumococci also produced active immunity but probably not of a degree equal to that engendered by Type I pneumococcus.

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Nuclear Phenomena Suggesting a Sexual Mechanism for the Tubercle Bacillus.

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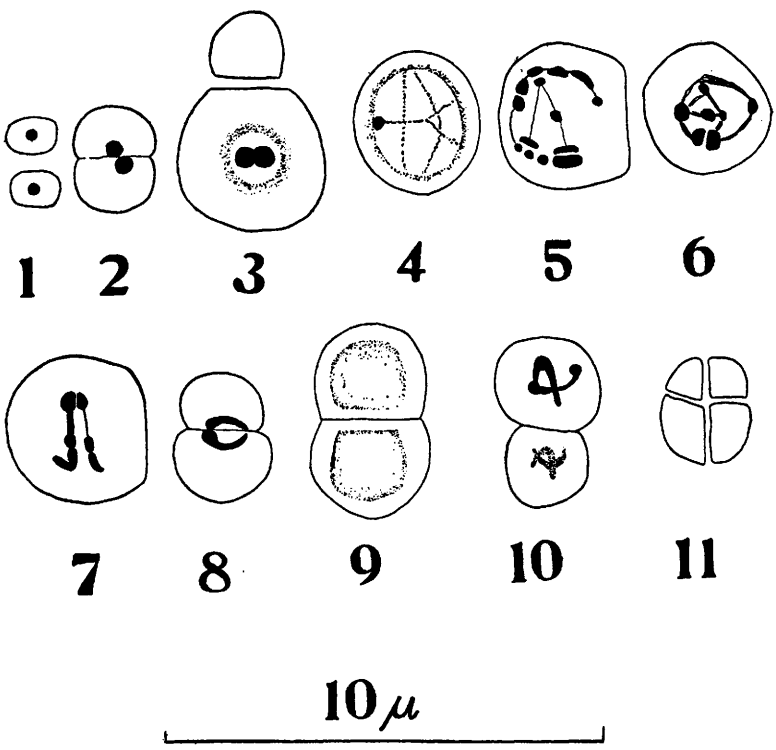
This inquiry takes immediate origin in the suggestive rôle of the macrotetrads in the life cycle of the avian tubercle bacillus (Mellon, *et al.*[1]); more remotely, in the proven rôle of macrotetrads in diphtheroidal-streptococcus transformations.[2]

[1] Mellon, R. R., Richardson, R. D., and Fisher, L. W., PROC. SOC. EXP. BIOL. AND MED., 1932, **30**, 80.

[2] Mellon, R. R., *J. Med. Res.*, 1920, **42**, 61.

Observations in the hanging drop have shown single macrotetrads, germinating as tiny cocci; which on agar slants again yield macrotetrads, thus completing a short cycle. Modern cytological technique has revealed nuclear phenomena of this cycle which are conventionally obscured. Figs. 1 to 11 are camera lucida reconstructions from aceto-carmine stained slides, and the sequence may not be valid. As against the possibility that the sequence indicated by the figures is incorrect there is the fact that this series (Figs. 4-11) resembles in a striking manner the stages of meiosis. Acknowledging the possibility of misinterpretation, the following hypothetical explanation is proposed.

Each coccus contains a single nucleus. These nuclei are about 0.2μ in diameter, and stain very heavily without showing vesicular structure. Two such cocci fuse by solution of a portion of their adjacent cell walls (Fig. 2) and one nucleus migrates into the adjoining coccus. This cell (Fig. 3) increases greatly in size. At one end the empty cell is still attached. In the larger cell the 2 nuclei fuse. This fusion takes place in a colorless area surrounded by the deeper staining cytoplasm. The zygote nucleus increases in



size until it nearly fills the cell and assumes the typical vesicular appearance of a true resting nucleus (Fig. 4). It has a definite membrane and contains many long, slender, faintly-staining threads. The increase in size following the sexual fusion parallels in a striking manner the nuclear phenomena in the young ascus of Neurospora and other Ascomycetes. Densely staining threads and granules appear in the nucleus. As many as 14 particles connected by slender threads have been found in a single cell (Fig. 5). These densely staining granules are the chromomeres. The number of chromomeres decreases and the zygote continues to shrink. Finally, about 7 discrete particles are visible in the cell (Fig. 6). Apparently about 7 chromomeres have been elaborated from each of the fusing nuclei. These have synapsed, producing 7 fused chromomeres. The chromomeres approach each other by the shortening of the intervening threads. Two chromosomes are produced (Fig. 7). One contains 4 nodes while the other contains 3 nodes. If this were a standard meiosis each chromosome should contain all 7 chromomeres. The morphology of these chromosomes is remarkably constant with respect to the 2 small terminal nodes and the thick and thin threads. It is difficult to resolve the larger nodes. The cell divides and one chromosome is found in each daughter cell (Fig. 8). This pair of cells now increases in volume and the chromosomes become vacuolate to form typical resting nuclei. Chromosomes appear in each cell and the second division occurs. As the tetrad divides on germination to form cocci, it increases in bulk, but no larger nuclei or cells are discernible.

These cytological observations have revealed a nuclear mechanism closely resembling the meiosis of fungi and higher forms. If hybridization is possible, the extreme variation which so frequently appears on plating out a culture containing macrotetrads is capable of a simple explanation. But if only a single chromosome exists, the only reassortment of factors which could be effected by hybridization would be due to crossing over.

Summary. Stained preparations of a non-acid-fast phase of the tubercle bacillus show nuclear structures resembling chromosomes, and nuclear changes suggesting a sexual mechanism.