the most marked evidence of such an injury the initial concentration of phenoltetrachlorphthalein in the plasma has been higher, its presence has persisted for an hour and the elimination of phenolsulphonephthalein has been greater than in the animals with a less marked liver injury.

The use of phenoltetrachlorphthalein as a test for liver function indicates a definite relationship between the degree of liver injury and the percentage elimination of phenolsulphonephthalein by the kidneys.

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Further Studies on the Life Cycle of the Avian Tubercle Bacillus.

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The primary object of this paper is to indicate briefly that the experimental high lights of a life cycle for the tubercle bacillus have been consummated. The cycle at present consists of 4 stabilized stages which are vegetative, and 3 transition stages between them which are reproductive or gonidial—7 in all. Of the reproductive stages 2 are probably asexual, and inquiry into the *possible* sexual nature of the other will be reported in a subsequent paper.

Each important stage has been thoroughly single-celled before progression to the next stage has been induced by germination of its appropriate gonidial form; which form constitutes the cytologic mechanism for the transition. For this reason Stages 2, 4, and 6 should perhaps be designated as "phases"* except for possible confusion in the text. Stage 1 is the S form of the avian tubercle bacillus which gives rise to Stage 2, which is filterable.[1, 2, 3] It in turn germinates as Stage 3 in stabilized diplococcus form. As a transition form of Stage 3 is the large tetrad form, Stage 4, which gives rise to the stabilized diphtheroid Stage 5, which in turn yields acid-fast gonidia constituting Stage 6. These

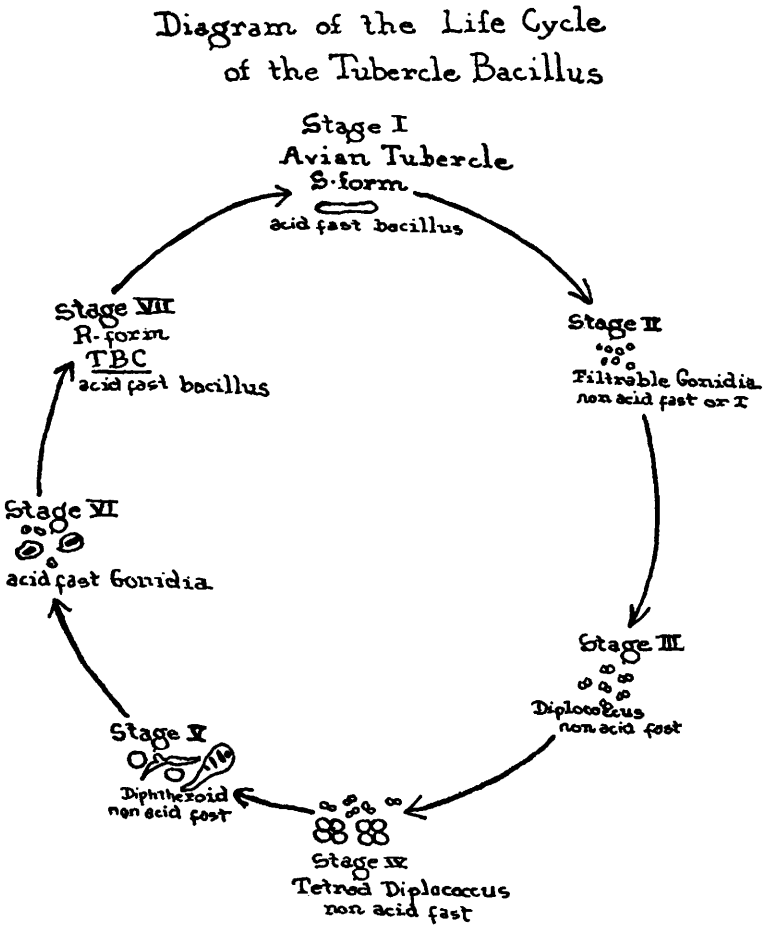
* The term "phase" indicates an absence of detectable multiplication of such a form before its germination into a "stage", which is capable of vegetative multiplication for many "generations".

1 Mellon, Ralph R., PROC. SOC. EXP. BIOL. AND MED., 1931, **29**, 206.

2 Mellon, Ralph R., and Fisher, L. W., *J. Bact.*, 1932, **23**, 18.

3 Mellon, Ralph R., and Fisher, L. W., *J. Inf. Dis.*, 1932, **51**, 117.

latter then germinate as the R form of the tubercle bacillus—Stage 7—and then presumably to the original S form. The cycle's completion rests only on transformation of the R to the S form, already well demonstrated for the avian bacillus by others. Stages 1, 6, and 7 are acid-fast; Stages 2, 3, 4, and 5 are non-acid-fast.



It is noteworthy that the stabilized diphtheroid Stage 5 was transformed to the R form of the tubercle bacillus (Stage 7) on 6 occasions by reason of breaking the dormancy of the acid-fast gonidia, by special methods to be detailed later. Most of the observations indicate its origin from the acid-fast spore-like gonidia, although it is not certain that it is limited to these. It appears that these coccoidal structures throw out a germ tube, as does a fungal spore, which elongates into an acid-fast filament, which simultaneously fragments to ordinary tubercle bacilli.

We have previously shown[1, 2, 3] that the non-acid-fast filtrable phase of a saprophytic acid-fast bacillus may revert to the original directly, or by way of the diphtheroid without its stabilization. But the interpolation of several stabilized non-acid-fast cyclostages between the filtrable form and the original is now shown for the tubercle bacillus. This establishes conclusively the reproductive or gonidial status of the filtrable form, which cannot be of "involution" nature.

Summary. Dissociation of the tubercle bacillus into a heterogeneous non-acid-fast progeny and its occasional reversion to the original is a very old observation. The S and R variability reversions are more recent, while demonstration of a filtrable phase (granules of Much and their congeners) for pure cultures is quite recent. The sum total of these observations constitutes a collection of "variability fragments", so to speak; but it requires orderly allocation by experiment to dispel the chaos that they have represented to monomorphic theory.

These studies represent, I believe, the first experimental integration of these several "variability fragments" in accordance with a single unifying conception, namely, the biologic sequences of a true life cycle. Single-celled cultures only have been employed. The variability of the non-acid-fast progeny is of such a character as to suggest strongly its implication with the genetic mechanism of the cell, which accounts in part for the following paper.[4]

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Therapeutic Effect of Specific Immune Serums Against a Metazoan Parasite (Cysticercus Fasciolaris)*

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Since it had been found possible[1] to protect the rat against infection with *Cysticercus fasciolaris* by means of serums from rats infected with this cestode or artificially immunized by powdered

[4] Lindegren, Carl C., and Mellon, Ralph R., PROC. SOC. EXP. BIOL. AND MED., 1932, **30**, 110.

* This investigation was made possible by a grant for research in science made to Washington University by the Rockefeller Foundation.

[1] Miller, H. M., Jr., and Gardiner, M. L., *Science*, 1932, **75**, 270; PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 779; *J. Prev. Med.*, in press.