"Genetic Control of Biochemical Reactions in Neurospora" (1941), by George W. Beadle and Edward L. Tatum [1]

By: Chhetri, Divyash Keywords: one gene-one enzyme [2] George Beadle [3] Edward Tatum [4] Neurospora [5] molecular biology [6]

George Wells Beadle [7] and Edward Lawrie Tatum's 1941 article "Genetic Control of Biochemical Reactions in *Neurospora* [8]" detailed their experiments on how genes [9] regulated chemical reactions, and how the chemical reactions in turn affected development in the organism. Beadle and Tatum experimented on *Neurospora*, a type of bread mold, and they concluded that mutations to genes [9] affected the enzymes of organisms, a result that biologists later generalized to proteins, not just enzymes. Beadle and Tatum's experiments provided an early link between genetics and the field of molecular biology.

Beadle and Tatum conducted the experiments on *Neurospora* while working at Stanford University [10], in Stanford, California. Beadle arrived at Stanford in 1937 after leaving a position at Harvard University [11] in Cambridge, Massachussetts. He remained at Stanford for nine years. Beadle first studied the fruit flies *Drosophila* [12]. He focused on eye color, hoping to show how genes [9] controlled metabolic reactions in a cell. He soon realized that *Drosophila* [13] was not the best organism for his research purposes. At that time, he worked with Tatum, who had arrived at Stanford in 1937 as a research associate. The two scientists, after dropping the *Drosophila* [13] experiments, decided to work with *Neurospora* instead.

Prior to Beadle and Tatum's experiments, scientists had established that many biochemical reactions were affected and controlled by specific genes [9] by studying the biochemical basis of traits in anthocyanin, which are vacuolar pigments in plants, and by studying organisms such as yeast. Beadle and Tatum argued that those approaches were limited to studying non-heritable characters, as well as visible traits. Beadle and Tatum sought to identify characters that were easier to analyze.

The organism *Neurospora* was suited for the type of study that Beadle and Tatum conducted. The scientists bombarded the spores with X-rays to cause mutations in their genes [9]. If these mutated organisms were placed in a medium lacking essential nutrients, most of them died because of their inability to complete the necessary chemical reactions to survive. However, some mutants survived, and they grew when placed in a medium with the necessary nutrients, so Beadle and Tatum could study them. *Neurospora* can use sucrose as a source for carbon, and they can use it to complete the appropriate reactions to survive. By inducing a mutation in the gene responsible for the hydrolysis of sucrose, the organism would then no longer be able to survive in a medium containing sucrose. However, there was the possibility that the mutated strain could still grow in a different medium, like glucose for example.

Beadle and Tatum then placed the *Neurospora* in two media to compare how spores differently synthesizing products across media. One was a medium that Beadle and Tatum called complete, meaning it already contained many of the components that the spores could normally synthesize. This medium consisted of agar, inorganic salts, malt extract, yeast extract, and glucose. After the mutants were placed in the complete medium, they were transferred to the minimal medium, for which the organism was required to synthesize the necessary products on its own. The minimal medium was composed of inorganic salts, disaccharides, fats, and other complex carbon sources, as well as biotin, the single growth factor that normal *Neurospora* cannot synthesize. Growth factors are substances that stimulate cell growth and differentiation [14]. Mutant strains of *Neurospora* that grew in the first medium but not the second couldn't synthesize the essential products. Beadle and Tatum then systematically examined these strains to identify what substance or substances the spores couldn't synthesize.

Beadle and Tatum found that three mutants grew normally on the complete medium, but did not grow in the minimal medium. One strain failed to produce vitamin B6, and the other two strains failed to synthesize vitamin B1 and para-aminobenzoic acid. From this result, Beadle and Tatum concluded that these substances were necessary growth factors for *Neurospora*. Additionally, they concluded that the inability of a mutant to produce vitamin B6, such a mutant is called a pyridoxinless mutant, was differentiated by a single gene, which they had mutated in spores via X-rays.

In 1945, Beadle published a more comprehensive account of the theories presented in the 1941 paper, titled "Genetics and Metabolism in *Neurospora*." The experiments on *Neurospora* allowed Beadle and Tatum to propose the one gene-one enzyme hypothesis, a theory that became central to genetics. The *Neurospora* experiments of the early 1940's laid the foundation for Beadle and Tatum's later Nobel Prize in Physiology or Medicine, awarded in 1958.

Sources

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