Beadle and Tatum's 1941 Experiments with Neurospora Revealed that Genes Produce Enzymes [1]

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1) X-rays damage DNA, causing mutations in *Neurospora* cells

2) The mutated *Neurospora* spores are dissected out of the perithecium and grown separately

3) The *Neurospora* strain with a mutation in nutrient production grows on complete medium but dies on minimal medium

4) The mutant *Neurospora* can grow on minimal media if a vitamin mixture is added but not when amino acids are added

5) The mutant *Neurospora* can grow when only one type of vitamin is added, but not others

*Illustrator: Amy Pribadi*

This illustration shows George Beadle and Edward Tatum's experiments with Neurospora crassa that indicated that single genes
produce single enzymes. The pair conducted the experiments at Stanford University in Palo Alto, California. Enzymes are types of proteins that can catalyze reactions inside cells, reactions that produce a number of things, including nutrients that the cell needs. Neurospora crassa is a species of mold that grows on bread. In the early 1940s, Beadle and Tatum conducted an experiment to discover the abnormal genes in Neurospora mutants, which failed to produce specific nutrients needed to survive.

1. Beadle and Tatum used X-rays to cause mutations in the DNA of Neurospora, and then they grew the mutated Neurospora cells in glassware. (2) They grew several strains, represented in four groups of paired test tubes. For each group, Neurospora was grown in one of two types of growth media. One medium contained all the essential nutrients that the Neurospora needed to survive, which Beadle and Tatum called a complete medium. The second medium was a minimal medium and lacked nutrients that Neurospora needed to survive. If functioning normally and in the right conditions, however, Neurospora can produce these absent nutrients. (3) When Beadle and Tatum grew the mutated mold strains on both the complete and on the minimal media, all of the molds survived on the complete media, but not all of the molds survived on the minimal media (strain highlighted in yellow).

4. For the next step, the researchers added nutrients to the minimal media such that some glassware received an amino acid mixture (represented as colored squares) and other glassware received a vitamin mixture (represented as colored triangles) in an attempt to figure out which kind of nutrients the mutated molds needed. The researchers then took mold from the mutant mold strain that had survived on a complete medium and added that mold to the supplemented minimal media. They found that in some cases the mutated mold grew on media supplemented only with vitamins but not on media supplemented only with amino acids. (5) To discover which vitamins the mutant molds needed, Beadle and Tatum used several tubes with the minimal media, supplementing each one with a different vitamin, and then they attempted to grow the mutant mold in each tube. They found that different mutant strains of the mold grew only on media supplemented with different kinds of vitamins, for instance vitamin B6 for one strain, and vitamin B1 for another. In experiments not pictured, Beadle and Tatum found in step (4) that other strains of mutant mold grew on minimal media supplemented only with amino acids but not on minimal media supplemented only with vitamins. When they repeated step (5) on those strains and with specific kinds of amino acids in the different test tubes, they found that the same mutated mold strains grew on minimal media supplemented solely with one kind of amino acid, and others strains grew only on minimal media supplemented with other kinds of amino acids. For both the vitamins and amino acid cases, Beadle and Tatum concluded that the X-rays had mutated different genes in Neurospora, resulting in different mutant strains of Neurospora cells. In a cell of a given strain, the X-rays had changed the gene normally responsible for producing an enzyme that catalyzed a vitamin or an amino acid. As a result, the Neurospora cell could no longer produce that enzyme, and thus couldn't catalyze a specific nutrient.