The summer sun sets and twilight descends, thousands of flashing, flying beetles take to the air. Their glowing, lantern-like abdomens annually send children racing, jar in hand, as if summer itself could be held captive on a windowsill. Poets have been similarly enchanted by fireflies-known to those living south of the Mason-Dixon line as “lightning bugs.”

Scientists have understood for some time that male fireflies flash to attract females, who wait in nearby trees or bushes. For very young fireflies, glowing abdomens may also be useful for warding off predators, as an “aposematic” display. And, researchers long ago explained how chemical energy is converted into a bioluminescent glow.

But, how does the firefly know exactly when to start flashing?

Like a chemical conductor’s baton, our nightly light-show gets the green light from nitric oxide (NO), a new Science study shows. A biochemical messenger that controls blood flow and mediates learning and memory in humans, nitric oxide is perhaps best known for its role in treating erectile dysfunction.

“We knew about the chemistry that makes fireflies light up,” said Barry Trimmer of Tufts University, lead author of the study. “Now, we have the missing piece of the puzzle that explains how they are able to throw the switch on and off.”

Many animals, including jellyfish and bacteria, are capable of the seemingly magical feat of bioluminescence. But, said co-author Sara Lewis of Tufts, “The firefly’s talent for producing precisely timed, rapid bursts of light is quite rare.” This ability has allowed fireflies to develop an elaborate courtship based on flash communication.

“Fireflies are very romantic beasts,” Lewis said, “because their whole adult life is spent courting.” Fireflies encompass thousands of different species, each with its own unique flash-code form of identification. Male and female flash patterns differ, but both sexes use a light-producing abdominal lantern.

“How do they do that?” is a question asked by firefly watchers of all ages.

The Science study shows that, jump-started by an influx of oxygen, a chemical reaction within cells in the firefly lantern produces the insect’s flow. Experiments suggested that nitric oxide transmits the neural message to “start flashing” from cells at the ends of branching air tubes in the firefly lantern, to mitochondria that surround the lantern’s light-producing organs. The researchers propose that nitric oxide inhibits mitochondrial oxygen respiration, which in turn raises the levels of oxygen available to the light-producing cells, turning on the flash.

These findings help explain how the flash-control machinery works, and how it is triggered by nitric oxide, described by co-author Thomas Michel of Brigham and Women’s Hospital as “the smallest molecule known to carry messages between cells.”

Such technical insight may be lost on toddlers reaching for glowing beetles this summer. But, the research contributes significantly to our understanding of the world around us.