



## The cat-and-mouse game of diabetes control

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Blood sugar powerfully affects how we feel, giving us bursts of energy or waves of sleepiness. When a person's blood sugar is low, their liver secretes glucose — the same thing that makes apples taste sweet — into the bloodstream. Their pancreas detects this sugar, and releases insulin. Insulin helps transport the sugar into cells, which reduces the sugar concentration in the blood -- and the cycle begins again.

For people with diabetes, this cycle is thrown out of balance. Their pancreas doesn't secrete enough insulin, so their blood sugar levels can become dangerously high. Over time, this can lead to blindness, nerve damage, heart disease, and ultimately death. To avoid this, they inject insulin. But injecting too much can also be deadly. The best solution would be a device that acts like a healthy pancreas, injecting just the right amount of insulin at the right time. But how much, and when?

Mathematics can provide the answer. Delay differential equations, which have offered insights in areas ranging from population biology to planetary motion, can naturally describe the delayed response of a healthy pancreas to spikes in blood sugar. This delay can cause blood sugar fluctuations, which are normal for a healthy person, but potentially dangerous for a diabetic. Using a mathematical model, we have shown how to inject insulin in order to maintain steady blood glucose levels within a healthy range. These guidelines could be programmed into an artificial pancreas, letting the device intelligently adapt to changes in a diabetic person's body.

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The Smith Institute, enabled by the generous sponsorship of our leading corporate partners, ran the TakeAIM competition in 2016 to make visible the crucial role that mathematics will increasingly play in all aspects of our lives. The competition was open to undergraduate and postgraduate students working in the mathematical sciences. The authors of the two best entries each received £1,250 of Apple vouchers as their prize, with Amazon vouchers being awarded to two runners-up.