Barnyard Pharmaceuticals

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These days scientists want more from eggs than just a tasty meal. Researchers at the Roslin Institute in the United Kingdom--birthplace of Dolly the cloned sheep--have genetically engineered chickens that lay eggs chock-full of cancer-fighting proteins. The strategy could lead to a faster, cheaper way of manufacturing anticancer drugs.

Some cancer treatments use antibodies to target and destroy specific tumor cells. Mass producing these proteins isn't easy. Pharmaceutical companies can spend hundreds of millions of dollars setting up and maintaining facilities where bacteria and other microbes churn out therapeutic proteins by the barrel. That can add up to hundreds or even thousands of dollars for every gram of protein harvested. Might employing animals instead of bugs be a cheaper way to go?

The idea has been around for a couple of decades. Some success has been achieved with goats, which scientists have genetically engineered to secrete therapeutic proteins in their milk. But goats themselves are expensive to maintain, especially in the numbers needed to mass produce such proteins. So Helen Sang, a molecular biologist at the Roslin Institute, and colleagues considered chickens. Chickens reproduce a lot faster than goats, with a generation time of just 5 months (versus 18 months for goats). What's more, females can lay an egg almost every day, and a single male can sire thousands of offspring each year. Still, developing a chicken that can reliably produce these proteins has been tricky.

Sang's team approached the problem by poking tiny holes into chicken eggs and injecting the embryos with viruses. Each virus contained genetic sequences coding for one of two proteins: miR24, a cancer-fighting antibody,

or human interferon beta-1a, a protein with antiviral properties. As adults, the chickens passed the new genes on to their offspring, and females consistently secreted these proteins into their eggs, the team reports online this week in *Proceedings of the National Academy of Sciences*. Chickens only produced these proteins in the oviduct, where egg whites are made. That's important, says Roslin Institute Director Harry Griffin, who was not involved in this study, because certain anticancer antibodies could be harmful to the chicken if produced throughout the body.

"This is a capstone paper," says James Petitte, a poultry biotechnologist at North Carolina State University in Raleigh. He is impressed that Sang managed to limit gene expression to the oviduct and achieve a "commercially viable" amount of therapeutic protein in the eggs. Griffin says the next step on the road to commercialization is testing the harvested protein's effectiveness in humans. He estimates it will be "probably five or more years" before drug companies begin using these chickens to make drugs.

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