Don't forget the 'epi' in genetics research, scientist says

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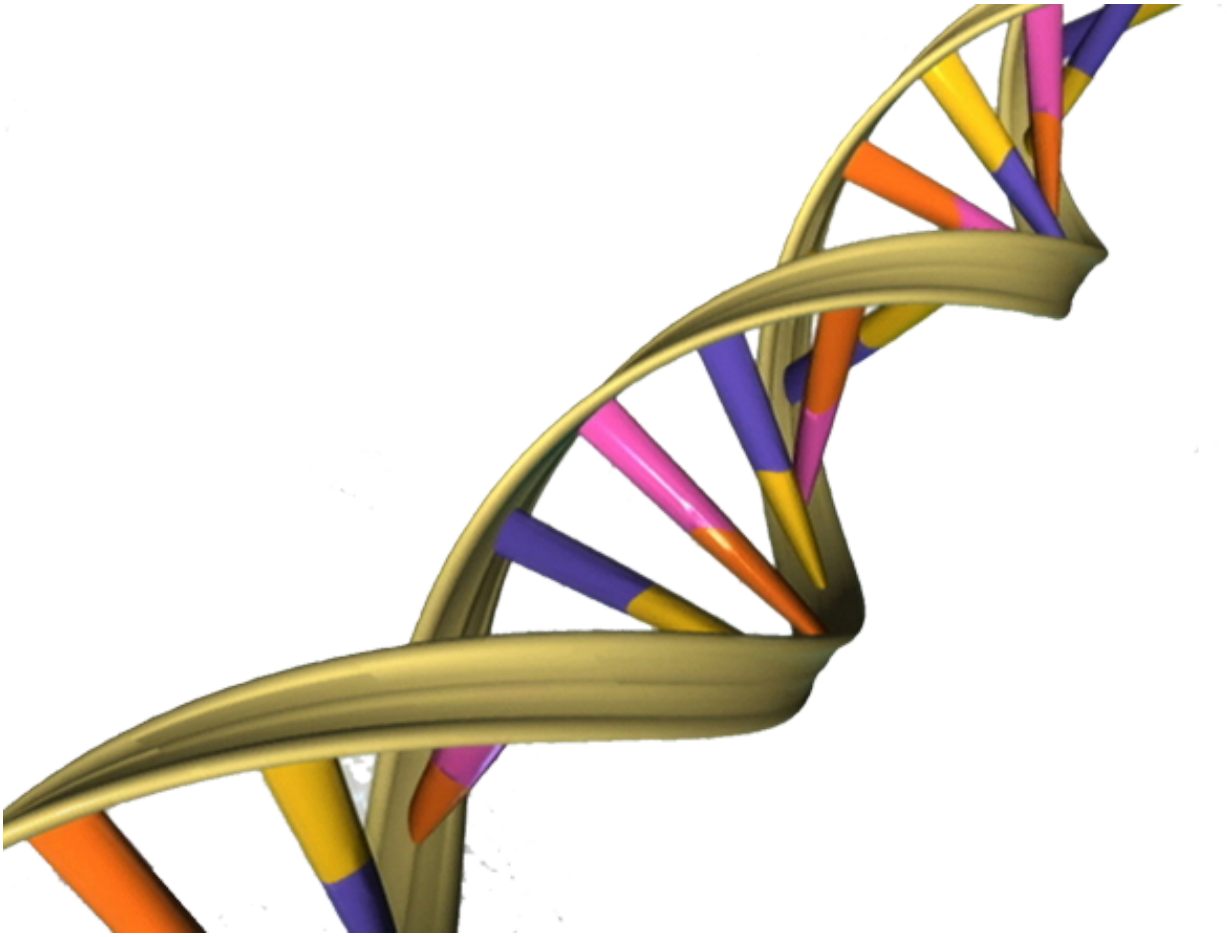

A depiction of the double helical structure of DNA. Its four coding units (A, T, C, G) are color-coded in pink, orange, purple and yellow. Credit: NHGRI

In a review article published April 5 in the *New England Journal of Medicine*, scientist Andrew Feinberg, M.D., calls for more integration between two fields of DNA-based research: genetics and epigenetics.

Most people are familiar with genetics, a field of research that focuses on the precise sequence of chemicals that form the ladder-like structure of DNA. However, epigenetics is not as well known among the public. It's the study of how information is added onto or influences the read-out of genes and, Feinberg says, is not combined often enough with genetics research to understand human disease.

Feinberg, who directs the Center for Epigenetics in the Johns Hopkins Institute for Basic Biomedical Sciences, says that the field of epigenetics captures what happens to our genome after environmental exposures in a way that DNA sequencing by itself cannot.

"We tend to think of our genome as static, but it isn't. Most disease is influenced by some component of the changing environment and our variable exposure to it," says Feinberg, the King Fahd Professor of Medicine, Oncology, Molecular Biology and Genetics. "Looking at our genetic sequence alone doesn't tell us everything about that exposure."

One type of epigenetic change to the genome occurs when small chemical groups glom on to the ladder structure of DNA. Such chemical flags don't change the DNA code itself. Rather, they change how genes are turned on and off. Similarly, other epigenetic changes occur in how DNA and proteins are compacted in the nucleus of the cell. If they are packed tightly, DNA is less open to structures that "read" the chemical alphabet of genes and manufacture proteins.

Epigenetic changes have been found in the lungs of smokers and cord blood of infants prenatally exposed to smoke, writes Feinberg. He also points to epidemiologic studies showing an association between famine

in Sweden, Germany and China and shortened lifespans and schizophrenia in subsequent generations, and studies in mice and humans of nutritional deficiencies that lead to disease, an indication that epigenetic changes may occur early in life and can be heritable.

In addition, he says, the modern revolution in gene sequencing has revealed many mutations in cancers that control epigenetic factors.

Yet, he sees a wide array of diseases, including autoimmune disorders, diabetes and rheumatoid arthritis, that can benefit from integrating epigenetic and genetic research. "Epigenetics stands at the interface of the genome, development and environmental exposure," he writes.

He suggests that combining genomewide and epigenomewide association studies can overcome problems of assigning cause and effect to specific alterations among either type of study alone.

Feinberg also sees potential in combining epigenetics and genetics to identify people at risk for disease and monitor a treatment's effectiveness.

He also says that scientists know comparatively little about how existing drugs may be altering patients' epigenomes. Such new discoveries, he says, will depend on collaborations between pharmacologists and computational and physical biologists.

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