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Making the microbiome part of precision medicine

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Studies of the microbiome should be integral to future precision medicine initiatives, argue scientists from the University of Chicago in a new commentary published Nov. 1 in *Trends in Pharmacological Sciences*.

A growing body of research shows the microbiome—the community of bacteria, fungi, viruses and other microorganisms living in the body, mostly in the digestive tract—plays a crucial role in human health and disease. Because of its influence on disease states and response to treatments, write Thomas Kuntz, a PhD student in the Department of Chemistry, and Jack Gilbert, PhD, Faculty Director of the Microbiome Center, the microbiome should play a crucial role in the field of personalized medicine, which has been dominated thus far by genetics.

"Ultimately, the microbiome must become an integral part of precision medicine as a whole, since so much of human functioning and metabolism is dependent upon it," the authors write. "If this is to happen in the near future, as it hopefully should, we must better understand the microbiome and its interactions with the human and the environment via a concerted effort and conversation between researchers, clinicians, patients, the government, and most importantly, the broader community."

In his 2015 State of the Union, President Barack Obama announced the Precision Medicine Initiative, a far-reaching research effort to develop medical treatments tailored for an individual's unique genetic makeup,

environment and lifestyle. Instead of relying on one-size-fits-all solutions designed to help the largest number of statistically average people, such treatments could leverage advances in genetic testing, molecular engineering and big data analysis to target diseases that are often unique to each patient.

Many early precision medicine projects have focused on genetic differences between individual patients, such as unique genetic mutations in a tumor. Kuntz and Gilbert suggest several key areas where microbiome research could complement and extend genetics-based, precision medicine efforts:

- Drug response and interactions—The way the body metabolizes drugs plays a key role in their effectiveness and potential for adverse reactions; likewise, the gut microbiome is an important driver of the body's metabolism and digestive process. More than 60 drugs have already been identified to have interactions with the microbiome, and as that number is surely to increase, a greater understanding of these interactions in the context of a patient's unique microbial community could lead to more effective treatments.
- Targeted treatments and antibiotics—Antibiotics have a direct effect on the microbiome, however, they have widespread effects on the microbial balance in the body, wiping out not only pathogens but helpful bacteria that are essential to health. Development of precision antibiotics and therapies that target specific pathogens and enzymes would improve the effectiveness of such treatments and reduce the spread of resistance by avoiding overuse of broad-spectrum antibiotics.
- Prebiotics and probiotics—Precision deployment of prebiotics, substances like metabolites that serve as food for microbes, could stimulate the growth of specific strains to help restore a healthy balance of gut bacteria. Likewise, a better understanding of the

individual communities of microbes in a patient, how they differ from diseased to healthy states and how to manipulate those communities reliably, could also help researchers develop more effective probiotic products to restore healthy microbiome function in the gut.

- Underserved community disparities—Several health conditions, including obesity and asthma, which disproportionately affect people living in low socioeconomic status or medically-underserved communities have been linked to disruptions in the microbiome. Such communities could greatly benefit by further research on the specific environmental and lifestyle factors that influence individual microbiomes and possibly contribute to the development of these conditions.

Because the human microbiome is incredibly complex and can rapidly change in an individual, it offers a prime opportunity for developing highly-personalized, precision treatments, the authors write.

"The time has come to include the microbiome and microbial responses in our assessments of health and disease," said Gilbert. "We should build an integrated database of all of these records to allow for appropriate meta-analyses, so that we can all benefit."

Provided by University of Chicago Medical Center