How FDA Advances Personalized Medicine

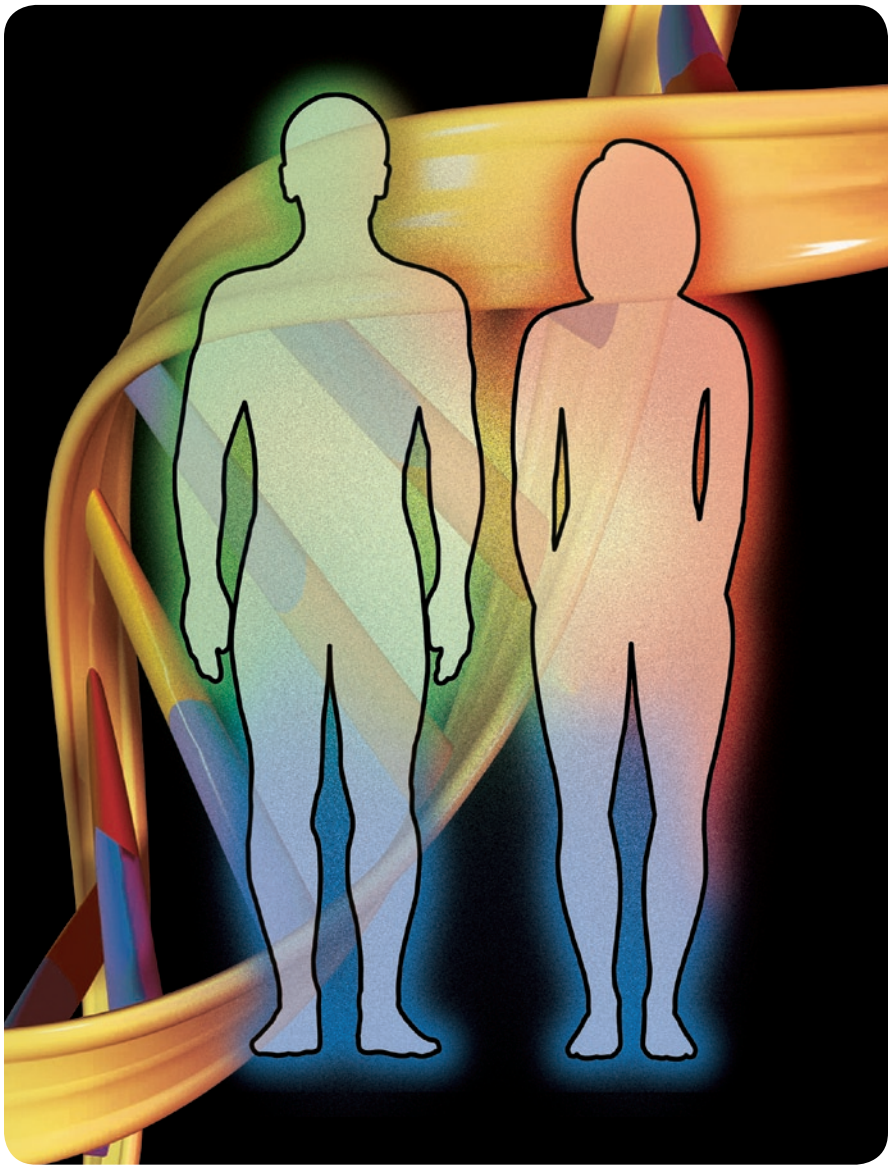
Medications have been prescribed over the years mostly by trial-and-error to reach the best dose for each patient. Typically, doctors diagnosed a condition and then selected what they believed was the most promising drug for treatment. If one didn't work, they'd try another.

Today, as science gives way to the understanding that people and diseases differ at the genetic or molecular level, doctors are learning to tailor treatments—or personalize them—to individuals more effectively.

By using "genomics," or the identification of genes and how they relate to drug treatment, doctors will be able to treat patients based on the actual biology of a disease and not just according to symptoms, and as an individual, not just a member of a population.

The Food and Drug Administration is especially interested in clearing the pathway for the development of safe and effective, leading-edge products that this burgeoning field of genomics is spawning—multiple tools, technologies, and sciences that will translate into the discovery and safety of drugs and medical products that the agency regulates.

By ensuring that new products and technologies are developed and made available to doctors and patients as effectively as possible, FDA believes



FDA / Michael Ermarth

Each person has a unique set of chemical blueprints that determine how his or her body looks and functions. These blueprints are contained in their own DNA which is made up of two twisting sequences or single strands that are able to be paired with another.

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this can only enhance the health of all Americans.

What is Personalized Medicine?

Personalized medicine uses information about a person's genetic makeup to tailor products that will detect, treat, or prevent disease in that person. The goal is to get the best medical outcomes by choosing treatments that work well with a person's genetic profile, or with certain characteristics in the person's blood or cells.

Scientifically, personalized medicine is known as pharmacogenomics (drugs combined with genes), or how genetic differences in individuals affect the way people respond to drugs. The science of pharmacogenomics tries to answer questions like: Why do some people get cancer and others don't? Why is cancer more aggressive in this person and not in that one? Why does this drug work for him and not for her? Why do some people show toxicity to a drug while others don't? Why does someone need twice the standard dose to be effective? And why do others need only half of the standard dose?

FDA / NCTR

FDA scientist preparing samples of rat urine for analysis. By studying certain molecules that are present in body fluids, researchers hope to be able to target groups of people most likely to benefit from a drug.

How Does It Work?

Someone diagnosed with colon cancer today would receive a treatment based on standard medication and dosing guidelines for that disease. The doctor might factor in weight, age, medical history, and how any blood relatives might have reacted to a certain medication. But the doctor cannot know how that person will respond to the medication, which may help the cancer or have no affect at all. The person could experience terrible side effects or none at all. And, it may be necessary for several revisits to the doctor for adjusting the dosage or to switch medications. This is considered the trial-and-error approach to medicine.

With personalized medicine, people may be able to take a genetic test that can help determine which diseases they are likely to develop, and a blood test to help determine which genetic variations they may have—even before they've taken a single dose of medicine. Based on test results, the doctor could tailor a patient's treatment by avoiding using a certain drug, prescribing another, or altering a dose to match the body's genetics. A person's unique genetic profile can help a doctor personalize treatments.

What's Involved?

New technologies and tools have been developed as a direct result

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of the nation's effort to understand DNA—deoxyribonucleic acid—the blueprint that determines how each person's body looks and functions. Those technologies and what they intend to accomplish within personalized medicine include:

- **Functional genomics**—measures gene expression under normal and troubled conditions and attempts to predict the gene expression profiles for these conditions.
- **Structural genomics**—addresses questions concerning individual genetic differences and the impact that these genetic differences have on the development of disease.
- **Proteomics**—seeks to discover all proteins in a living organism, and determine their function and how they affect each other.
- **Metabolomics**—studies all the molecules involved in metabolism (metabolites) in a living organism by evaluating tissues and body fluids, such as urine, blood, plasma, and saliva for changes.
- **Genomics and medical devices**—understands how certain diseases, or increased risks pass from generation to generation.
- **Nanotechnology**—uses materials or devices at the level of molecules and atoms too small to be seen with a conventional laboratory microscope.

What are the Benefits?

- Diagnosing disease or predicting risk of disease.
- Determining whether a treatment is working or not.
- Monitoring healthy people to detect early signs of disease.
- Producing safer drugs by predicting the potential for adverse effects earlier.
- Targeting specific groups of people most likely to benefit from a drug, while keeping its use from those who may be harmed by it.
- Providing researchers the opportunity to get a global view of the events that are always changing within a cell.
- Producing new classes of structural materials that are expected to bring about lighter, stronger, smarter, cheaper, cleaner, and more precise medical products.

What Are the Challenges?

- Personalized medicine is new and still in the early stages.
- Using a pharmacogenomic test to determine who will respond to a treatment or who should not get a treatment may narrow the market for certain drugs—manufacturers may be reluctant to invest time and money.
- Identifying all of the genetic variations (perhaps millions) that may exist could take years.
- How a person responds to a medication may not be determined by just one gene, but rather, several genes and their products interacting with each other.
- This new way of doing things likely will be expensive and time-consuming.

FDA's Role

Tests that scientists are beginning to use on body fluids and cells to determine the variations of disease were not available in the past. Such tests, coupled with the understanding of the expression of each individual's genes, will allow scientists to detect differences between patients and diseases much more precisely. FDA's Critical Path Initiative—the scientific process through which a medical product is transformed from discovery to development—is organizing work across 76 science and regulatory areas to improve medical product development, especially for gene-oriented drugs and diagnostic tests.

FDA encourages applications for approval of new tools and technologies for a number of reasons:

- The ability to bridge data gaps that exist in preclinical studies (animals) and clinical studies (humans) used to assess the safety and effectiveness of products it regulates.
- Technologies can be used not only in the discovery phase of potential products, but also in the safety and effectiveness evaluation phase of development and submission to the agency.
- Adverse events likely can be predicted prior to the approval and marketing of a product.

FDA's role in personalized medicine will be to bring balance to an evolving science in a way that does not inhibit its growth. Thousands of cancer patients are already benefiting from several targeted drugs, such as Tarceva and Gleevec, both known to work better in people with certain genetic profiles. Hope for the future is that personalized medicine will improve the safety, quality and effectiveness of health care for every American. FDA