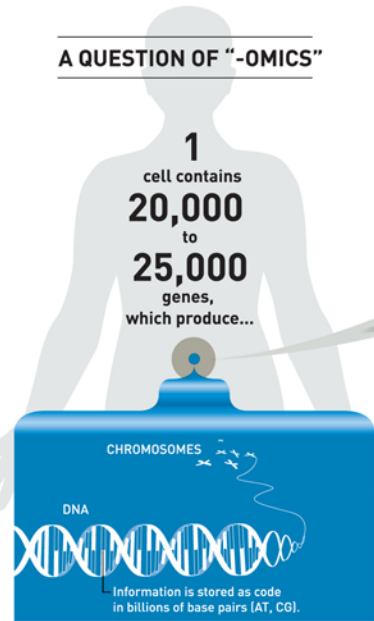


Beyond the Genome

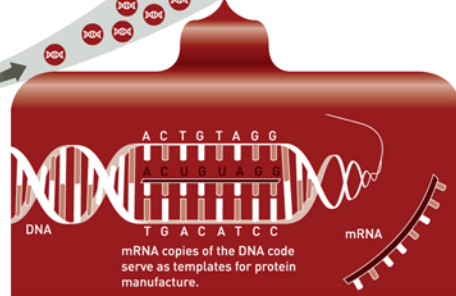
BY JENNIFER BAILS // INFOGRAPHIC BY FLYING CHILLI

Six years ago, when the complete sequence of 3 billion chemical base pairs that make up human DNA was finally mapped and published, a great leap forward was taken. Yet the genome alone can't reveal how our bodies function—and malfunction. So, in the postgenomic era, scientists are decoding myriad other “-omes” to fill in the blanks. The size of the challenge is mind-boggling: Each human cell has 20,000 to 25,000 genes capable of producing as many as 1 million proteins to carry out its work, such as driving essential metabolic reactions. In turn, there are 2,000 to 20,000 by-products of metabolism. Detecting and identifying these genes, proteins and other small molecules—and figuring out how they work together to create our physiology—lie at the heart of the “-omics” revolution. Here are several crucial “-omes” and how they could prove important in understanding disease.

A QUESTION OF “-OMICS”



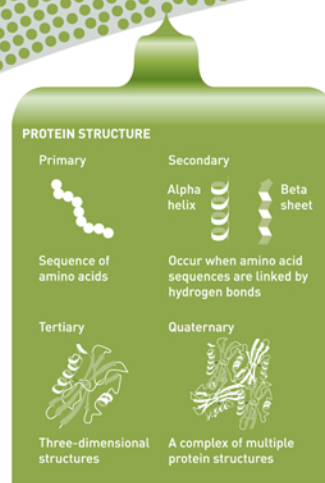
1 million mRNA transcripts, the templates for producing...



Transcriptomics: What Is Ordered to Happen

To follow the genetic code's instructions, a cell creates messenger RNA copies, or “transcripts,” of sections of code. Some of these transcripts are then used as templates to manufacture, or “express,” proteins that do the actual work in the body, from storing oxygen in red blood cells to helping nerve cells fire. By analyzing the transcriptome (all the mRNA in a cell), scientists can determine which genes were turned on and when—and acquire a deeper understanding of how differences in gene expression may contribute to disease.

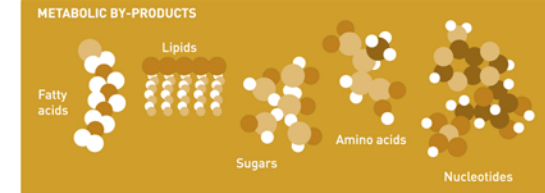
250,000 to 1 million proteins, which carry out the cell's work, yielding...



Proteomics: What Makes It Happen

Proteomics attempts to understand how hundreds of thousands of proteins carry out almost everything the body does, an endeavor several orders of magnitude more complicated than understanding the genome. It's not only that a single gene can encode as many as 1,000 different proteins, but that protein function depends on more than just the sequence of amino acids. How the proteins fold and are modified, how many copies are expressed and how long they remain in the cell are crucial factors too.

2,000 to 20,000 by-products of metabolism.



Metabolomics: What Actually Happens

Because it most closely predicts human physiology, the metabolome can be viewed as the end point of the “-omics” cascade. That's why some experts think that analyzing the thousands of by-products of metabolism, or metabolites, will lead to clinical uses sooner than the other “-omics.” Plus, metabolite profiles are cheap compared with DNA and protein analysis. Though the functions of many metabolites are already well known—elevated cholesterol, for example, has long been associated with heart disease and stroke—the field is still in its early stages, as researchers learn how to identify and quantify metabolites in biological samples.

Some caution that metabolic changes might be too far “downstream” from a disease or influenced by environmental variables to disclose much about the underlying causes. No single “-ome” will provide the full picture—it's the integration that's important.

The suffix *ome* comes from the Greek for all, every or complete. It was originally used by German botanist Hans Winkler, who coined the word *genome* in 1920 by the coupling of *gen* and *some* from *chromosome*. New “-omes” are thought up regularly: An online glossary [genomicglossaries.com/content/omes.asp] that tracks this evolving terminology now contains more than 150 definitions. Here are just a few.

- epigenome:** the history of environmental influences on a genome, an approach that could help tease out external factors leading to genetic variation
- interactome:** list of interactions between all macromolecules in the cell, which may help explain our biological complexity
- metallome:** all the inorganic species within a cell, including metal ions, which play a vital role in fundamental processes from signaling and gene expression to reaction catalysis
- microbiome:** the full collection of microbes within the human body—knowledge of which might help scientists understand how these organisms interact with the body