

# Challenges of Nutrigenomics

**David Wishart**

**University of Alberta**

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**Agriculture Institute of Canada Conference 2007  
Making Choices: consumers and their impact on  
Canada's agriculture & food**

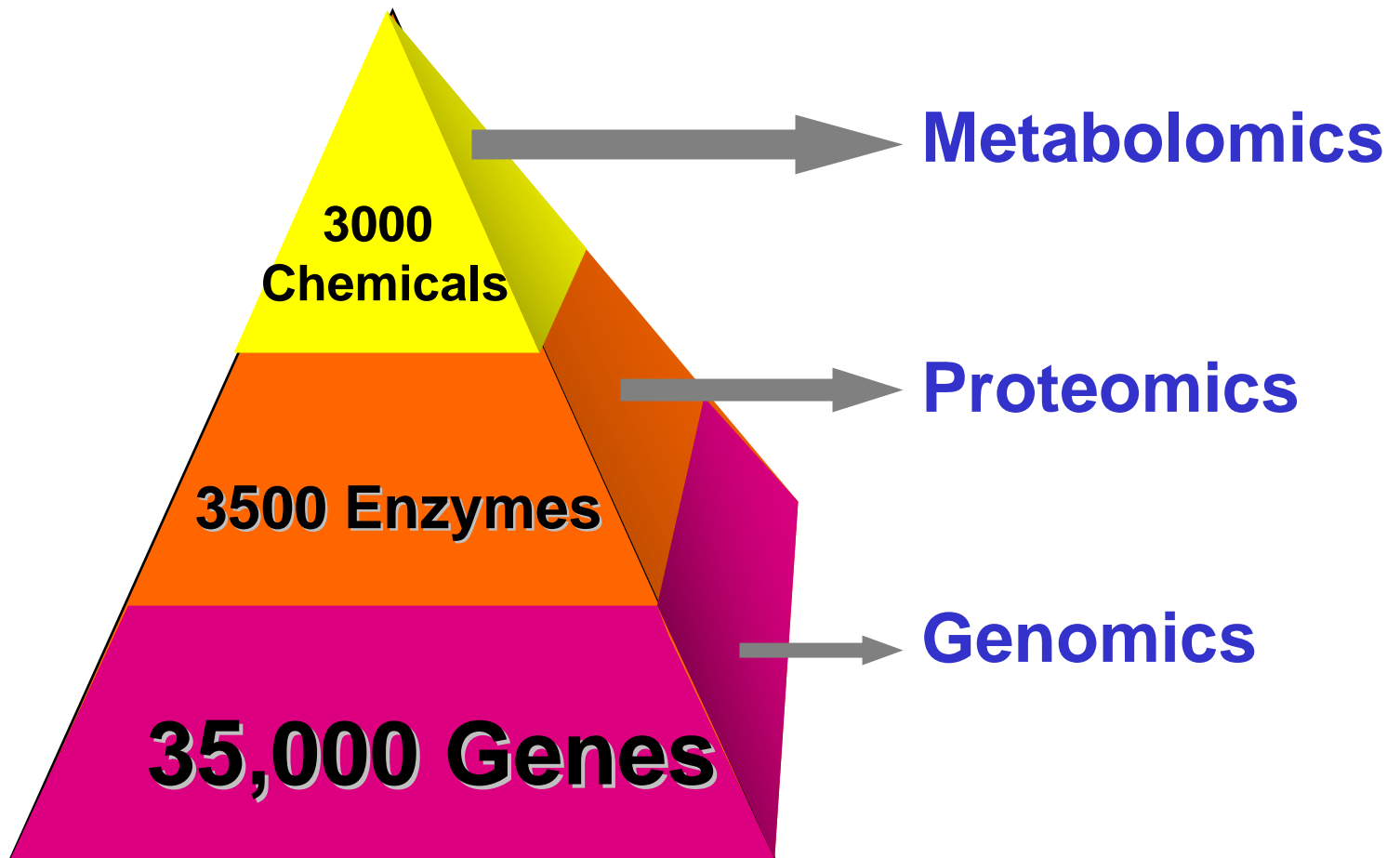
# Defining Nutrigenomics

- *Nutrigenomics* is a newly emerging field that employs **genomics, proteomics and metabolomics** to better characterize the relationship between diet and health. It focuses on identifying the molecular relationships between nutrients and genes, to help us understand how dietary changes can affect both human and animal health.

# Other “Omics” Definitions

- **Genomics** - A field of life science research that uses High Throughput (HT) technologies to identify and/or characterize all the *genes* in a given cell, tissue or organism (i.e. the genome).
- **Proteomics** - A field of life science research that uses High Throughput (HT) technologies to identify and/or characterize all the *proteins* in a given cell, tissue or organism (i.e. the proteome).
- **Metabolomics** - A field of life science research that uses High Throughput (HT) technologies to identify and/or characterize all the *metabolites* in a given cell, tissue or organism (i.e. the metabolome).

# The Pyramid Of Life



# Genomics Technologies

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**SNP Chips for rapid  
mutation ID**

**Roche 454 Sequencer  
500 million bp/day**

# Metabolomics & Proteomics Technologies



- UPLC, HPLC
- CE/microfluidics
- LC-MS
- FT-MS
- QqQ-MS
- NMR spectroscopy
- X-ray crystallography
- GC-MS
- LIF detection

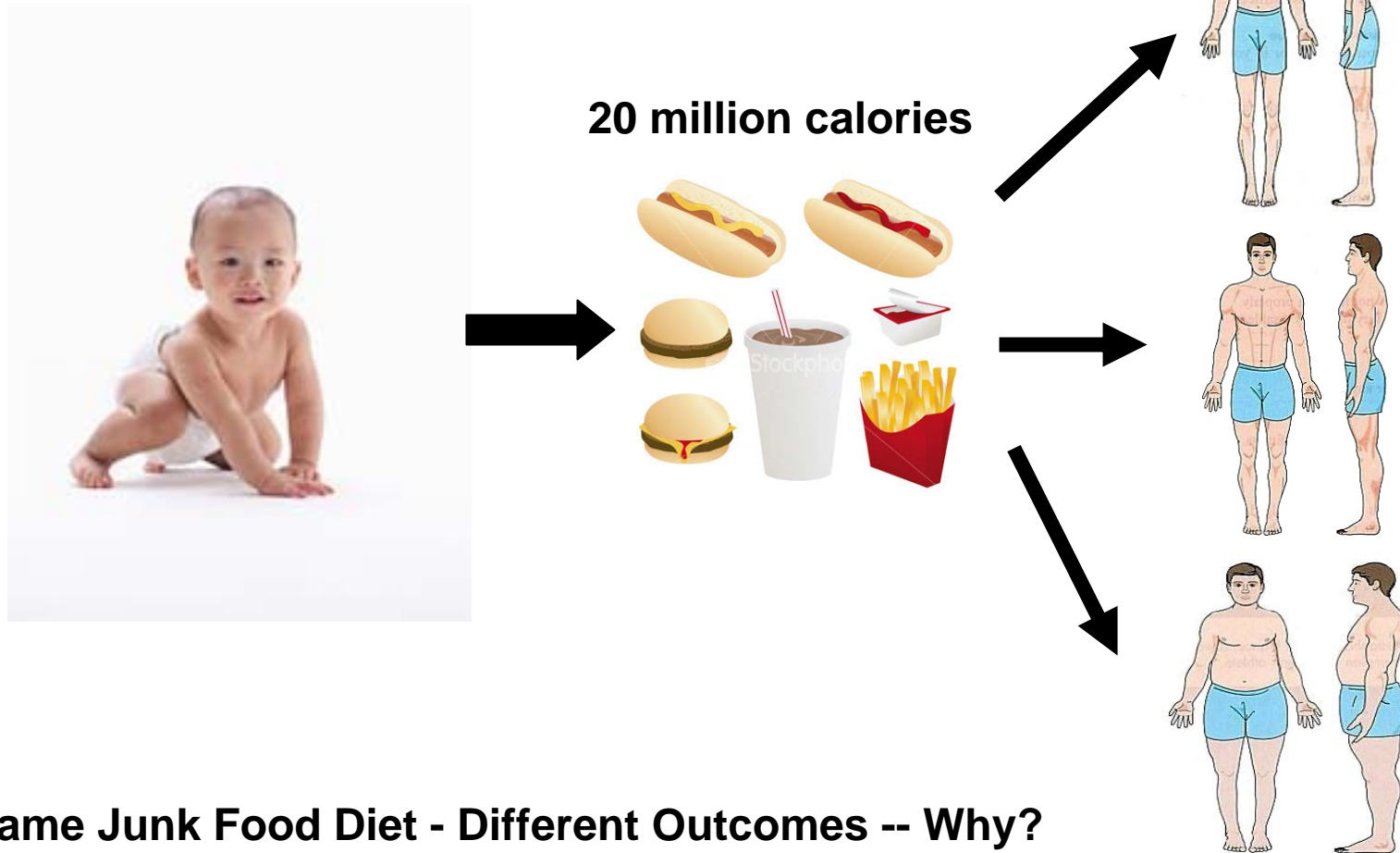
# How Will These Technologies Change Our Views of Food?

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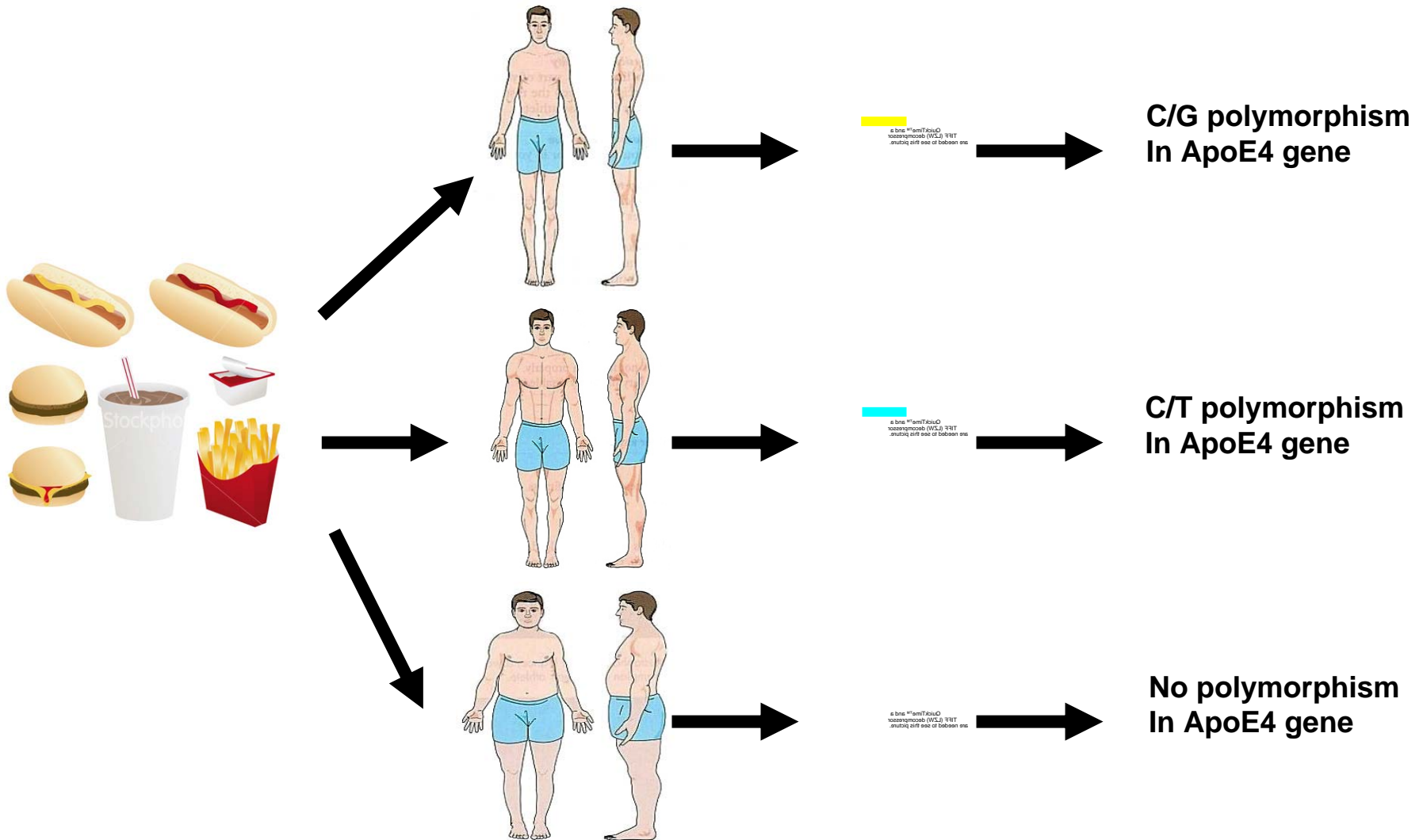
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# Food and Phenotype - 1



# Genomics Has An Answer



# Nutrigenomics Challenges:

- **What genes play a role in defining our propensity for obesity, diabetes and atherosclerosis?**
- **Even if we knew which genes were responsible, could we test people for these?**
- **Given this knowledge, how could we get people to change their diets? their lifestyles?**

# Meeting the “Gene Finding” Challenge

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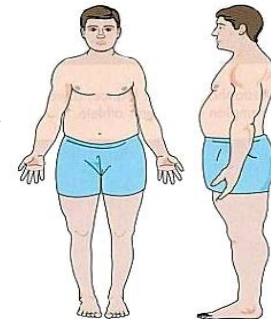
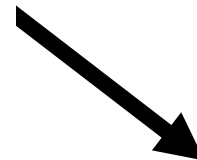
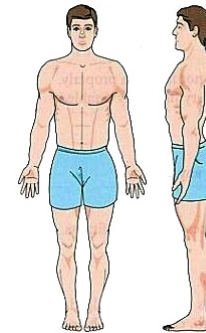
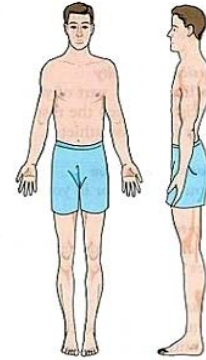
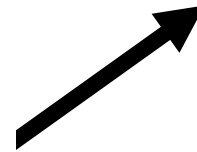
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# Gene Testing Now & Beyond

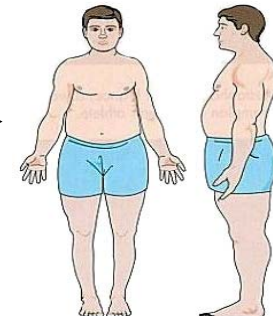
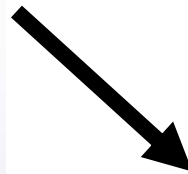
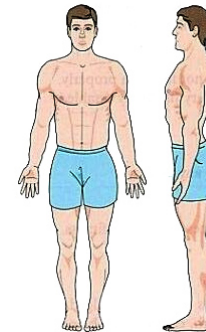
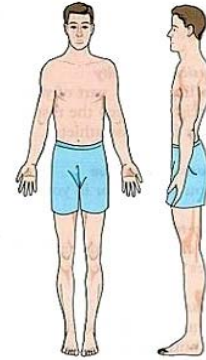
- **It is now possible to sequence a human genome for <\$300,000**
- **In 5 years it will be possible to sequence your genome for <\$10,000**
- **It is now possible to identify most human mutations (SNPs) for <\$10,000**
- **In 5 years it will be possible to do this test for \$100**

Personal genome project: <http://arep.med.harvard.edu/PGP/>

# The Future: A Hand-held Gene Test For Obesity Risk?



# Food and Phenotype - 2

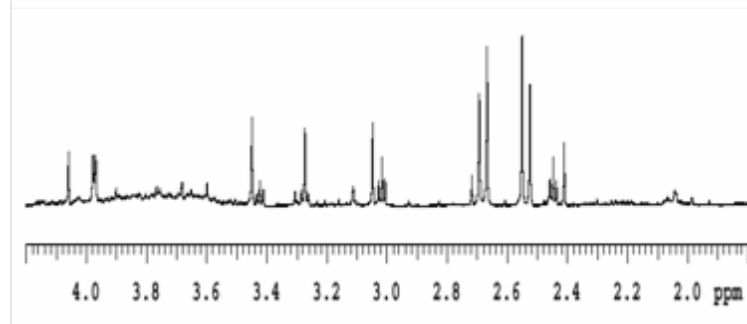
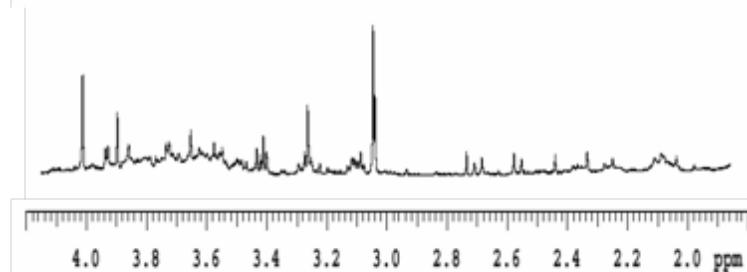
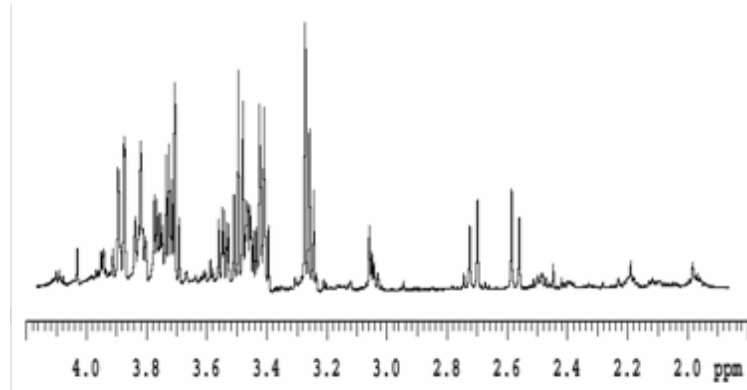


**Different Diet - Different Outcomes -- Why?**

# How Does Diet Influence Our Genome?

- **What are the key (functional) nutrients that are in certain foods?**
- **How do certain nutrients change our cellular physiology?**
- **How do some nutrients change our genetic programming?**
- **How can we develop personalized nutrition plans?**

# Metabolomics & Nutrient Analysis



# Nutrient Analysis

- **Metabolomics allows 100's of compounds to be rapidly identified and quantified in **foods****
- **Metabolomics also allows 100's of compounds to be rapidly identified and quantified in **our bodies****
- **Alberta is a world leader in metabolomics**

# Home-Grown Metabolomics & Nutrient Resources

FooDB: Intro - Windows Internet Explorer  
http://hmdb.med.ualberta.ca/foodb

**FooDB**  
The Food Component Database

Home Browse DrugBank HMDB

Search

**Welcome to the FooDB food component database**

FooDB is a comprehensive database providing information on food components. The list of food components has been taken from the HMDB. The first stage of annotation (automated) is based on the HMDB. The second stage of annotation (manual) is based on the HMDB.

FooDB has been built from the ground-up using the FooDB framework.

Questions or corrections regarding FooDB can be sent to [foo@hmdb.med.ualberta.ca](mailto:foo@hmdb.med.ualberta.ca).

Designed and tested with:

- Safari 2.0+
- Firefox 2.0+
- Internet Explorer 7.0+

This project is supported by Genome Alberta & Genome Canada, leading Canada's national genomics strategy with the goal of understanding the human genome and its interactions with the environment.

| ID | Name                                | CAS       | Formula  | Structure | Show |
|----|-------------------------------------|-----------|--|-----------|------|
| 1  | 2-Methylcyclopentanone              | 341-91-3  | C <sub>6</sub> H <sub>10</sub> O<br>238.400                            |           | Show |
| 2  | 2-Aminonicotinic acid, methyl ester | 111-79-5  | C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub><br>176.249 |           | Show |
| 3  | 1-phenyl-L-2-propanone              | 579-67-7  | C <sub>9</sub> H <sub>10</sub> O<br>146.174                            |           | Show |
| 4  | phenylethyl methanone               | 4419-66-5 | C <sub>9</sub> H <sub>10</sub> O<br>136.174                            |           | Show |
| 5  | ethyl acetate                       | 109-43-2  | C <sub>4</sub> H <sub>8</sub> O <sub>2</sub><br>88.106                 |           | Show |
| 6  | general isothiazole                 | 2345-26-8 | C <sub>2</sub> H <sub>2</sub> N <sub>2</sub> S<br>74.076               |           | Show |

Metabolomics Toolbox - Netscape  
http://hmdb.med.ualberta.ca/~hmdb/foodb/foodb/PEP/

**Metabolomics Toolbox**

Home Browse ChemQuery Test Query SeqSearch Data Extractor The Human Metabolome Project DrugBank

**Metabolite Database**

Search HMDB for:

The Human Metabolome Database (HMDB) is a free human body. It is intended to be used for applications to contain or link three kinds of data: 1) chemical, 1400 metabolite entries including both water-soluble and lipid-soluble metabolites. Additionally, approximately 1000 metabolite entries with half of the information fields are hyperlinked to other databases (KEGG, PubChem, etc.). The database supports extensive text, sequence, etc.

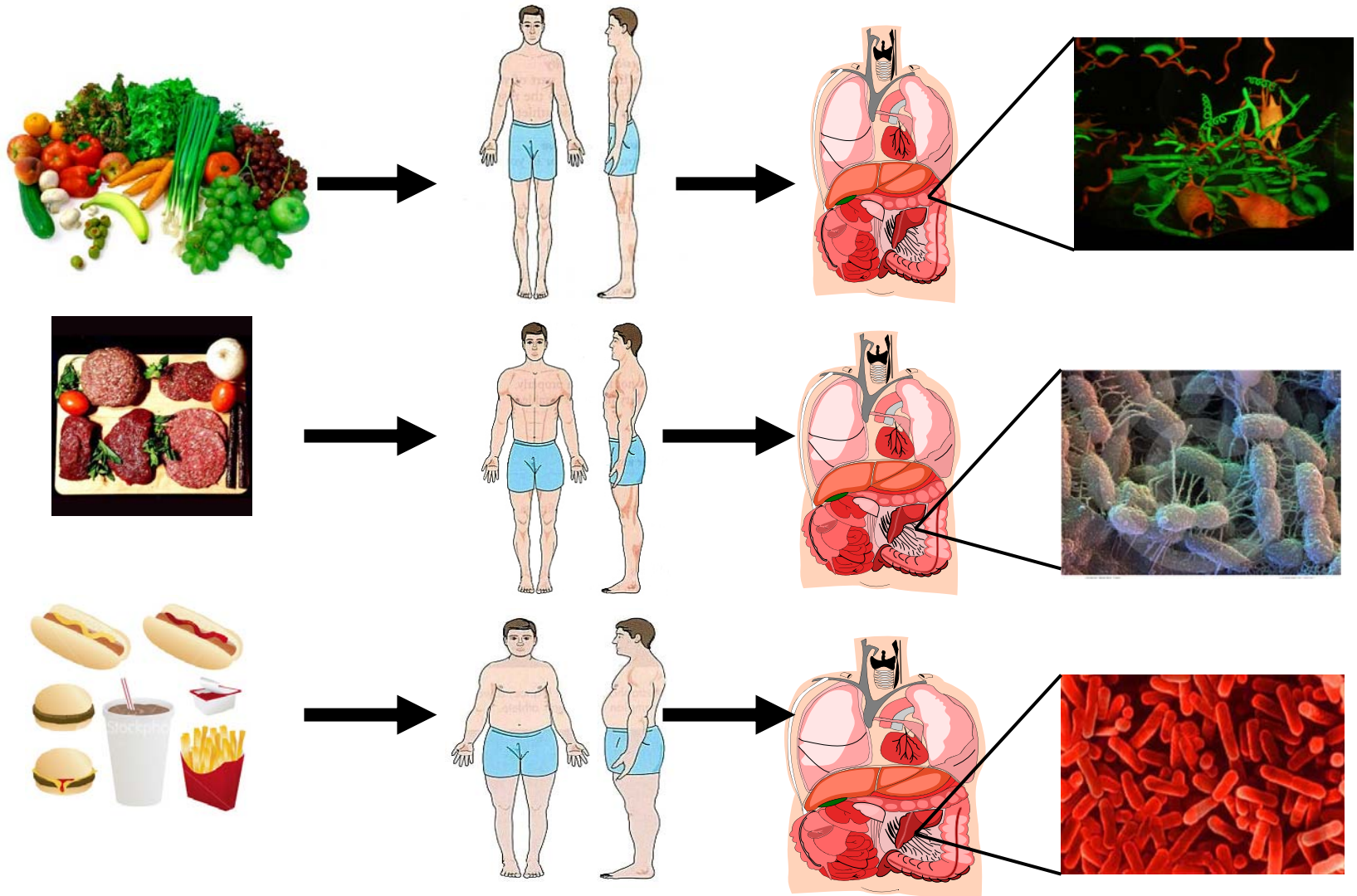
The simple test query (below) supports general navigation panel above and below) generates a table re-sort its contents. Clicking on a given MetaboliteCard draw (using a ChemSketch applet) or write (using compound). The TestQuery button supports a more complex query. The SeqSearch button allows users to conduct BLAST queries (whole proteome) BLAST queries are supported. The Data Extractor button allows users to extract data from various combinations of subfields. The Data Extractor button allows users to extract data from various combinations of subfields. The Data Extractor button allows users to extract data from various combinations of subfields.

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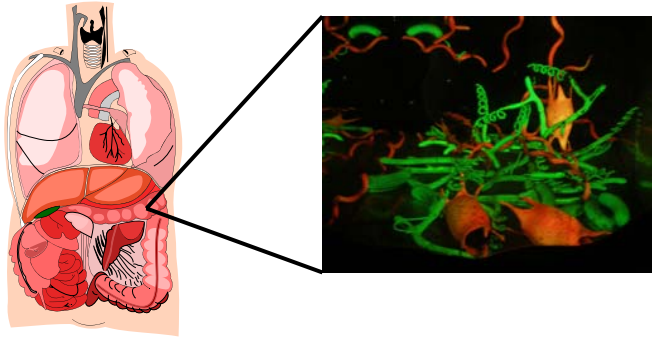
<http://hmdb.med.ualberta.ca/foodb>

<http://www.hmdb.ca>

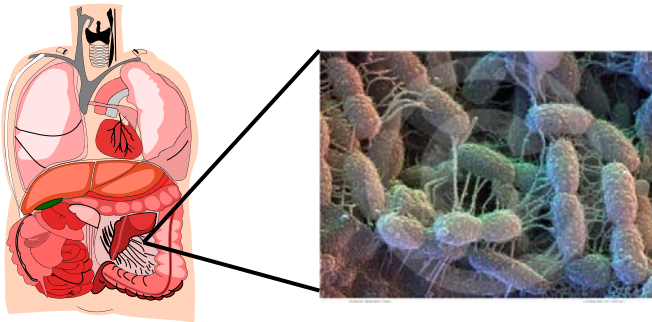
# Diet Influences What Lives in Our Intestines



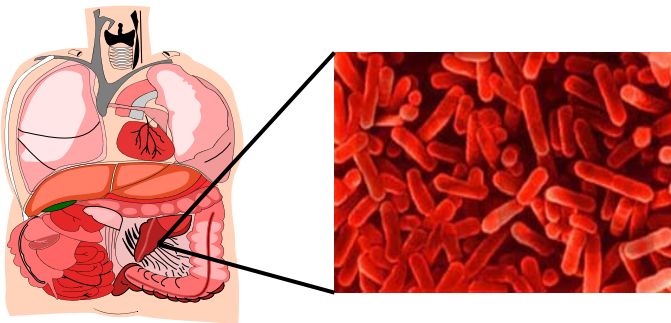
# Genomics Can Reveal These Changes



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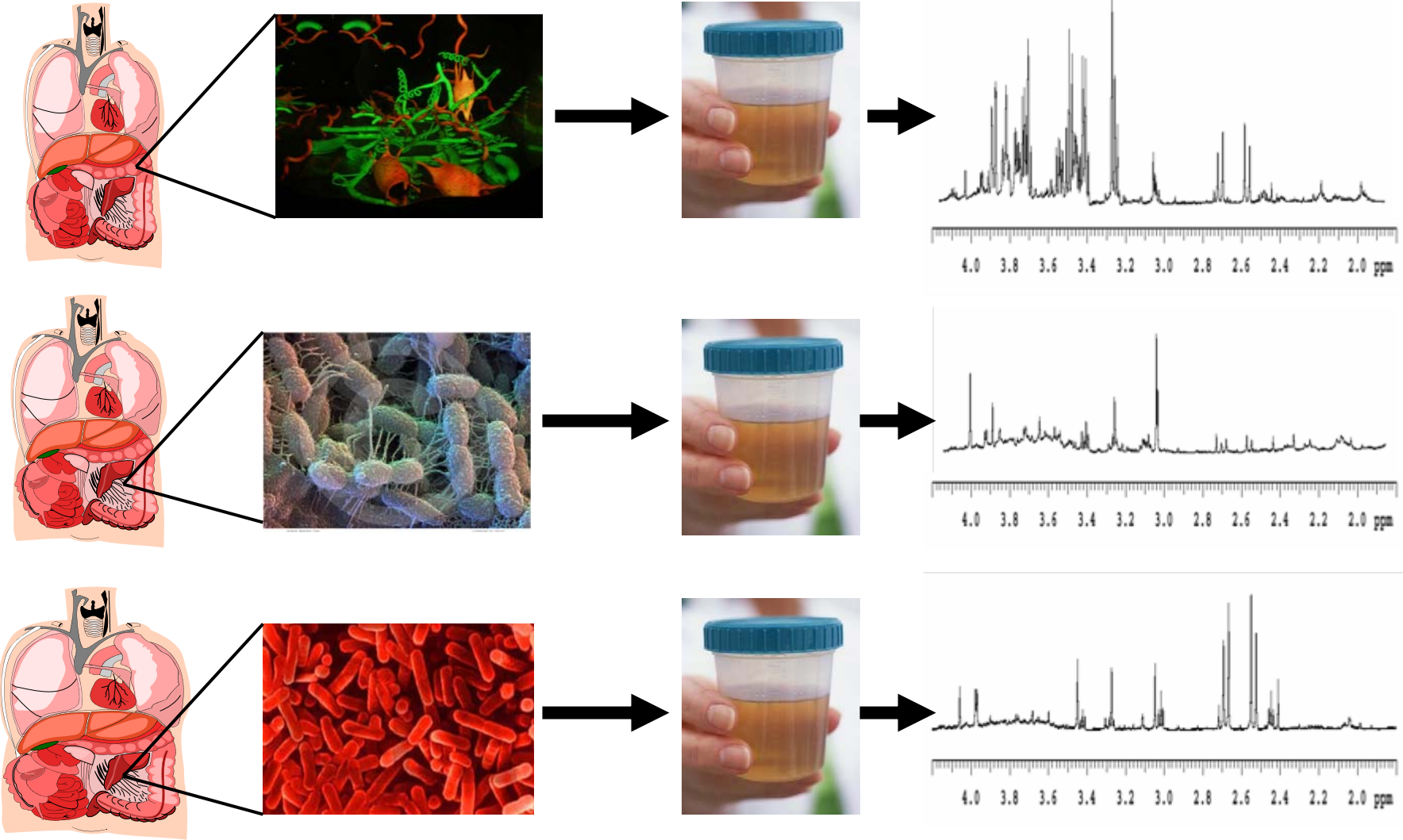


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# Metabolomics Reveals Changes Too



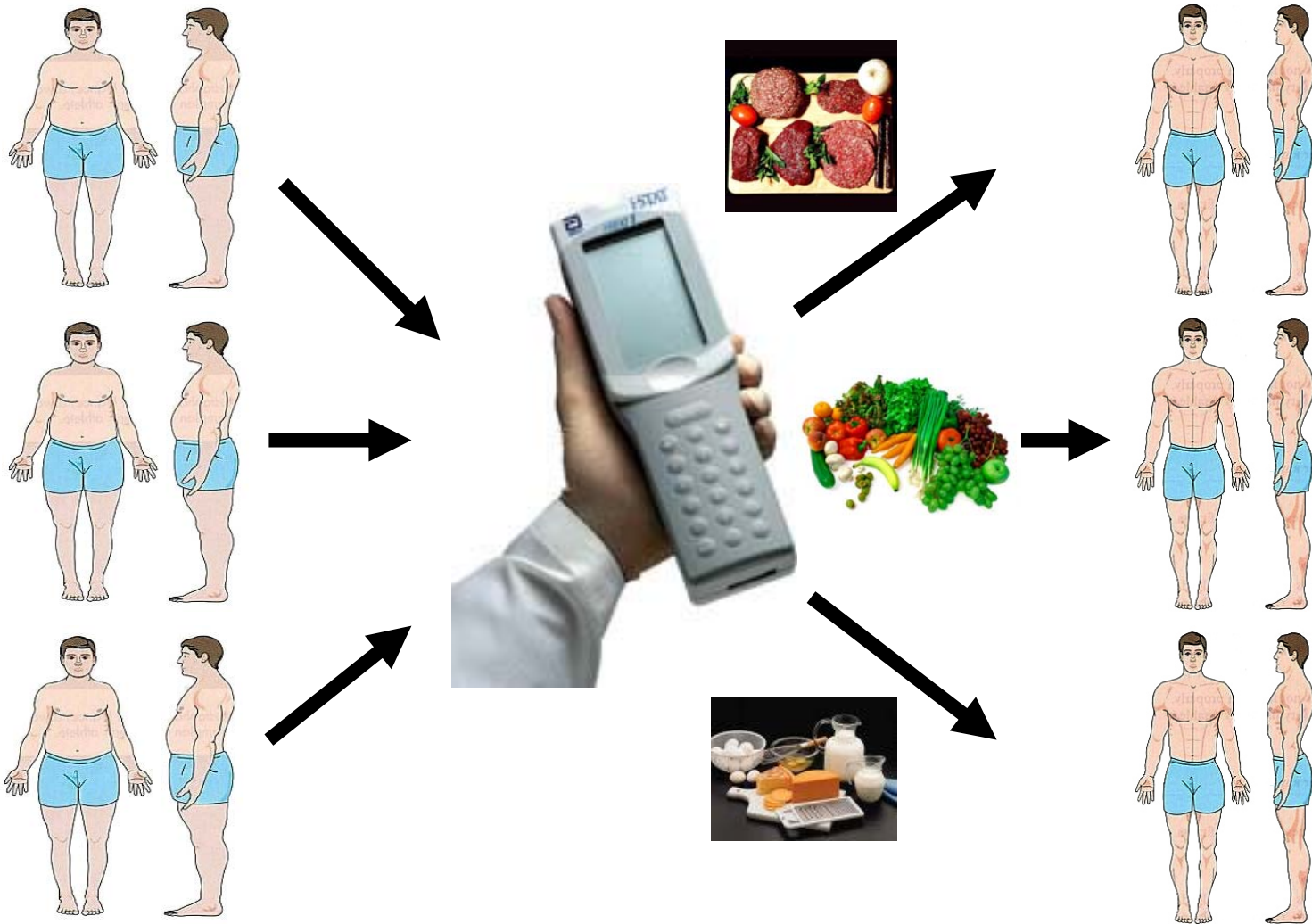
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# Food & Phenotype

- **Genomics and Metabolomics allow detailed characterization of gut microflora and their nutritional or phenotypic consequences**
- **These techniques may allow customization of diet and nutrition to change gut microflora to a “better” type (personalized nutrition)**

# The Future: Personalized Nutrition?



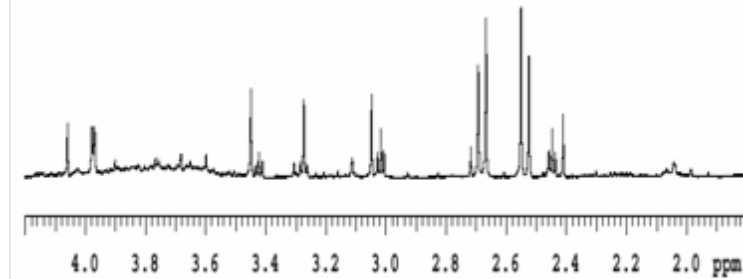
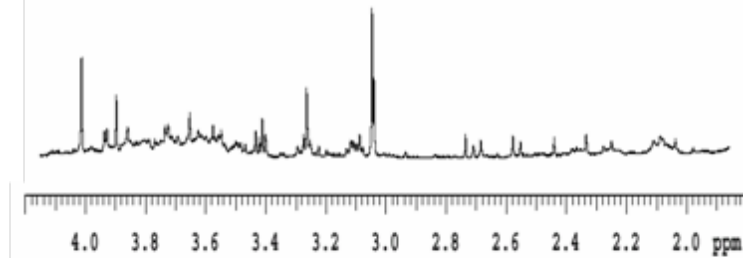
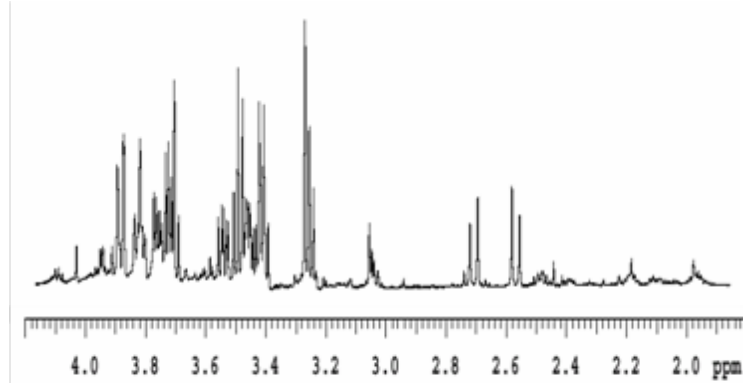
# How Will Nutrigenomics Influence Food Producers?

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# Improving Nutrient Analysis

canola



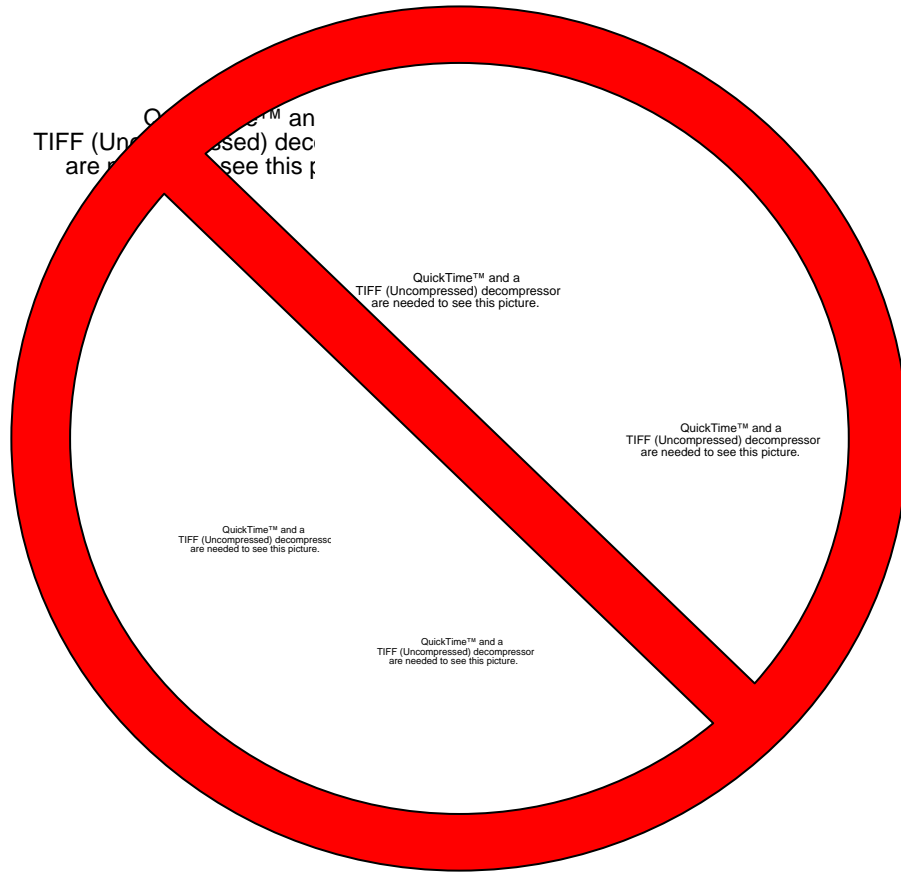
**Same apparent phenotype -- completely different nutrient profile**



# How Will Nutrigenomics Influence Consumers & Regulators?

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# More Informed Dieting



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# Other Potential Influences

- Higher expectations for food and/or nutrient labeling
- More selective purchasing and greater demand for healthy foods
- Greater demands for functional foods
- Stricter enforcement of functional food claims
- More frequent safety and efficacy testing
- Making nutrition more of a science and less a lifestyle choice
- *A healthier population*

# Conclusions

- **The “omics” revolution is changing every facet of the life sciences**
- **Nutrition is one of the last “islands” to feel the “omics” effect**
- **Nutrigenomics will substantially change how we eat and how we grow or prepare food**
- **Nutrigenomics will also have important consequences for health and quality of life issues**
- **Alberta is in a unique position to exploit many of the latest developments in nutrigenomics**

# Acknowledgements



**Genome**Alberta



**Genome**Canada



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