

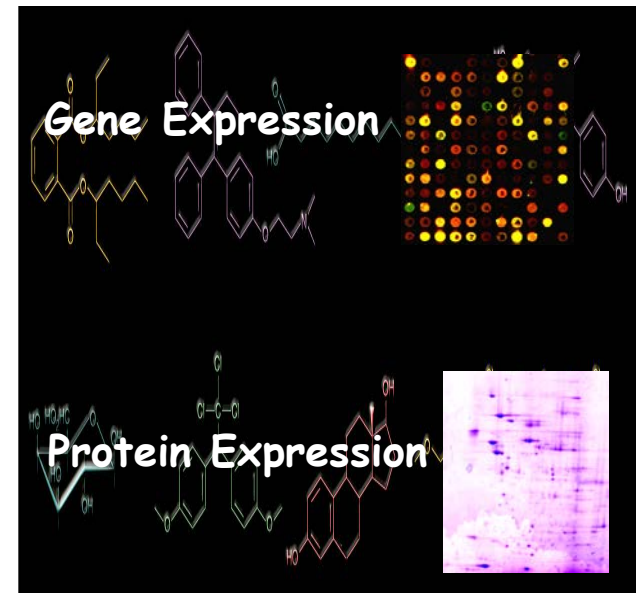
Personalized Nutrition and the Future of Dietary Supplements

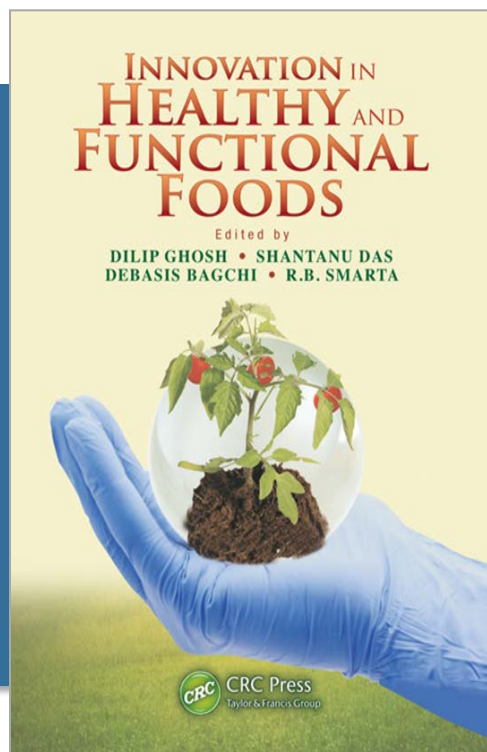
Dilip Ghosh, PhD, FACN

Director, **nutriconnect**

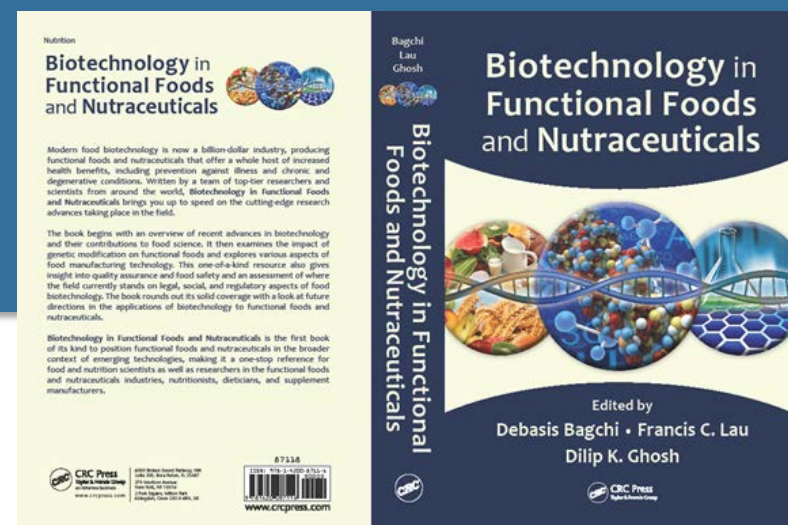
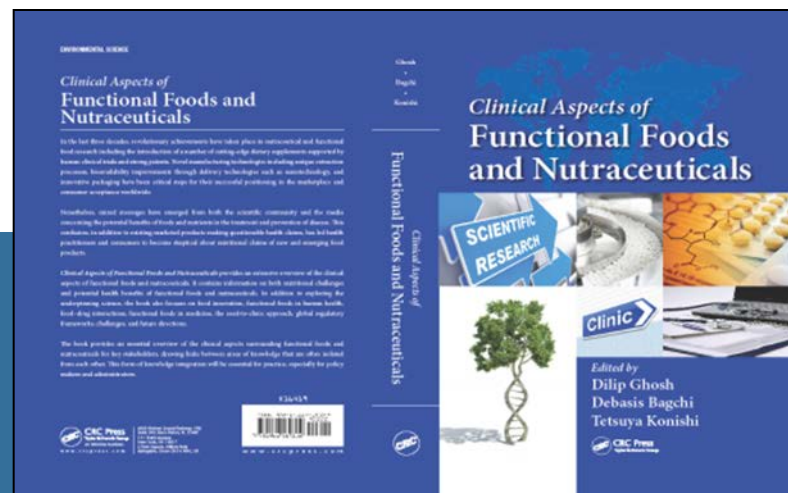
dilipghosh@nutriconnect.com.au

www.nutriconnect.com.au

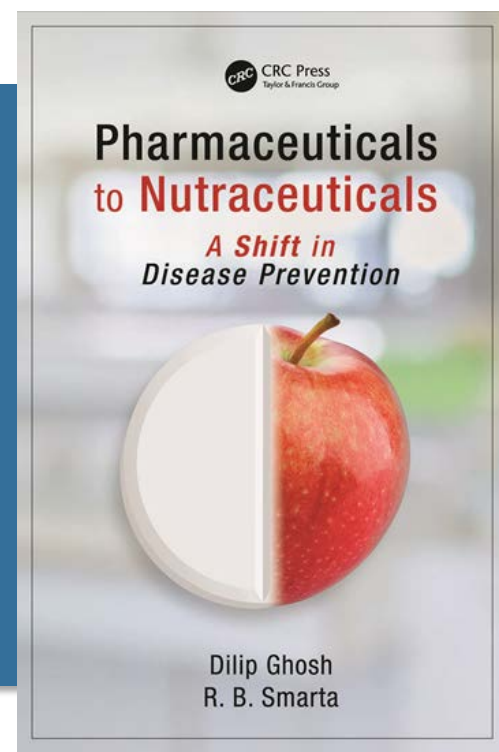




Science



Practice



Regulation

NO
IMAGE

The Future of Dietary Supplements and Personalized Nutrition

[Dilip Ghosh](#)

ISBN: 978-1-119-18642-7

352 pages

July 2017, Wiley-Blackwell

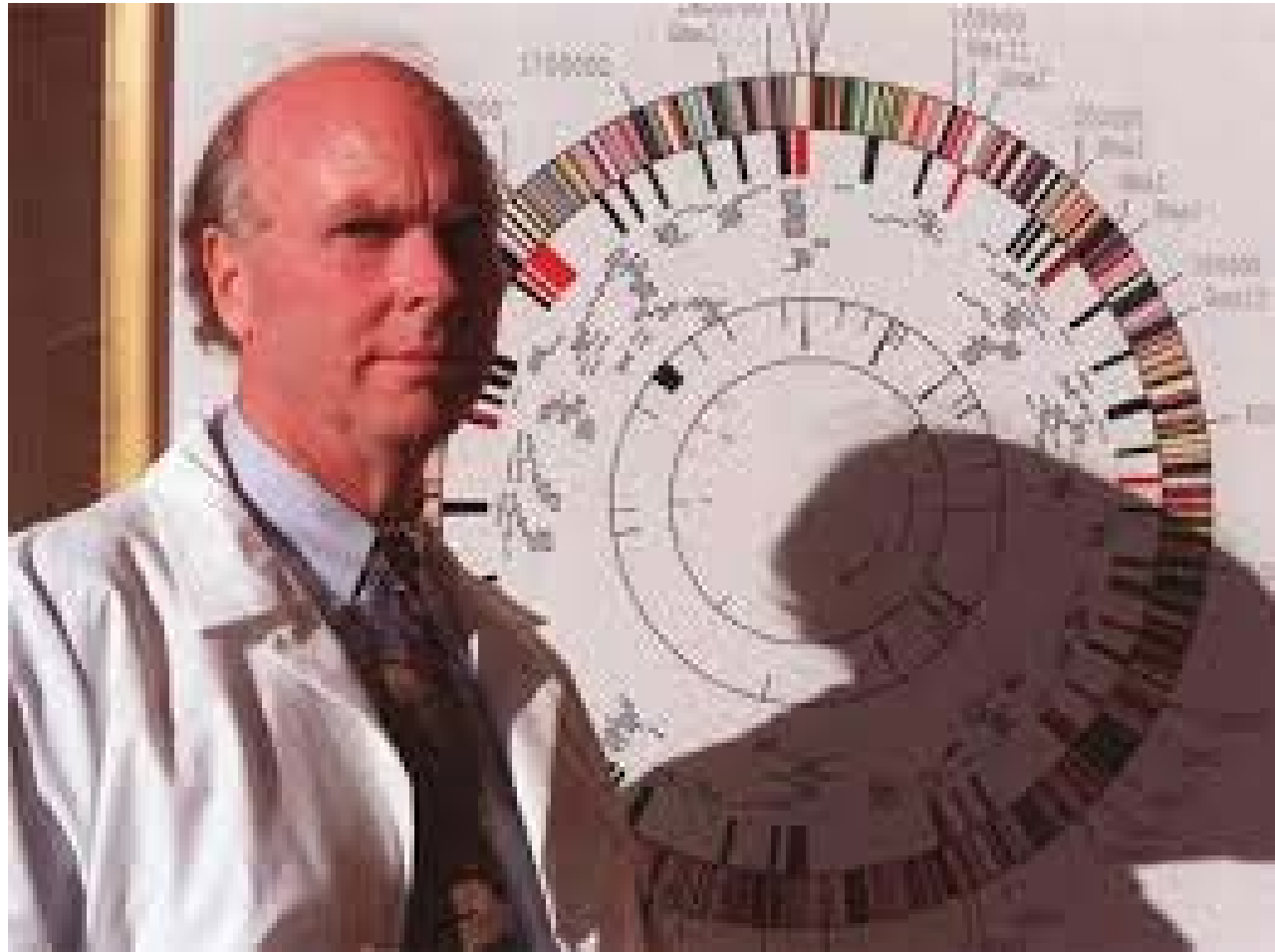


Who is he?

Science

Practice

Regulation



Who is he?

Science

Practice

Regulation



Who is he?

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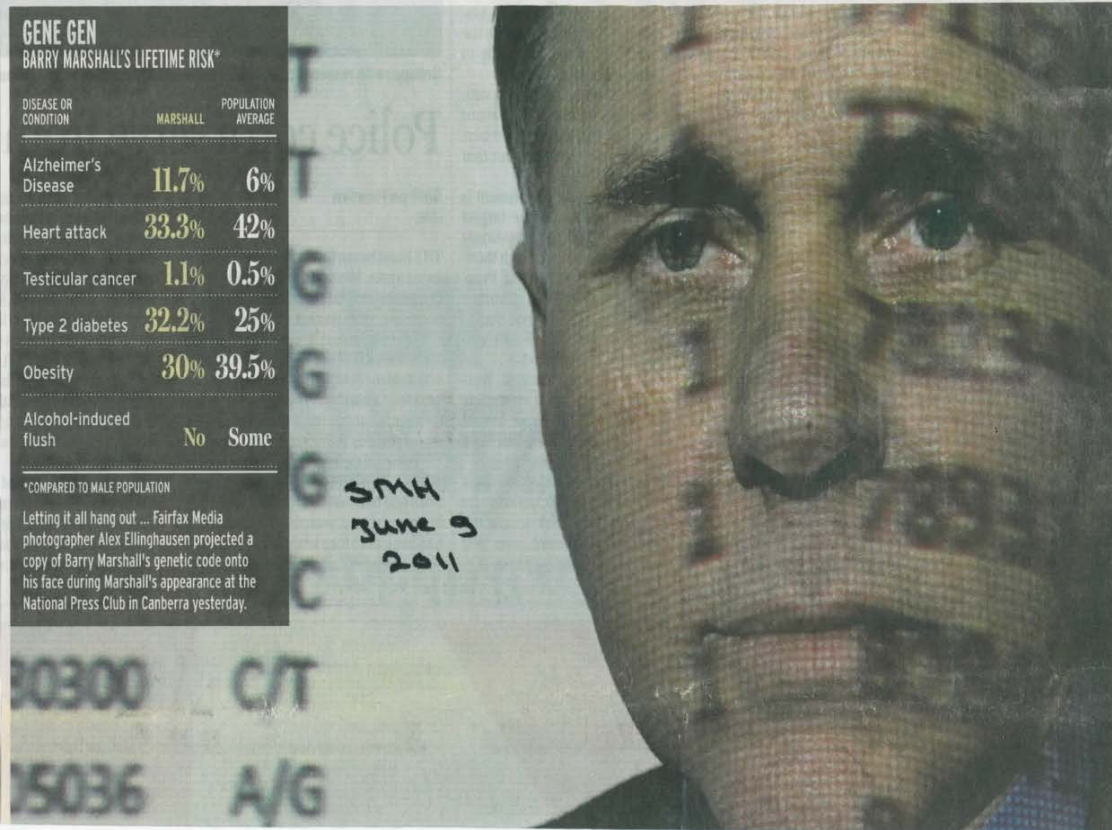
Practice

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Internet DNA-ting: I'll show you mine if you show me yours

Internet DNA-ting: I'll show you mine if you show me yours

GENE GEN: Prof. Barry Marshall's Lifetime Risk



1st Aussie Celebrity to post his full genetic code on the internet

Prof. Barry Marshall:

1st Aussie to post his full genomic code

What are his lifetime **RISKS** ?

Macular degeneration: 3 times ↑

Alzheimer's Disease: 2 times ↑

Heart attack: marginally ↓

Type 2 diabetes: marginally ↓

Two words changing the world: Customisation and Personalisation

Customisation of supplemented products is based on 4 tenets:

- Shift towards natural ingredients
- Cultural customization to suit specific regions and specific target groups
- Shift towards new delivery mechanisms
- Disease/Condition specific formulations



Criteria underlying consumer personalization

Platform	Criteria
Taste & flavour	<ul style="list-style-type: none"> • Most immediate & easily accessed criteria. • Genetic diversity of taste & olfactory sensation are now well established. • Olfactory preference is most driving force
Cultural mores	<ul style="list-style-type: none"> • Based on religious & philosophical value system. • Halal, Kosher, vegan, religious fasting etc.
Life stage	<ul style="list-style-type: none"> • Specific physiological needs of the stages of life stages. • Pregnancy, lactation, weaning, infancy, aging, recovery from illness etc. • Both short term and long term supplementation
Lifestyle	<ul style="list-style-type: none"> • Products for athletes at different stages of training. • High altitude training • Frequent traveler
Lifestyle diseases	<ul style="list-style-type: none"> • Diagnostics related to high risk disease condition as a direct result of chronic lifestyle choices. • Excess body weight, intestinal discomfort, smoking, sedentary behavior, high-fat diet etc.
Inherited Diseases	<ul style="list-style-type: none"> • Relevance to family history of inherited diseases • Food & supplement intervention is recognized an integral part of this solution such as allergies & intolerances. • Inborn error of metabolism, phenylketonurea can well managed by metabolite-based diagnostics with low phenylalanine food & supplements
Genetic Predispositions	<ul style="list-style-type: none"> • Personalisation based on genetic variations • Target population-based product development • Strong linkage with ethical-legal-social issues



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Personalisation in different way

Coca-Cola puts people's names on bottles in 'Share a coke' campaign



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MyMuesli: Another example of personalisation



Just three easy steps!



Australia's
first custom-made
Muesli service.

- 1 Choose your Muesli Base
- 2 Add Dried Fruits, Nuts, Seeds & our delicious Naughty Bits
- 3 Name your Mix, and check-out

Create your own muesli in minutes
and have it delivered straight to your door!



Start Mixing

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Challenge 2: We're not all the same!



And We do not want to be!!!!



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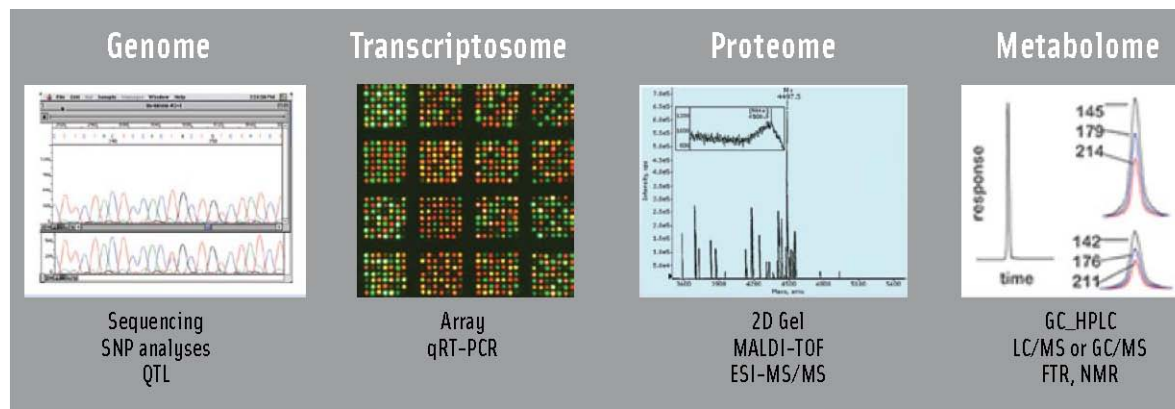
Sports Illustrated 2002

Regulation

Welcome

To the

'Omics



Bioinformatics
Biocomputation

Diet

+

**Functional
genomics**

=

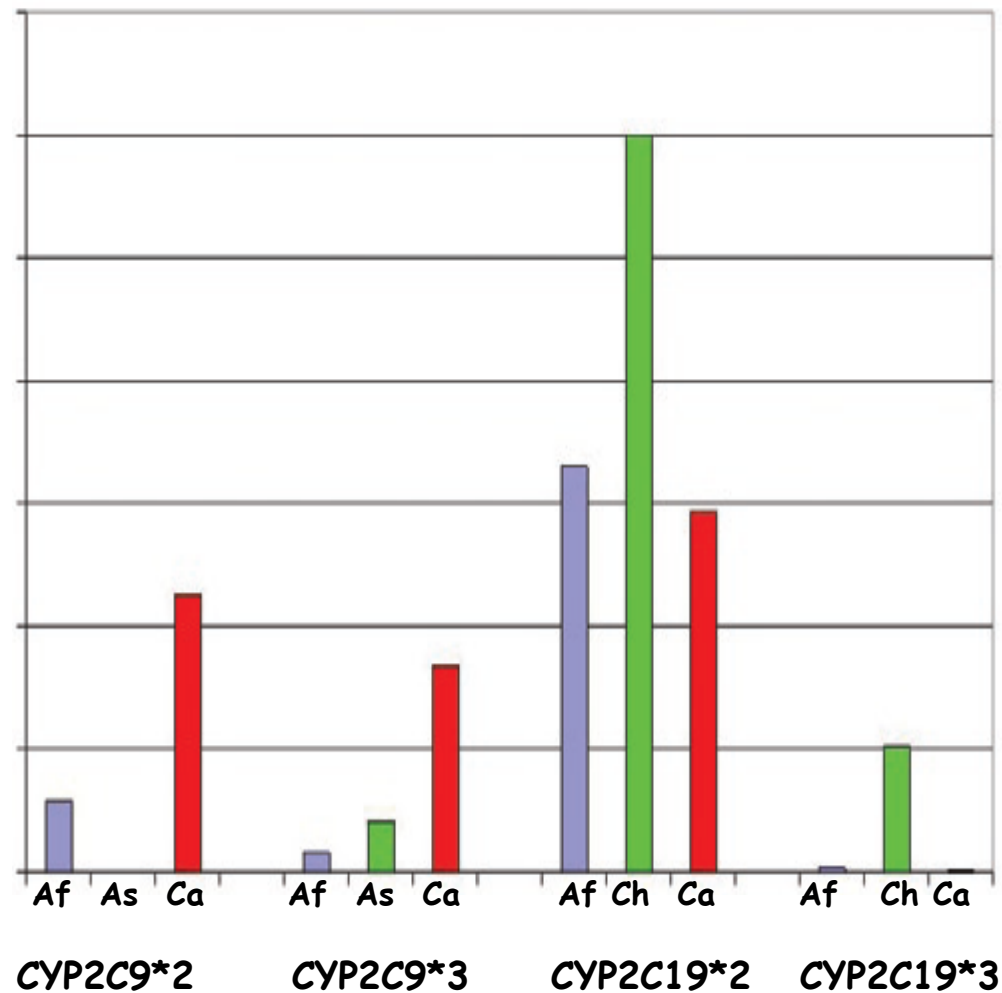
Nutritional Genomics

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Different allele frequencies of 4 variants in CYP (Cytochrome P450) genes among various ethnic groups



Ng et al. Clin Pharmacol Ther. 2008

Diet: driving force for human evolution



The greatest divergence between the genome of humans and chimpanzee is found among genes that control metabolism and are closely associated with DIET



Somel et al. 2008

“Every individual is different from another and hence should be considered as a different entity”

Charaka 4000, Ayurvedic Medical system

Chinese medicine is a highly developed personalized or individualized medicine, are not designed to treat symptoms of a specific illness; rather, they are tailored specifically to the individual

Sasang typology, a Korean traditional medical system, explains the individual differences in behavioral patterns, physical characteristics, and susceptibility to a certain disease on the basis on their biophysiological traits

Potential areas for development of personalised medicines/functional foods

- Type 2 diabetes & Obesity
- Antidepressants
- Inflammatory Bowel Disease (IBD)
- Anti-coagulant/Thromboembolism
- Few Cancers
(breast/colorectal/lung/prostate)
 - Asthma
 - Nicotine dependence

Platforms

Niche Products

- Gluten-free foods for celiacs
- Familial hypercholesterolemia patients without saturated fats
- Dairy protein-free food for inherited galactosemia
- Mood Enhancement foods

Mass-Market Products(for Critical genetic variations & Biomarkers:

- Low glycaemic load products for Insulin resistance, Obesity & Diabetes.
- Optimised sports nutrition in all phases of the life cycle
- Anti-depressants

Story starts with-----



NitroMed

Heart failure drug for
African-American

BiDiI

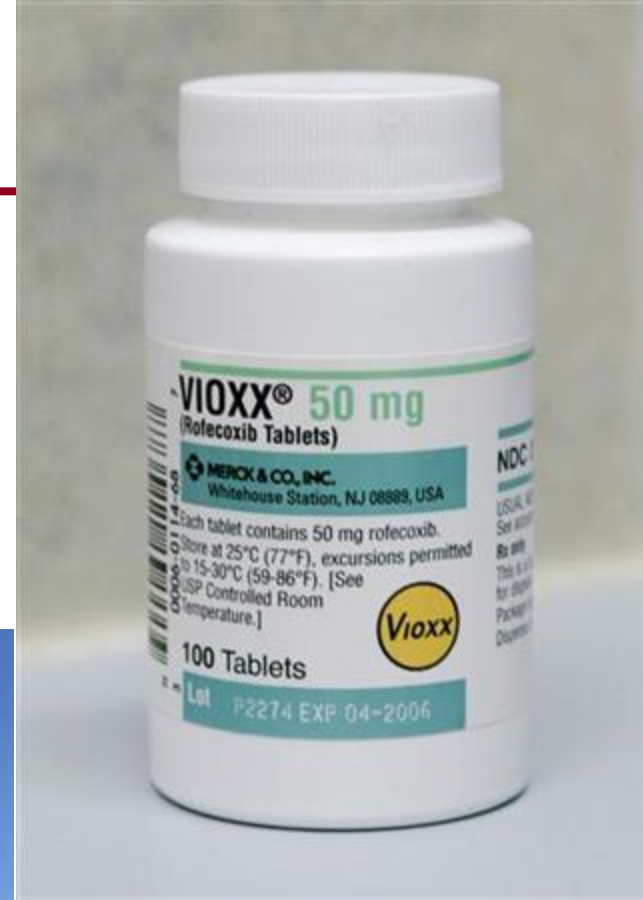
Vioxx

Hepcepin



Roche

To treat certain breast cancers



Merck

Anti-inflammatory

Science

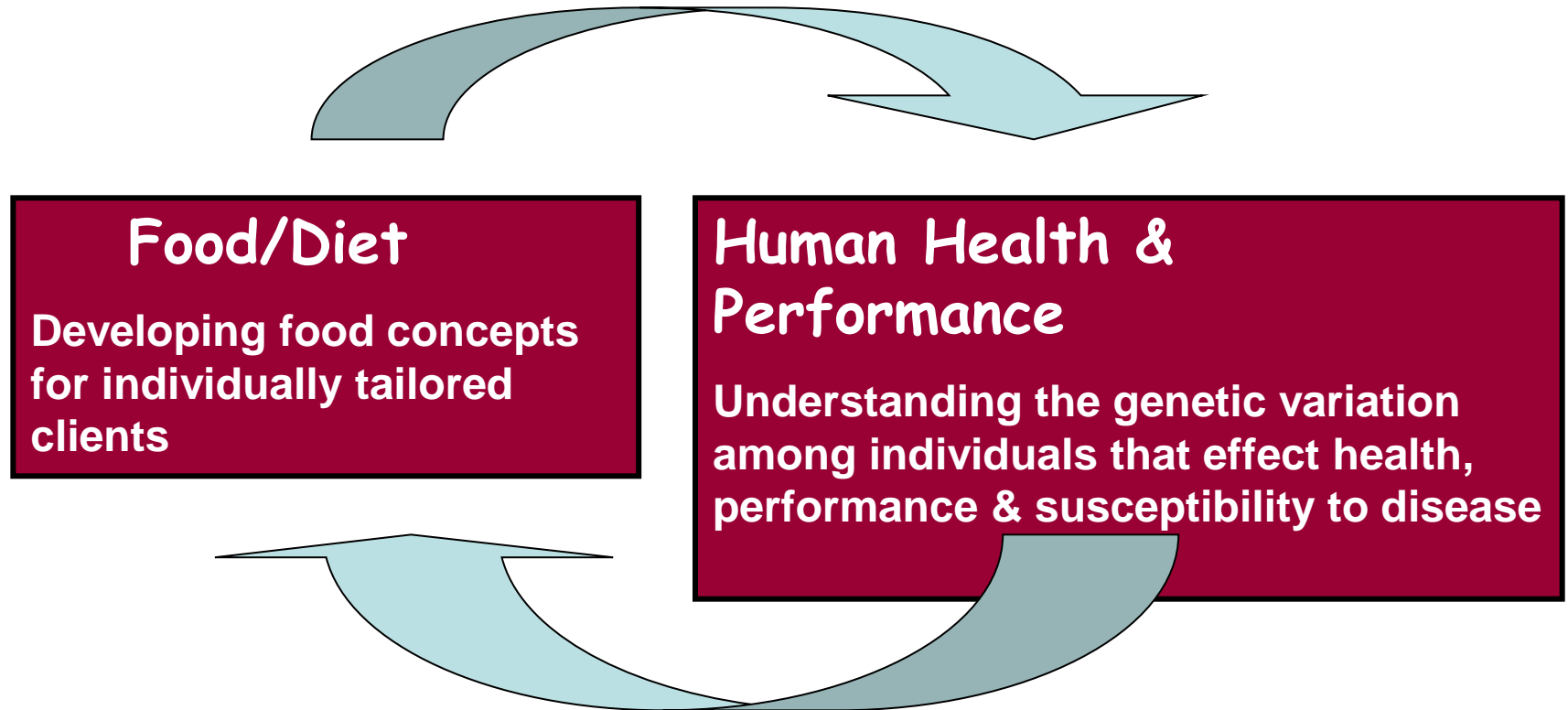
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Nutrigenomics

- Nutrigenomics is the study of the response of humans to food and food components using genomics, proteomics and metabolomics approaches
- In near future, nutrigenomics will most probably revolutionize the human comprehension of the entire field of nutrition based on individual human genotypes

Diet & Genes Interaction



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Gene-Diet-Environment Interaction

Nutrition

**Intrinsic
Genetic
Susceptibility**

**Human
Health/
Disease**

Behavior/Age/Stage of Development

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DNA to Genome



Intentionally skipping this section

A brief journey

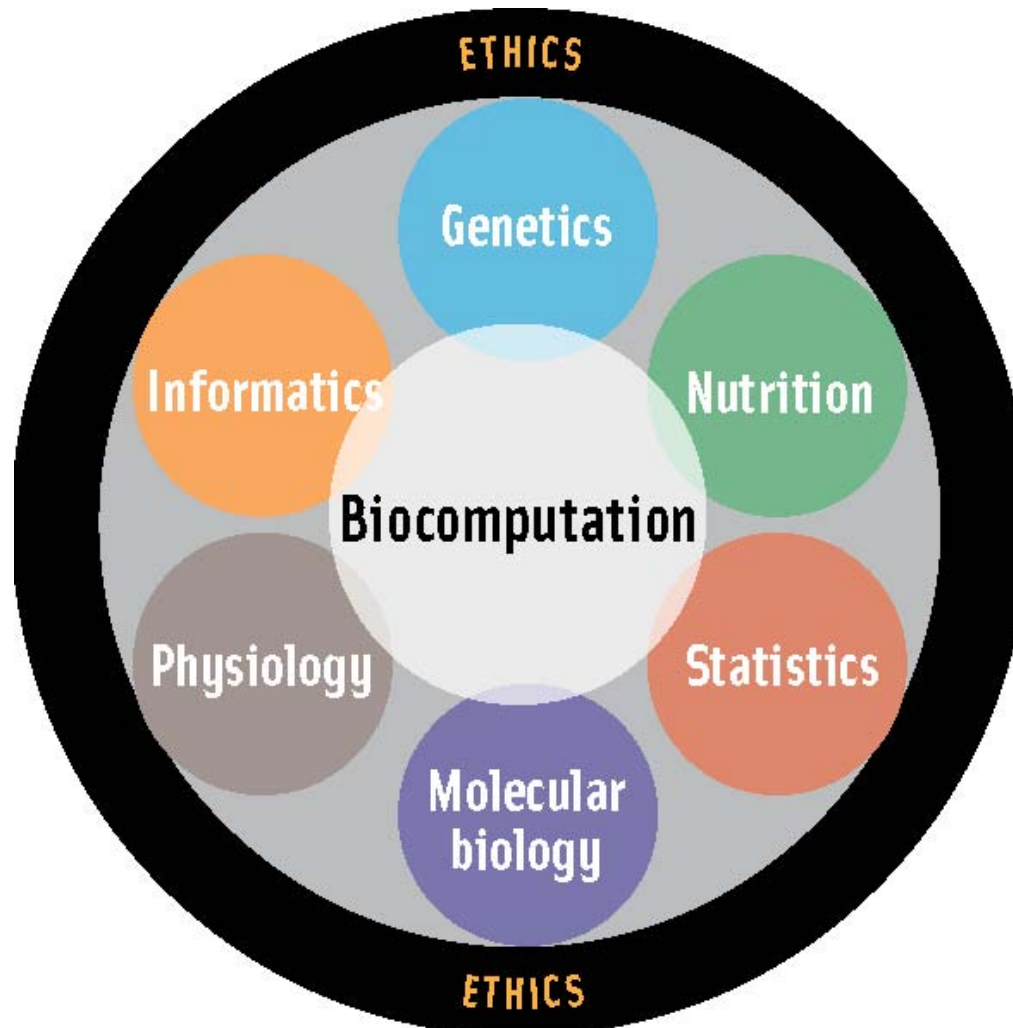
Tiny differences



- Effects on health are different from one person to the next
- What determines these differences?

Although 99.9% of human DNA sequences are identical, the 0.1% difference between any two individuals has profound biological significance

Some Scientific Disciplines of Nutrigenomics

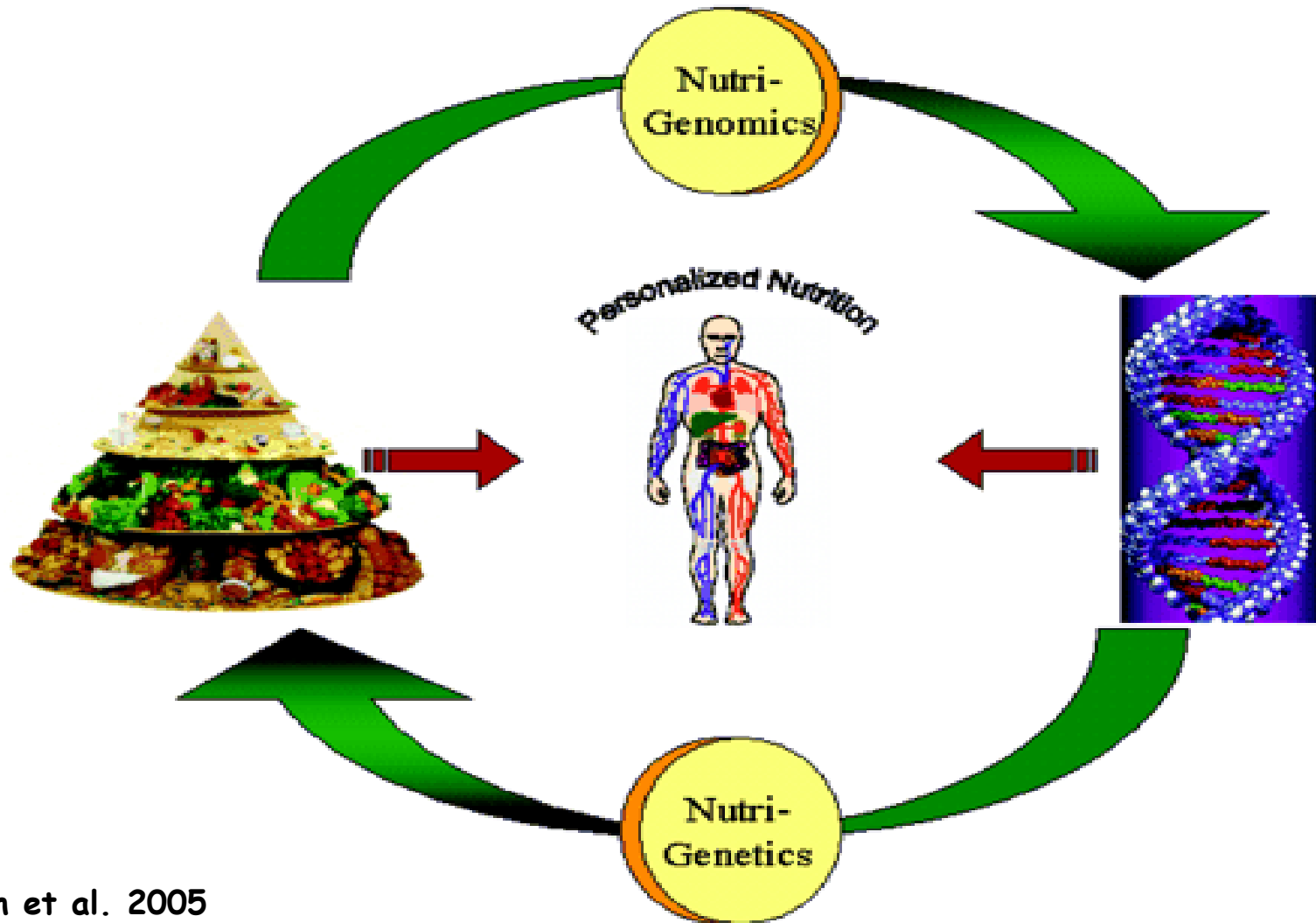


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Nutrigenomics & Nutrigenetics: two sides of a coin



Mutch et al. 2005

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Regulation of genes by nutrients

Nutrient	Gene impact	Disease potential
Folic acid	DNA methylation	Cancer
Fatty acid	Bind to transcription factors	Obesity
Vitamin D	mRNA stability	Kidney disease
Flavones	Increase mRNA synthesis	Cancer
Theaflavins	Decrease mRNA synthesis	Arthritis

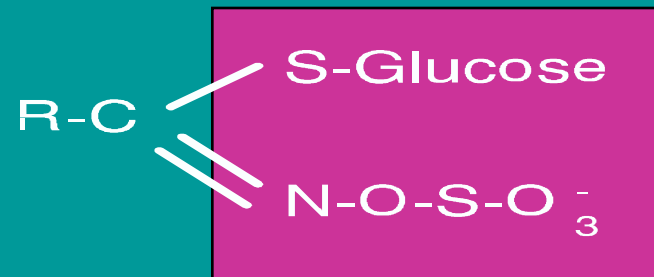
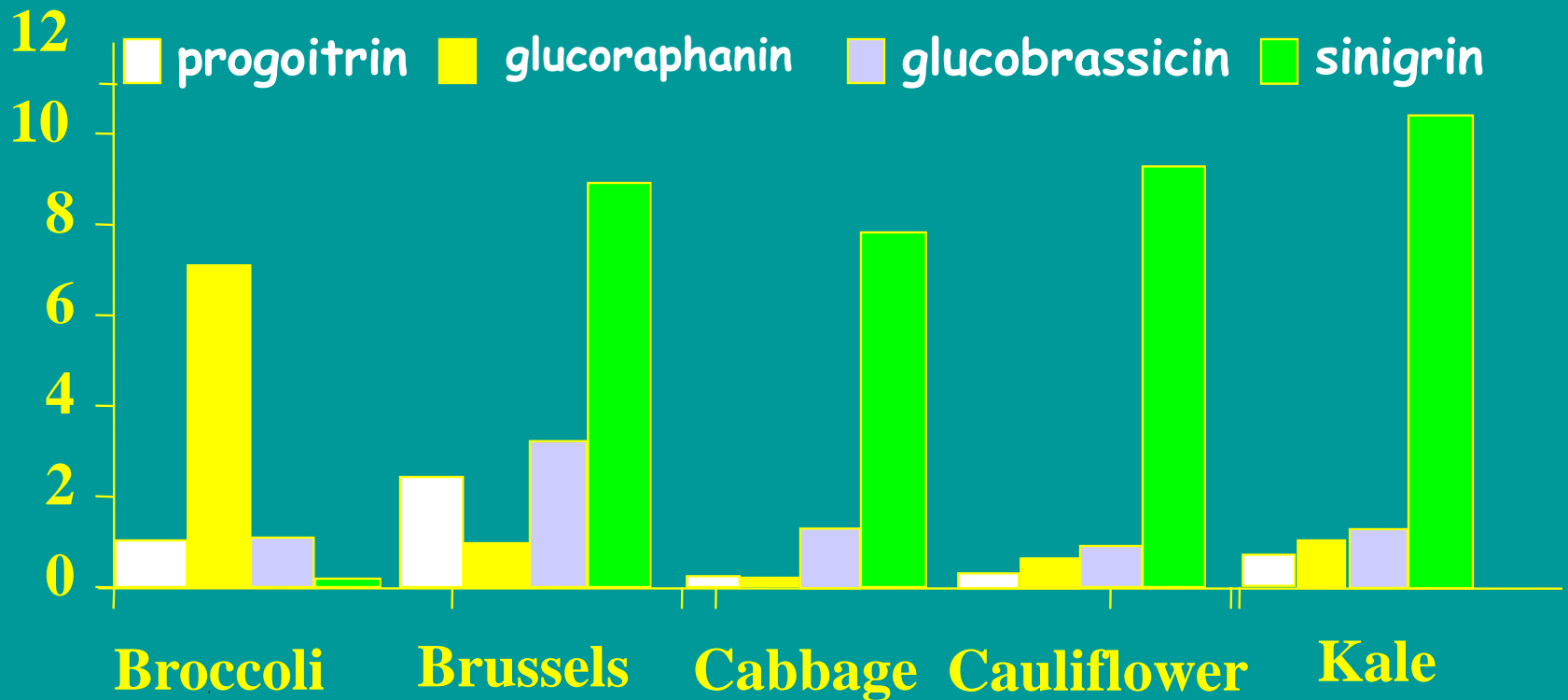
Source: Foodtechnology, 2005

Science

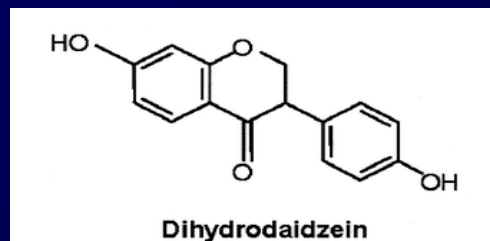
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Variation in Glucosinolate Among Cruciferous vegetables ($\mu\text{mol/g DryWeight}$)



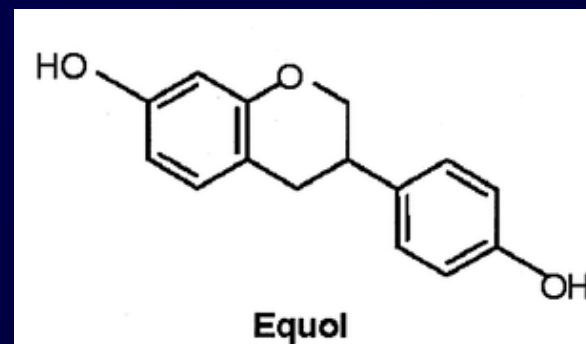
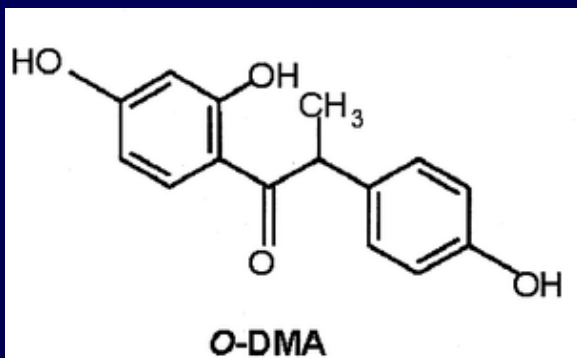
Daidzein in Soy Converted to Equol in Some but not All Individuals!



80-90% of Population

30-50% of Population

Intestinal Bacteria



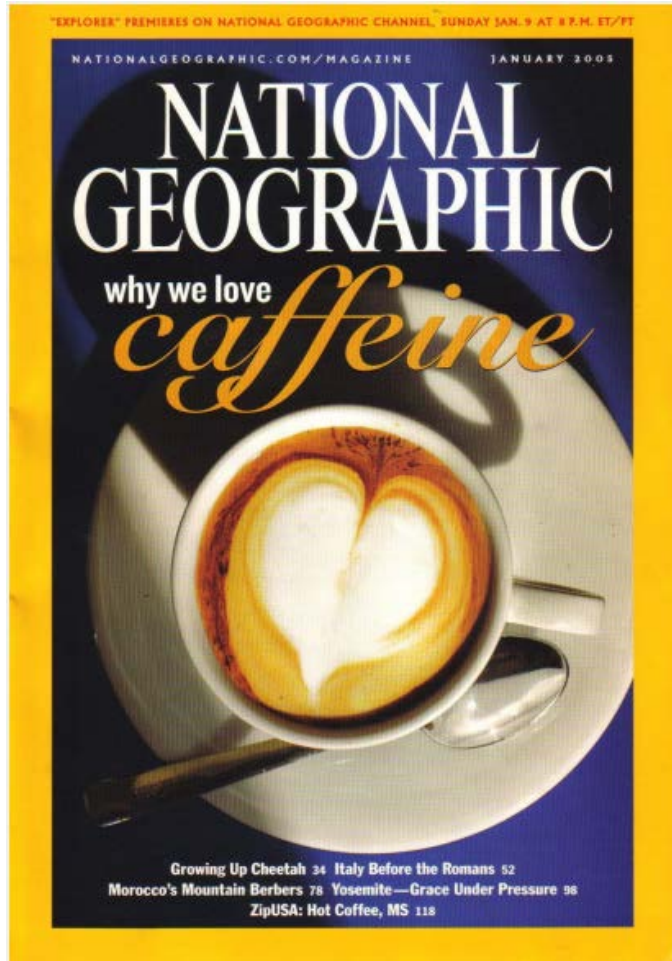
F Rafii et al,
Arch
Microbiol
180: 13, 2003

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Coffee: Recent media headline



Science

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Regulation

Genes decide if coffee hurts or helps your heart

By Roxanne Khamsi

Coffee can raise or reduce your chances of suffering a heart attack – it all depends on your genes, researchers suggest.

People with a genetic makeup that causes them to metabolise caffeine more slowly have a 36% greater risk of heart attack if they drink two to three cups of coffee a day than people with the same gene who drink one cup or less a day, according to a new study. And if they drink more than four cups, this risk rises to 64%.

“Our data suggest that the longer caffeine is lingering in the system, the more harm it can do,” says Ahmed El-Sohemy at the University of Toronto, Canada, who led the study.

On the other hand, individuals who metabolised caffeine quickly and consumed two to three cups of coffee a day had a 22% reduction in the risk of heart attack compared with those with the same genetic makeup who consumed just one cup or less each day.

Genes determine coffee heart risk

Drinking large amounts of coffee each day could increase the risk of heart attack for people with a particular genetic profile, a study has suggested.

Four thousand people in Costa Rica were monitored in the Journal of the American Medical Association study.

Those who were slow at breaking down caffeine were 64% more likely to suffer a heart attack.



'Heavy' coffee drinkers are those who drink around four cups a day



First Successes and What We Learned

Caffeine

Fast metabolizers

- Low risk for heart disease

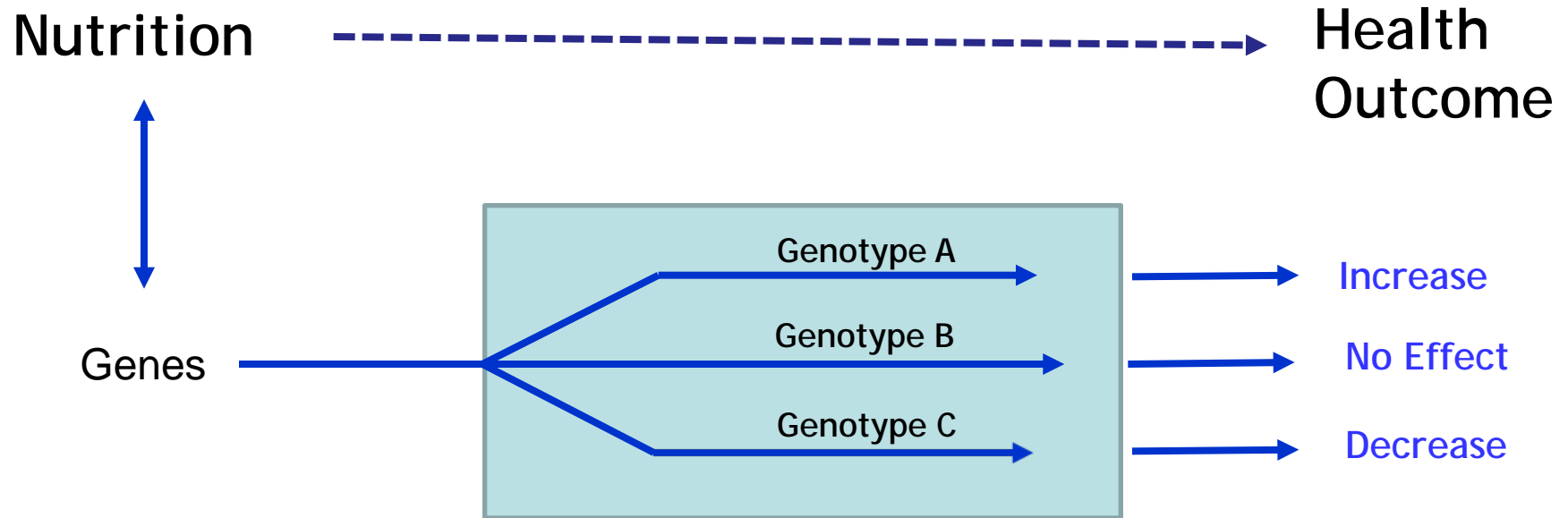
Slow metabolizers

- Higher risk for heart disease



Courtesy: Dr A El-Sohemy, Canada

Why genetics/genomics affect us?



One size
doesn't fit all.



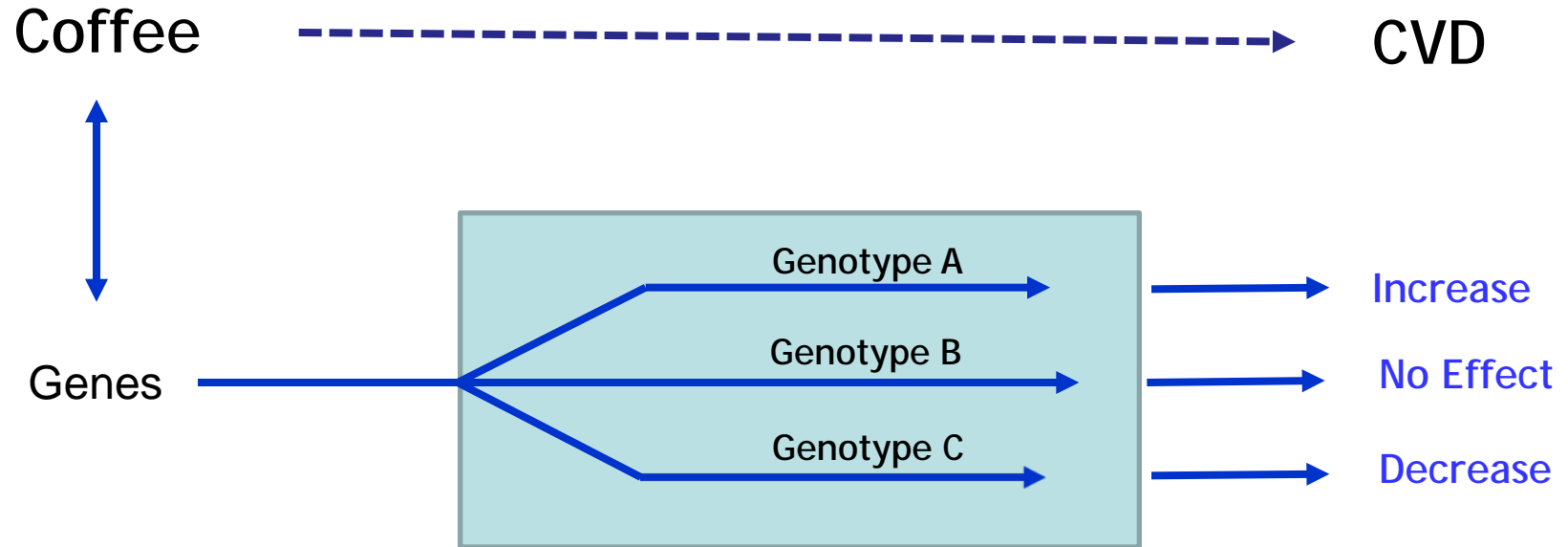
Courtesy: Dr A El-Sohemy, Canada

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Is Coffee associated with CVD?



Courtesy: Dr A El-Sohemy, Canada

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Bioactives in Coffee

Magnesium

Aliphatic acids

Caffeine



Potassium

Melanoidins

Diterpenoids

Polyphenols

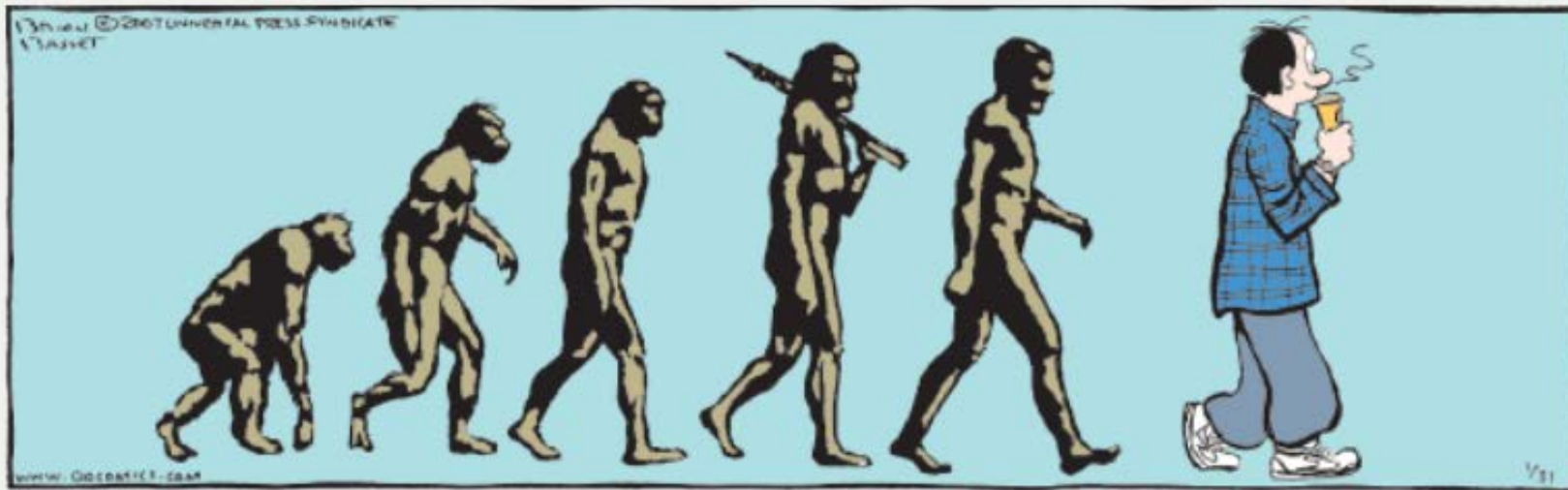
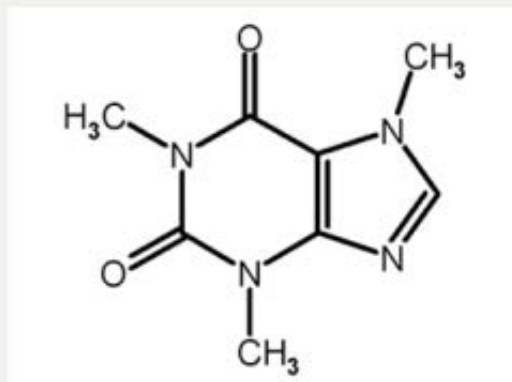
Courtesy: Dr A El-Sohemy, Canada

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Caffeine (1,3,7-trimethylxanthine)



Courtesy: Dr A El-Sohemy, Canada

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Coffee, CYP1A2 Genotype, and Risk of Myocardial Infarction

Marilyn C. Cornelis, BSc

Ahmed El-Sohemy, PhD

Edmond K. Kabagambe, PhD

Hannia Campos, PhD

Context The association between coffee intake and risk of myocardial infarction (MI) remains controversial. Coffee is a major source of caffeine, which is metabolized by the polymorphic cytochrome P450 1A2 (CYP1A2) enzyme. Individuals who are homozygous for the *CYP1A2*1A* allele are "rapid" caffeine metabolizers, whereas carriers of the variant *CYP1A2*1F* are "slow" caffeine metabolizers.

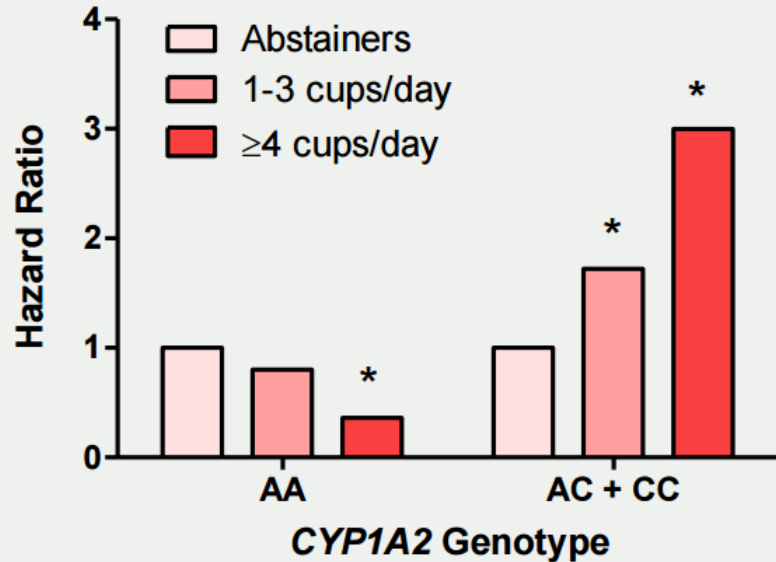
Cornelis et al. JAMA, 2006, 295: 1135-41

CYP1A2 genotype modifies the association between coffee intake and the risk of hypertension

Paolo Palatini^a, Giulio Ceolotto^a, Fabio Ragazzo^a, Francesca Dorigatti^a,
Francesca Saladini^a, Italia Papparella^a, Lucio Mos^b, Giuseppe Zanata^c and
Massimo Santonastaso^d

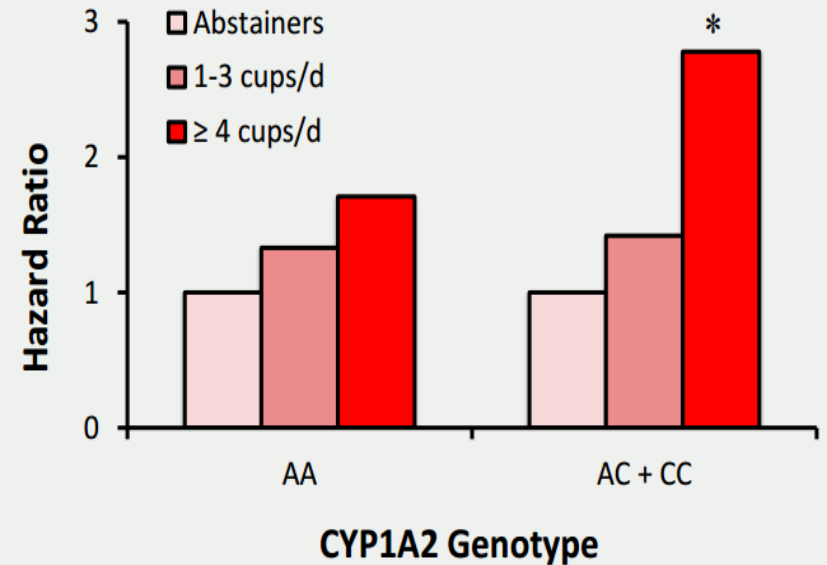
J Hypertension, 2009, 27: 1594-1601

Coffee Intake and Risk of Hypertension/Risk of Impaired Fasting Glucose



* P<0.05

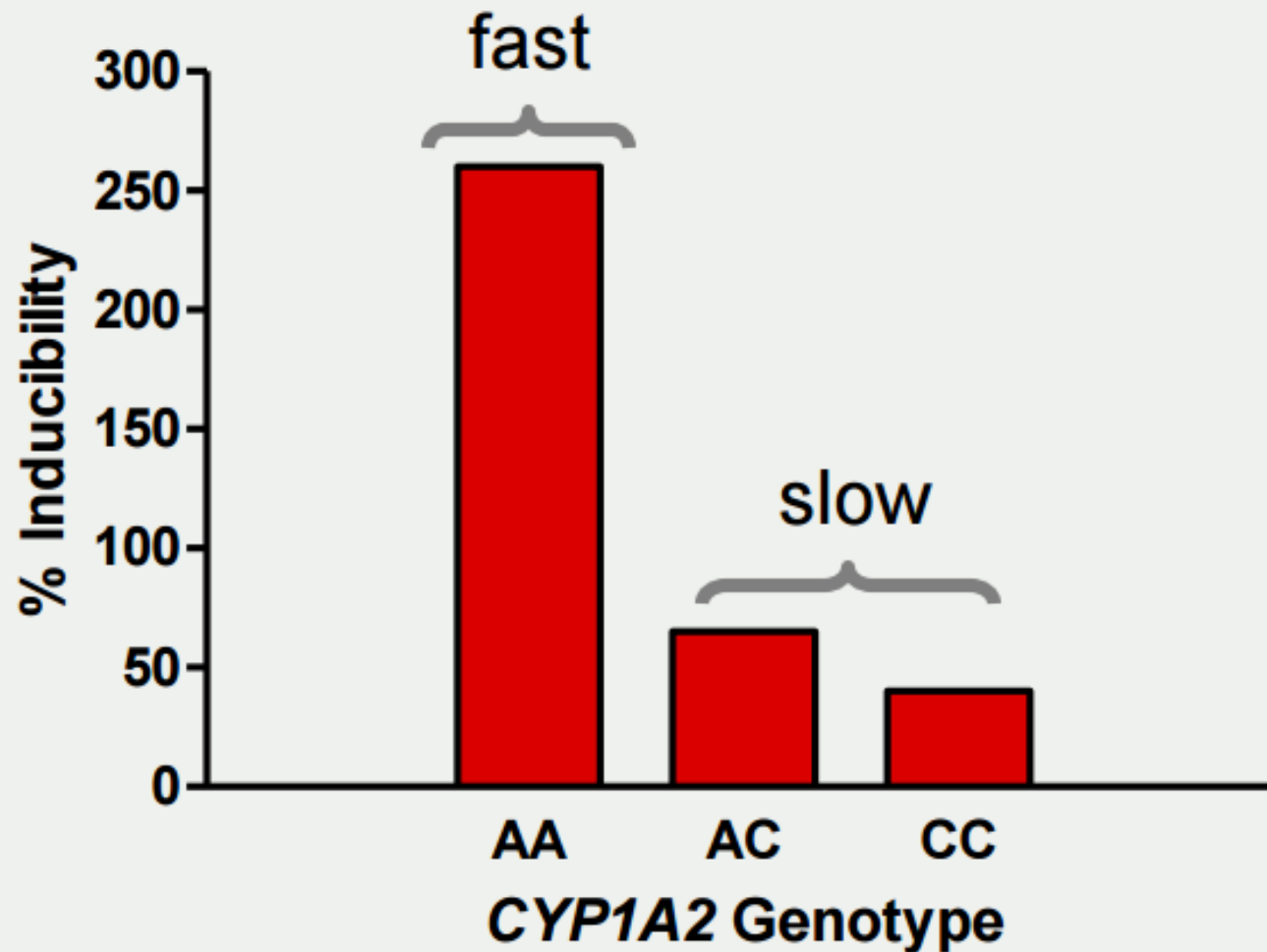
Palatini et al., J Hypertens 27: 1594-1601, 2009



* P<0.05

Palatini et al. Eur J Epidemiol. 2015;30:209-217.

Genetic Variation in CYP1A2^{-163 A>C}



Other side of the coin

(Commercial use of great science)



Is public health going private?

Cooperation between bio-science & industry

A large Dutch Insurance company (VGZ) aspires to improve public health by refunding (up to €40 a year) customers who buy pharma food products from Unilever (e.g. Becel pro-activ products)

Your Genetic Journey

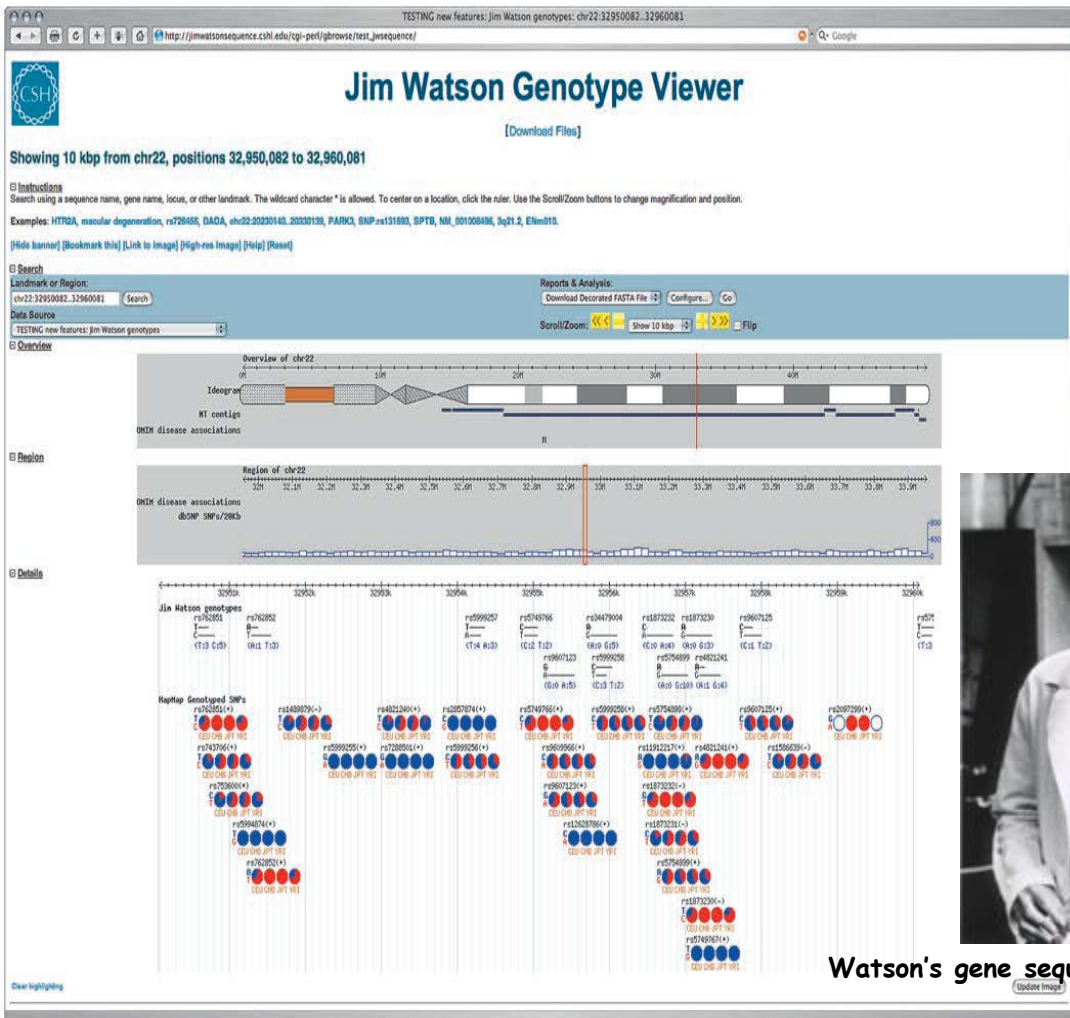
**“Did you ever wonder about your most
ancient ancestors?
The Genographic Project will introduce
you to them, and
explain the genetic journeys that bond
your personal
lineage over tens of thousands of
years”**

Genographic Project by National Geographic & IBM

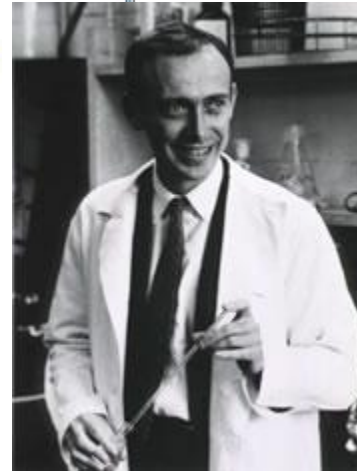
“Personalised genomes go to mainstream”

Nature 30 Oct. 2007

2 Silicon Valley start-up will start giving customers a peek at their genomes for a few thousand dollars



- 23andMe (Google back-up)
- Navigenetics



Watson's gene sequenced less than a million \$

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Welcome to Sciona

Sciona provides personalized health and nutrition recommendations based on an individual's diet, lifestyle and unique genetic profile. The company has created a powerful set of tools enabling consumers and consumer product companies to harness the scientific information derived from the Human Genome Project.

Sciona gains license to explore Asian nutrigenomics potential



14/03/2007 - Australia's Genetic Technologies (GTG) has bestowed a license to its non-coding DNA patents to personalised nutrition company Sciona, which is expected to be the start of a long relationship in the lifestyle and life-extension arena.

Now Pandora Box Is Open

Not only Sciona

Other players are

❖ Genelex

❖ Market America

❖ Suracell

List of Relevant Genes Tested

Company	Tests offered
23andMe (California)	Taste perception/breast & prostate cancer/Crohn's disease/type 1 & 2 diabetes & more
Consumer Genetics (California)	Caffeine & alcohol metabolism/fetal gender
Cygene Direct (Florida)	Osteoporosis/thrombosis/athletic performance
DeCODE	Asthma/cancers/MS/more
Genelex (seattle)	Diet & weight management/celiac disease
Mygenome (Massachusetts)	Alzheimer's/CVD/thrombosis
Navigenetics (California)	No tests offered yet

Genetics & Public Policy Center; Company websites

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Coffee, CYP1A2 Genotype, and Risk of Myocardial Infarction

Marilyn C. Cornelis, BSc, Ahmed El-Sohemy, PhD, Edmond K.
Kabagambe, PhD, Hannia Campos, PhD
JAMA. 2006; 295: 1135-1141



Try the new CaffeineGEN™ test today
Standard &129.00 in 5 business days
Express \$159.00 in 2 business days

Which Gene Do I Have?

CaffeineGEN™ Test is an easy-to-do genetic test that tells you whether you have the “fast” or “slow” variant of the gene for breaking down caffeine. Knowing which gene you have will help you make lifestyle choices that would be more healthy for your unique genetic makeup.



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TABLE 1: PREDICTIONS FOR DISEASE RELATIVE RISKS FOR FIVE INDIVIDUALS

Disease	Female A	Female B	Female C	Male D	Male E
Breast cancer	↑↑	↑↑	↓↓		
Coeliac disease	↓↓	↓↓	↓↓	↓↓	↓↓
Colon cancer	=	=	=↓	↑↑	=↓
Crohn's disease	↓↑	↓↑	↓↓	↓↓	↓=
Heart attack	↓↓	=↓	=↓	=↓	↑↑
Lupus	↑↓	↓↓	↓↓	↑=	↑=
Macular degeneration	↓↓	↓↓	↑=	↓↓	↓↓
Multiple sclerosis	↑↑		↓↓	↓↓	↓↓
Prostate cancer				↑↑	↓↑
Psoriasis	↓↑		↑↓	↑↑	↓↓
Restless legs syndrome	=↓	↑↑	↓=	↓↑	↑↑
Rheumatoid arthritis	↑↑	↑↑	↓↓	↓↓	↑↑
Type 2 diabetes	↓↓	=↓	↓↓	↑↓	=↓

↑ increased risk (RR > 1.05), ↓ decreased risk (relative risk (RR) < 0.95), = average risk (0.95 ≤ RR ≤ 1.05). First prediction is from 23andMe; second prediction is from Navigenics. Different predictions are highlighted in beige.

Source: Kalf RJ et al. 2014. Genet. Med.

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James Watson Decoded

Genome sequenced	HGP (2003)	Venter (2007)	Watson (2008)
Time taken	13 yrs	4 yrs	4.5 mos
Number of scientists (as authors)	>2,800	>31	>27
Cost of sequencing	\$2.7 bn	\$100 mn	<\$1.5 mn
Coverage	8-10 x	7.5 x	7.4 x
No of institutes involved	16	5	2
No of countries involved	6	3	1

QUICKER, SMALLER, CHEAPER

Wadman, Nature, 2008

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\$5,000 genome next year, company promises

Complete Genomics, California

Innovation



6 October 2008 | Nature



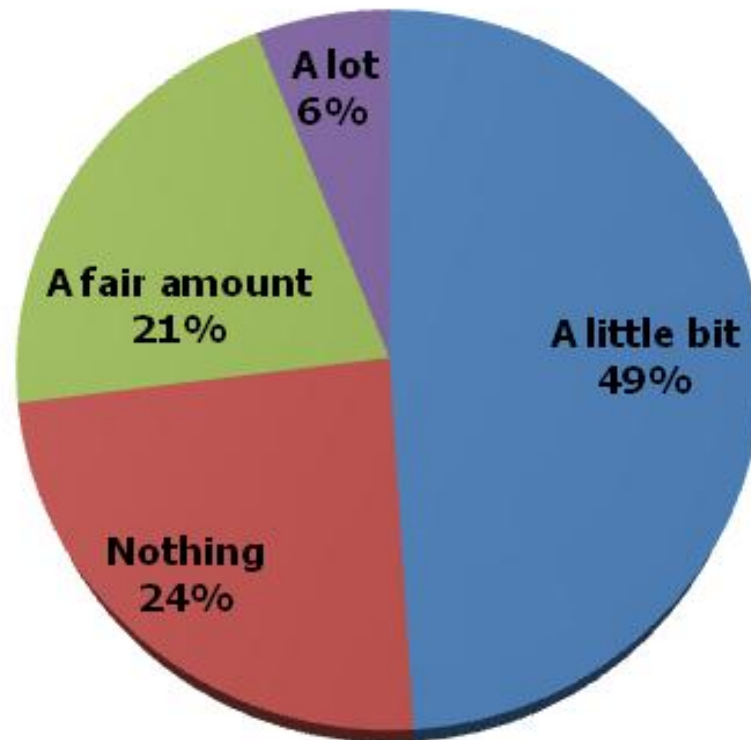
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What Consumer's think?

US Consumers' Genomics Awareness



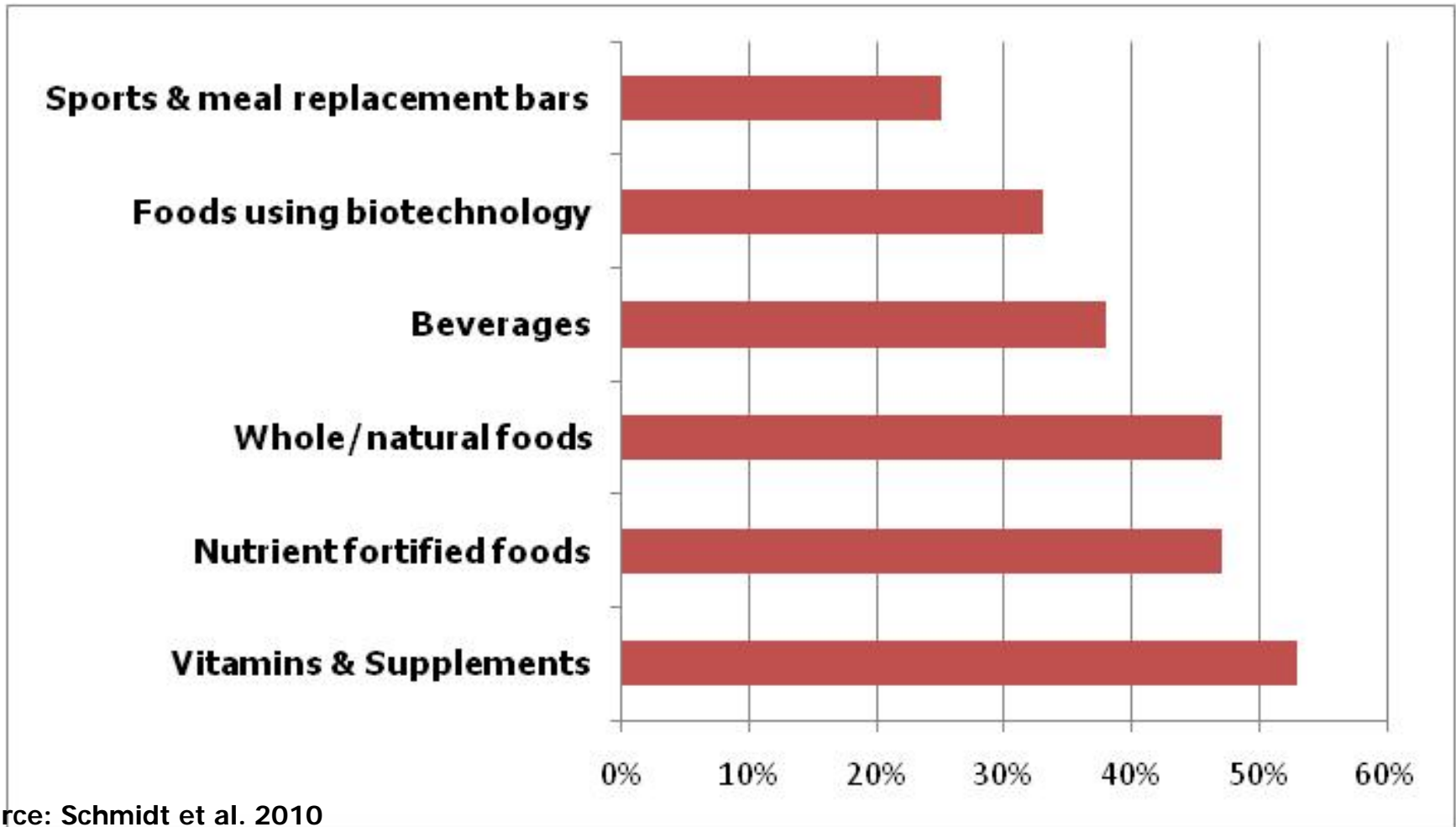
Source: Schmidt et al. 2010

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Interest in Genetically Tailored Products



Source: Schmidt et al. 2010

Regulation

trundles along belatedly after New Technologies,
like a **RUBBISH VAN AFTER A PARADE**

Types of Tests Available

- **medical condition**
 - with or without possibility of intervention
- **lifestyle / educational**
 - optimise health through lifestyle changes
- **recreational**
 - genealogy, love matches

Courtesy- Nola Ries

"Nutrigenomics - sky's
the limit?"

"Genome health
clinics not far away-
-----"

Science fiction or science fact?
Could we soon be stopping off for
a quick genetic test to let us know
which foods and supplements to
take to reduce our risks of certain
diseases?

“With nutrigenomics, this is looking to the horizon.

There are a lot of knowledge gaps, particularly in terms of what the research is saying and what is actually possible”

Dr. Andrew Shao, Ex-VP, US Council for Responsible Nutrition

Q-??????

Should nutrigenomics testing be delivered directly to consumers or through healthcare professionals?

Who should be tested?

Who should have access to test information?

How should individual privacy be protected?

How should genetic discrimination be prevented?

Future

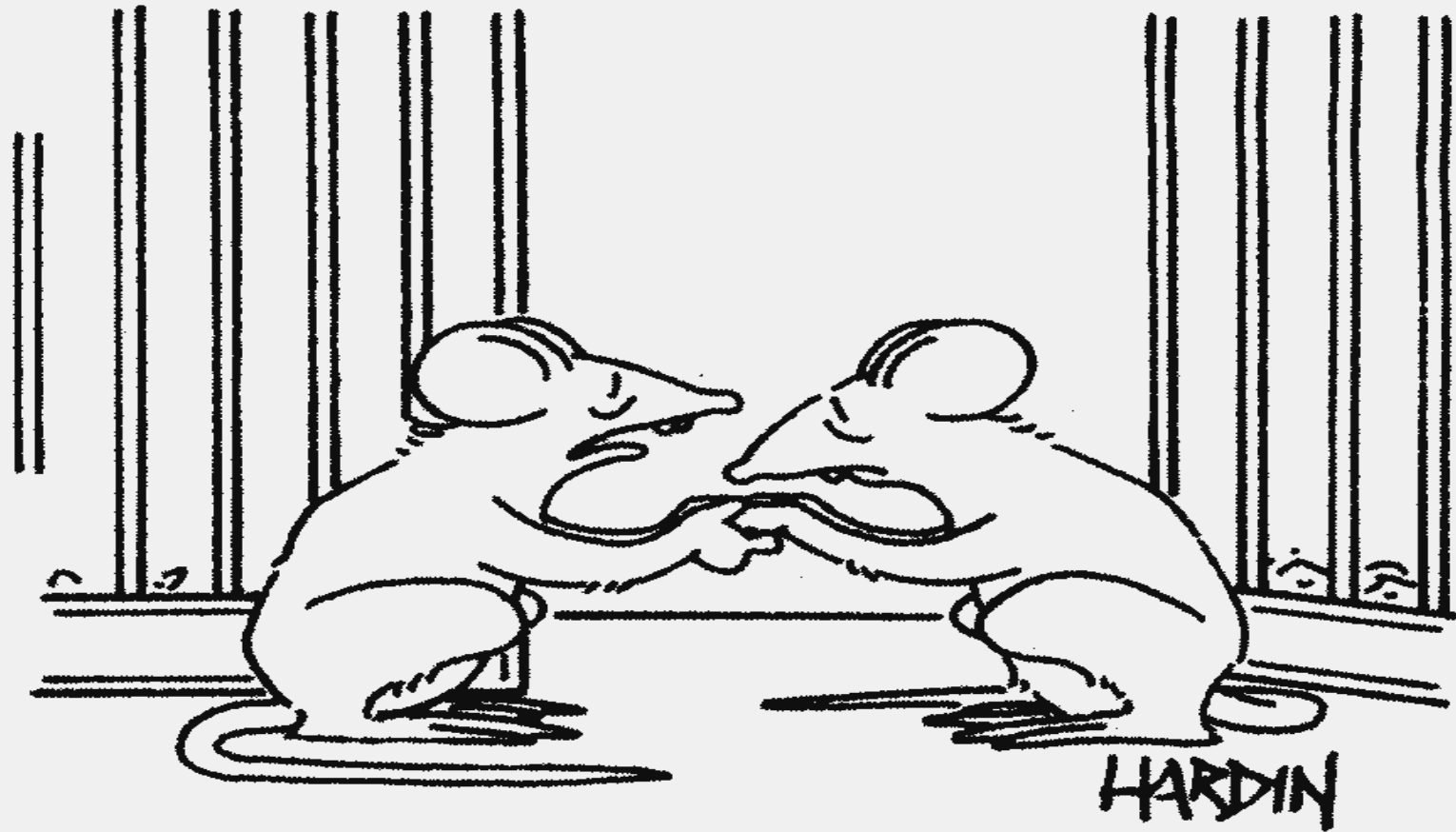
Genetics has always been special – specially controversial. It began with polemics between Darwinism & religion, followed by the 19th century Eugenics debate to recent GM controversy.



Science

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"It would never work, Nichole; I'm in the experimental group and you're in the control."

Thank you !

Dr.Dilip Ghosh, PhD, FACN

Director

nutriConnect

Sydney, Australia

dilipghosh@nutriconnect.com.au

+61-(0)449 154 917

