Personalized Nutrition: Nutrigenomics as a tool in Dietetic Practice Current Approach and Challenges in India

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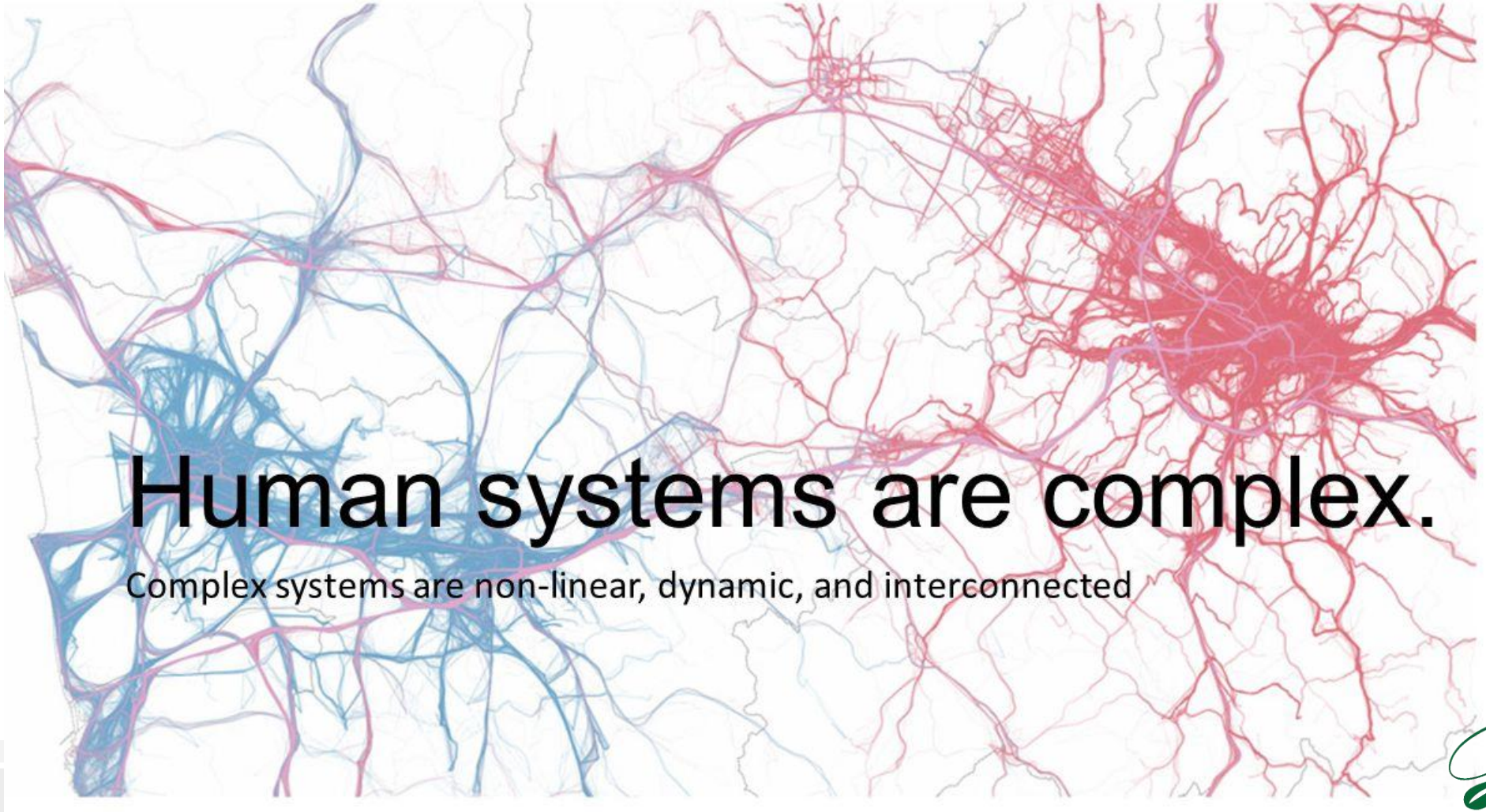
Is this so simple that we can think

"one size suits all"



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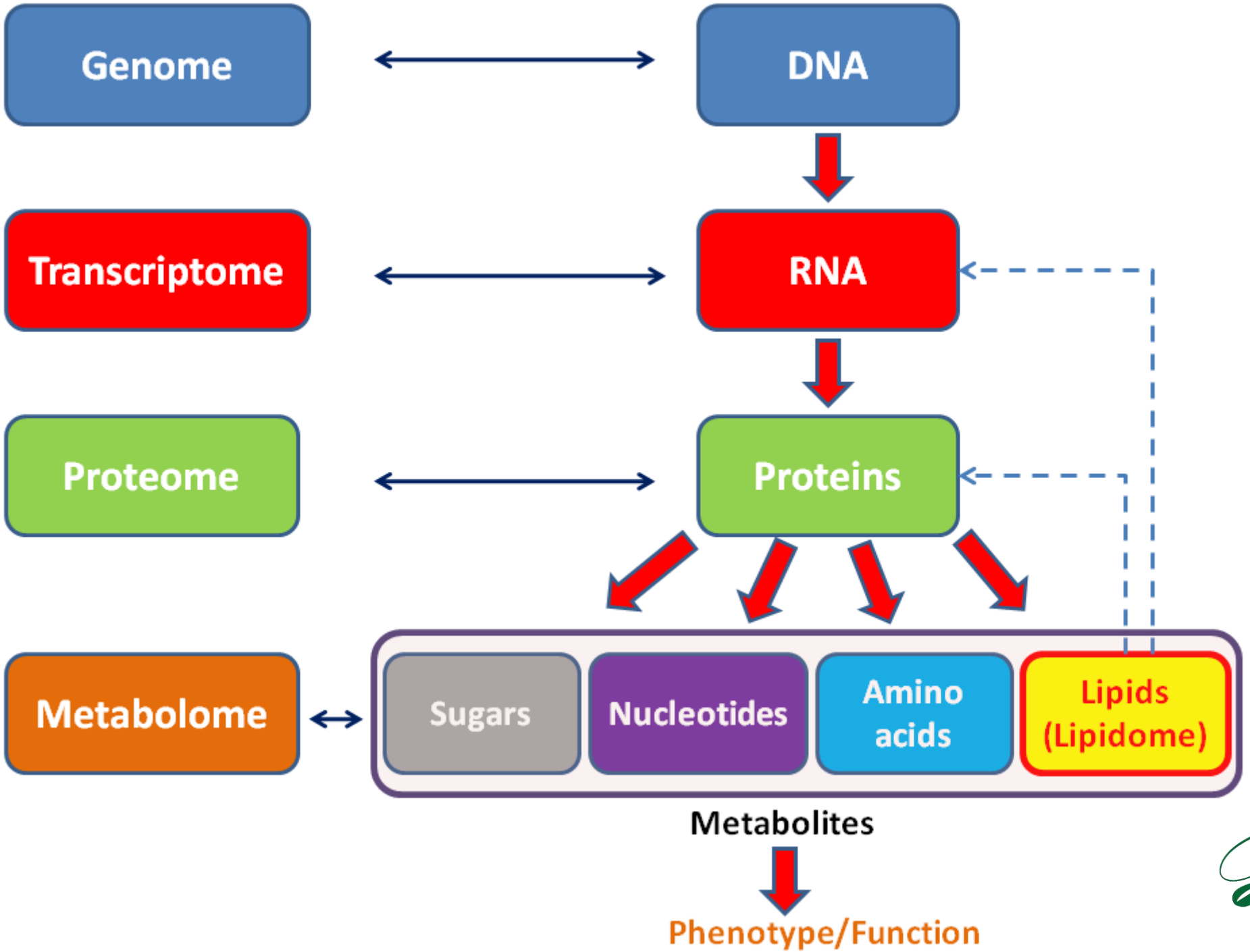
Ancient diet

Present diet

DNA diet
-the future


Genome
DNA
Transcriptome
RNA
Proteome
Proteins
Metabolome
Sugars
Nucleotides
Amino acids
Lipids (Lipidome)
Metabolites
Phenotype/Function

Goal From global recommendations for healthier diet habits to personalised nutrition

Global recommendations

Population

Health Public Policy Strategies

Healthy Diet

Subpopulation

Clinical Nutrition

Personalised Nutrition

Genotype/Phenotype

Personalised Diet

Nutritional Genomics

GLOBAL RECOMENDATIONS COULD BO NOT OPTIMUM FOR YOU

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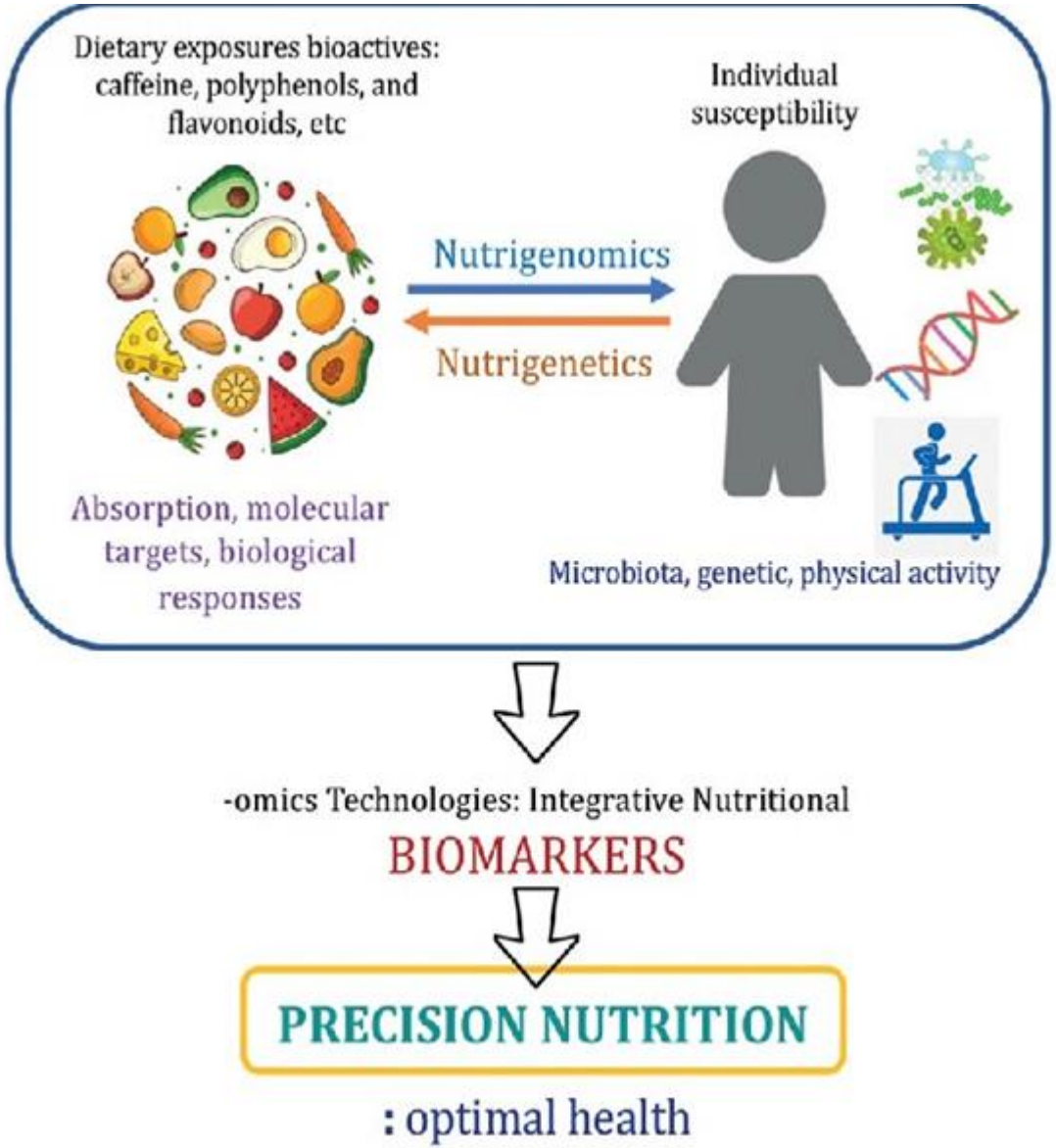
Nutrigenomics

- What you eat directly determines the genetic messages your body receives. These messages, in turn, control all the molecules that constitute your metabolism.
- Genetic constitution control the messages and instructions they give your body and your metabolism .



Hyman M. *Book on Ultra-metabolism: the simple plan for automatic weight loss.* New York: Atria Books; 2006. p. 24

Origin of Nutrigenomics:

- PKU (Inborn Errors of Metabolism)
- Lactose intolerance
- 1990 – Human Genome Project
- 2007 – Inter-relationships between genes, nutrition and disease

Molecular Nutrition Focus

20th Century - Micronutrients (vitamins and minerals) (Menon etal.2010)
21st Century – focus changed to NCD with rise of obesity and type 2 Dm (Mohan et al 2007)

In prevention of disease nutrition research optimization to maintain cellular, tissue and organ and whole body homeostasis.

. Epidemiology and Physiology to Molecular Biology and Genetics and **Nutrigenomics**

Ghoshal S, Pasham S, Odom DB, Furr HC, McGrane MM. Vitamin A depletion is associated with low phosphoenolpyruvate carboxykinase mRNA levels during late fetal development and at birth in mice. *J Nutr.* 2003;133:2131.
Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. Indian J Med Res. 2007;125:217-230

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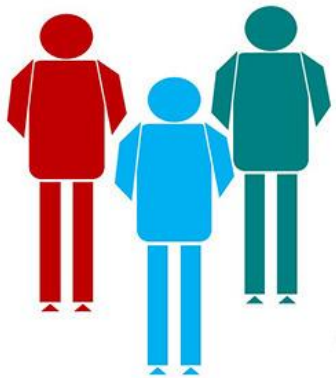
Risk factors for disease development

Family history, food choices, demographic variation, medical history, Race/origin, economical differences

Personalized & clarified disease risk stratification

Genomics or omics based nutrient biomarkers, dietary habits, eating behaviors, lifestyle aspects



Nutrigenomics

Nutrigenetics

Diet-Gene interaction

metabolomics

Microbiome or microbiota

1.Nutritional Phenotypes

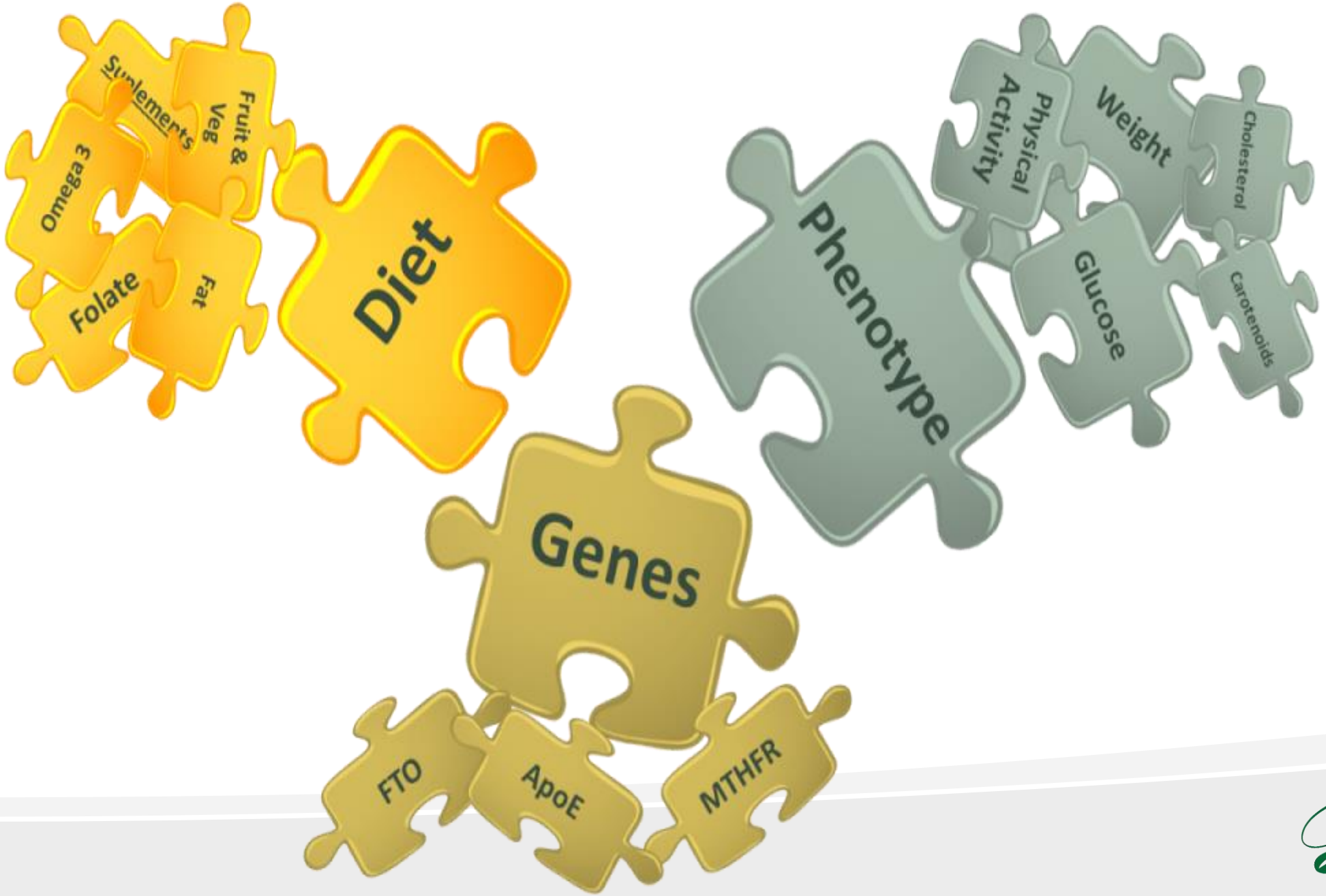
2. Clinical applications

Population based diet advice Target:

1. To obviate nutrient deficiency
2. To manage or treat non-contagious diseases

Precision nutrition Target:

1. To develop healthier relationship with food.
2. To provides essential nutrients for survival


Supplements
Fruit & Veg
Omega 3
Folate
Fat
Diet
Phenotype
Physical Activity
Weight
Cholesteral
Glucose
Carotenoids
Genes
FTO
ApoE
MTHFR

Journal of the Academy of Nutrition and Dietetics
The premier source for the practice and science of food, nutrition, and dietetics

Genetic dietetics: Nutrigenomics and the future of dietetics practice

The genomic blueprint of organisms, from viruses to plants and animals, is revealing a detailed molecular and mechanistic understanding of all of life's processes. Functional genomics is translating this information into the basis for guiding the future of human health and disease. Nutrigenomics is not a single field, but is considered the combination of two—nutritional genomics and nutritional genetics.

http://dx.doi.org/10.1016/j.jada.2005.02.034

Personalised Nutrition	Individually tailored nutrition (Environment ,Phenotype and Genotype)
Precision Nutrition	Personalised with specific focus to food , nutrients and health.
Nutrigenetics	Personalised Nutrition for different phenotypic responses (NCD) to a specific diet depending on genotype.
Nutrigenomics	Response of individual genes to nutrients and metabolic consequences.
Exposome	Collection of environmental factors, such as stress, physical activity and diet, to which an individual is exposed and which may affect health

Personalised nutrition and health *BMJ* 2018; 361

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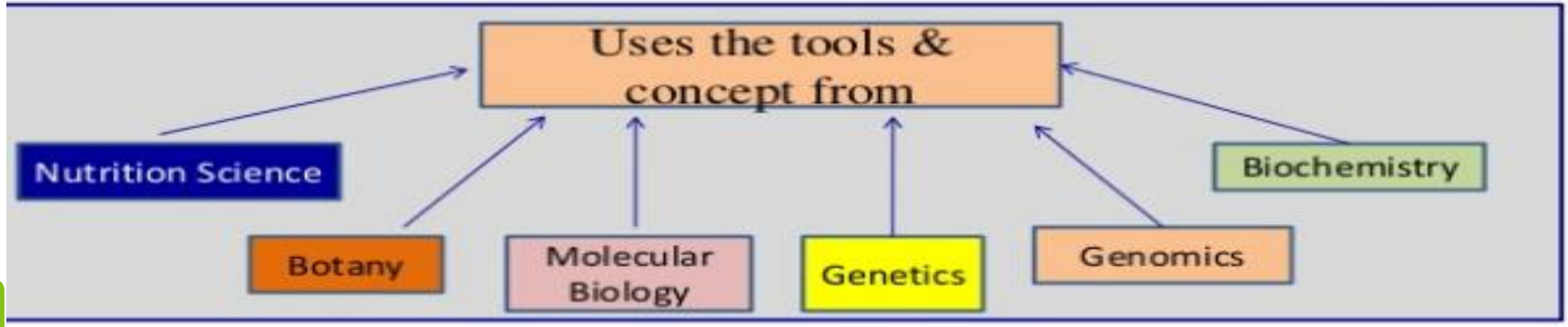
Changing the Nutrition Prescription

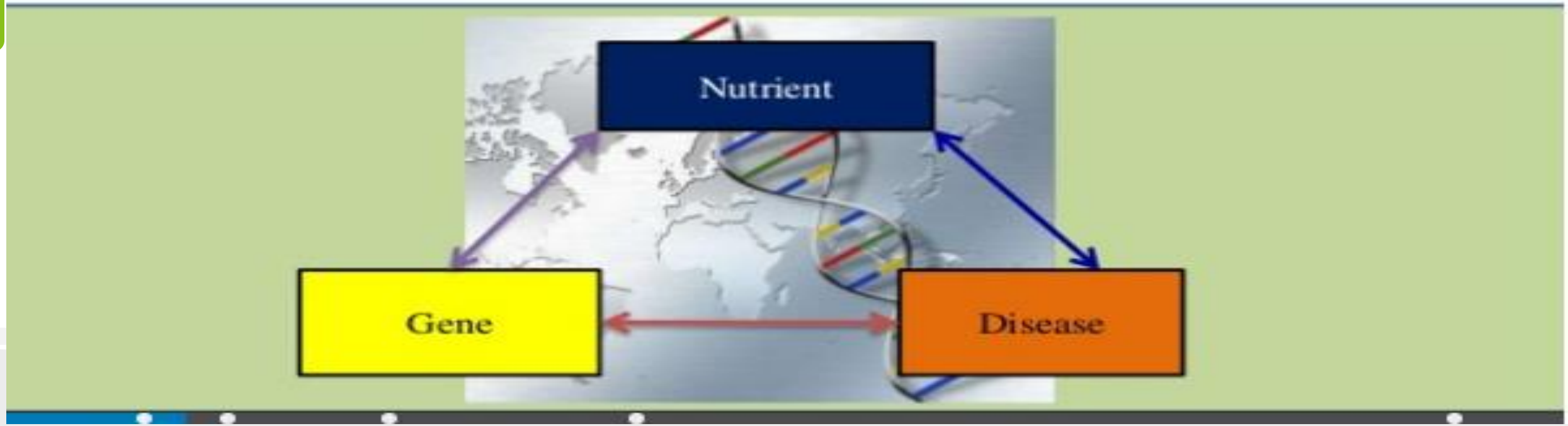
As one moves from stratified to personalised to precision nutrition, it becomes necessary to apply more and more dimensions or characteristics to achieve the desired goal.

Specific Information, Anthropometry, Biochemical, Clinical, Dietary, Exposome And genotype

i.e **Phenotype, Environment and Genotype**

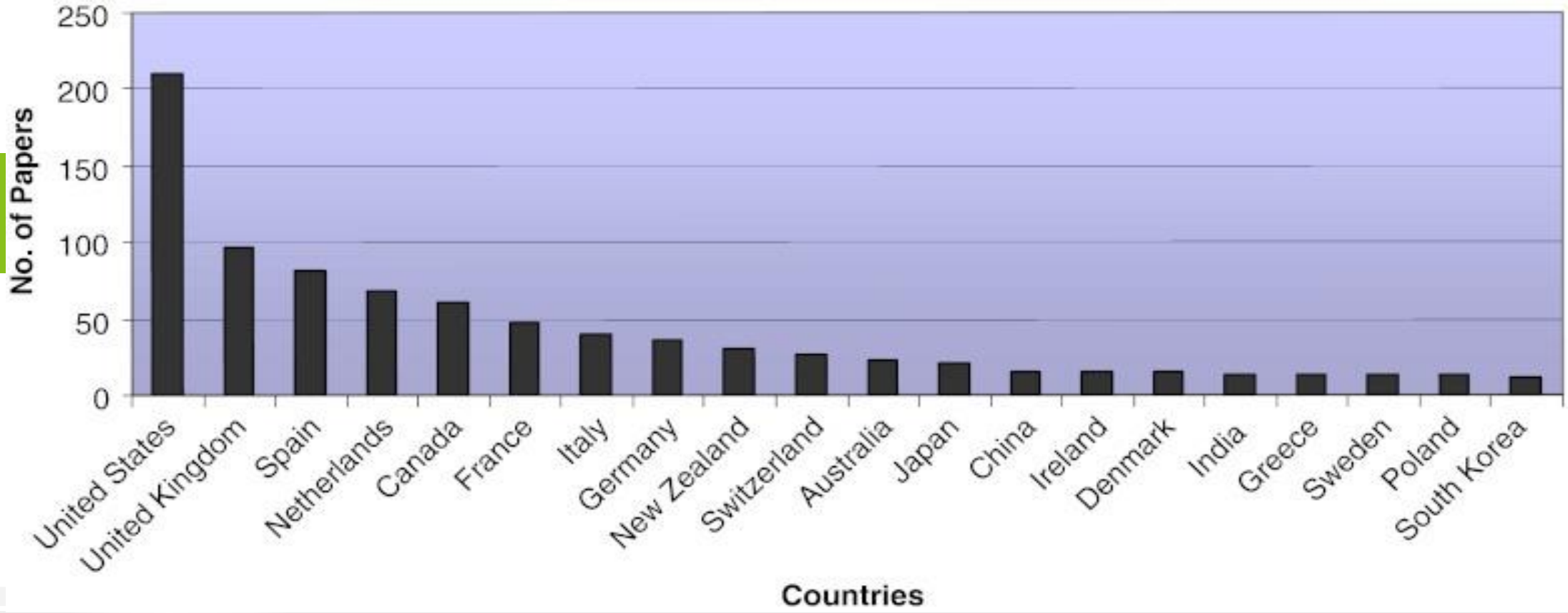
Nutrigenomics → Integrative System Biology





Global status of nutrigenomics research (as per Scopus database)

According to Scopus database, US and UK have the highest contribution, while India is in 16th position, suggesting that nutrigenomics research in India is still in the infancy.



Scopus Database http://www.scopus.com/home.url?null

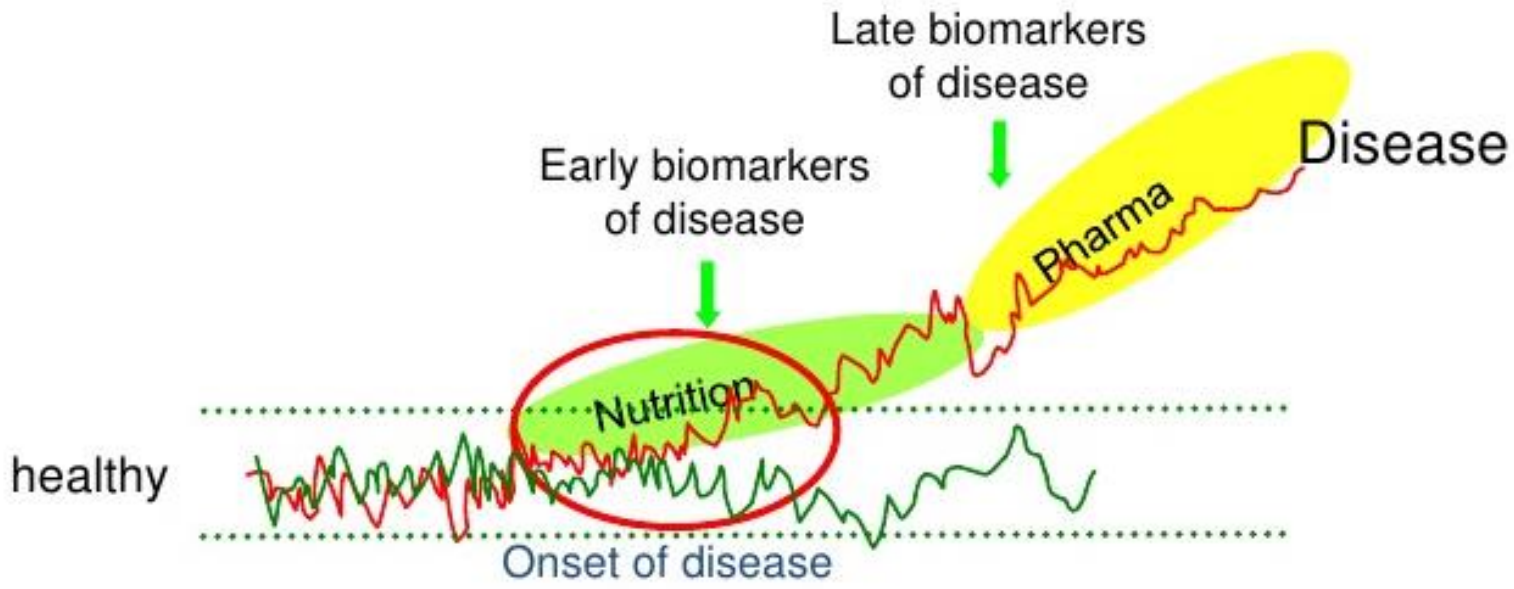
Nutrigenomic approach provides:

- a snapshot showing genes that are switched on/off (the genetic potential) at any given moment;
- a view of how gene/protein networks may collaborate to produce the observed response; and
- the method to determine the influence of nutrients on gene/protein expression.

Benefits of NGx

Early biomarkers in human nutrition research

- Biomarkers of early disease state
- Single marker vs multimarker profiles



Epigenetics and Gene Activation
for Improved Health and Longevity

Excercise
- BDNF

Signaling molecules

Transcription factors

Environment
- Clean air, water and soil
- No smoking

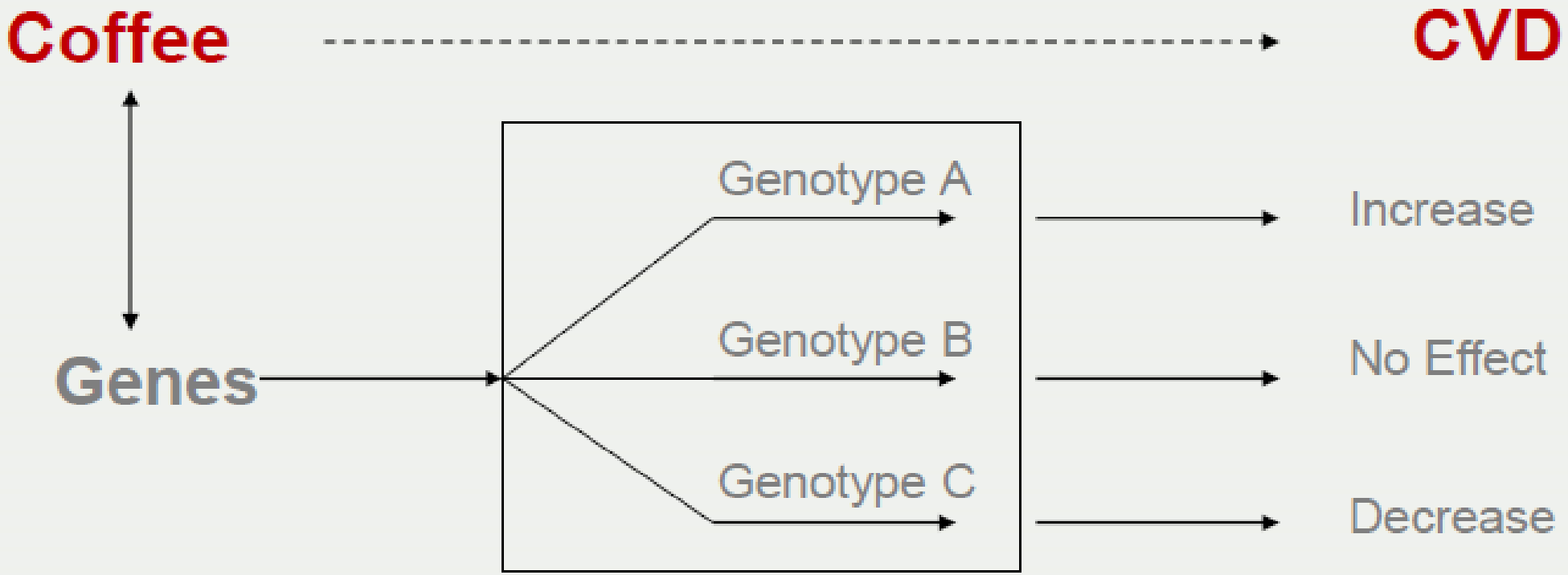
Nutritional Factors
- Calorie Restriction
- Mediterranean Diet
- Polyphenols

Emotional Health
- Religion
- Meditation
- Spirituality

Caffeine Tolerance(CYP1A2)

Caffeinated-coffee was found to **increase** the risk of a heart attack among individuals who carry a version of a gene that makes them **'slow' caffeine metabolisers**, but has **no effect** among individuals who are **'fast' caffeine metabolisers.**

Is Coffee Associated with CVD?



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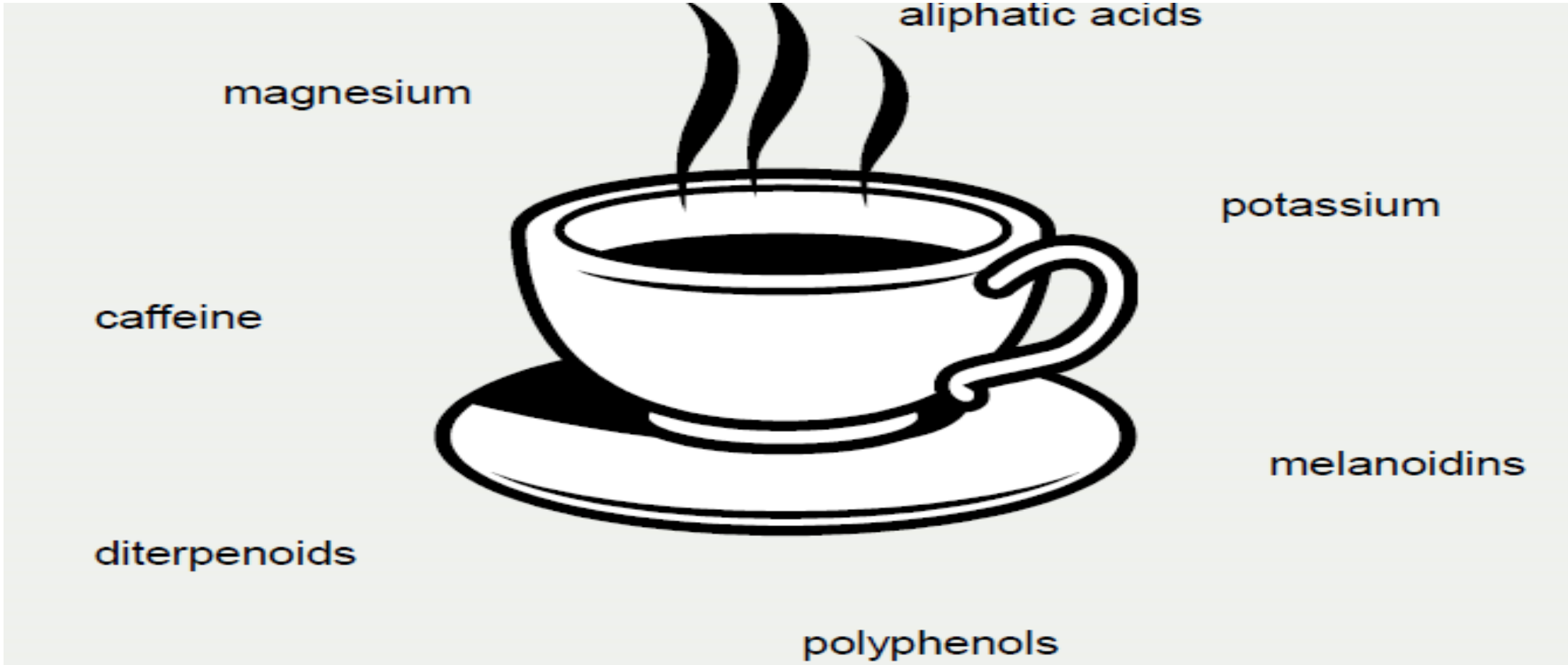
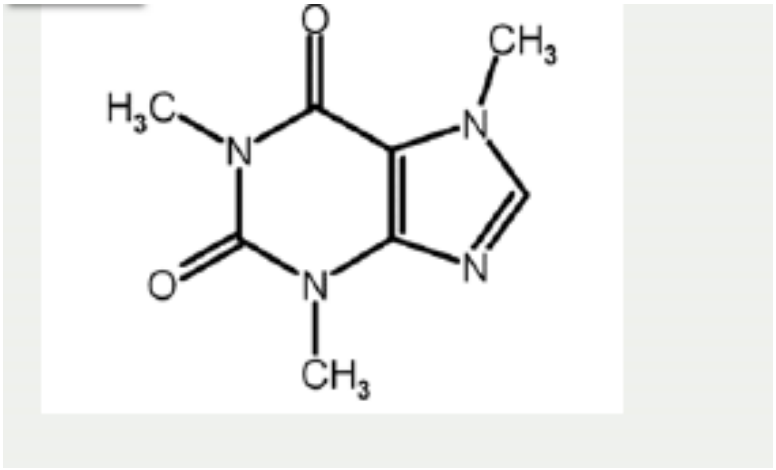
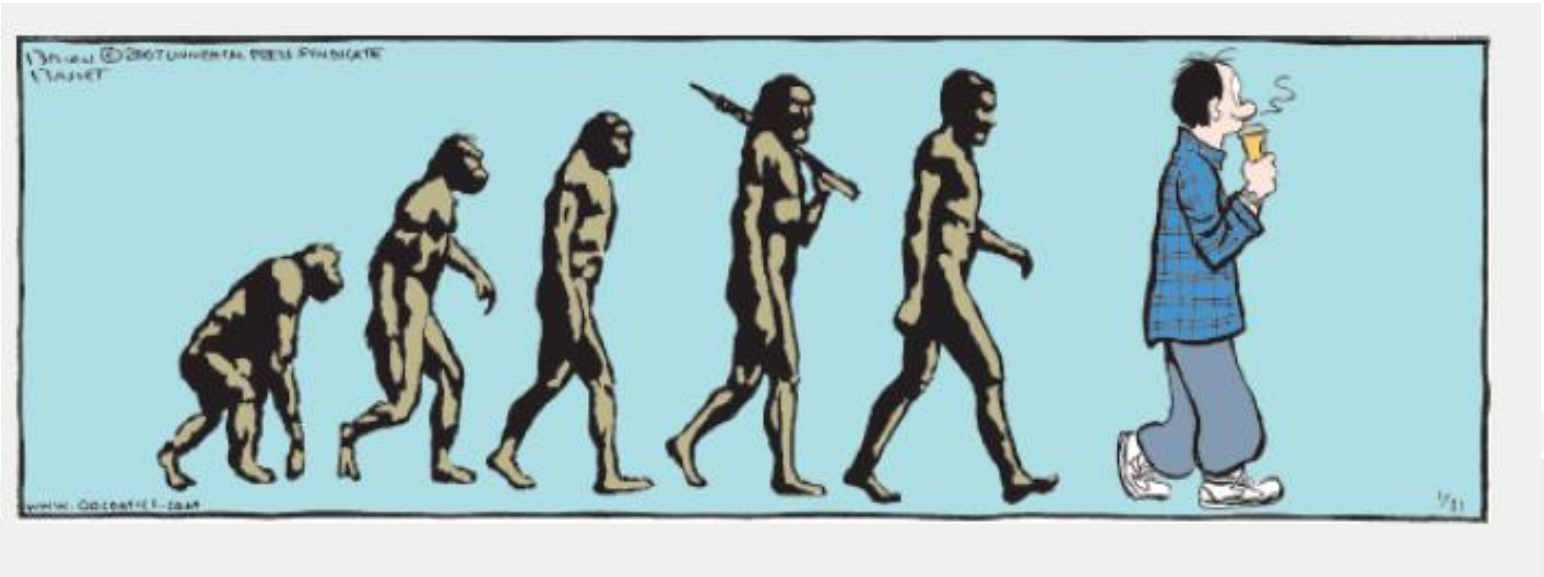
Bioactives in Coffee

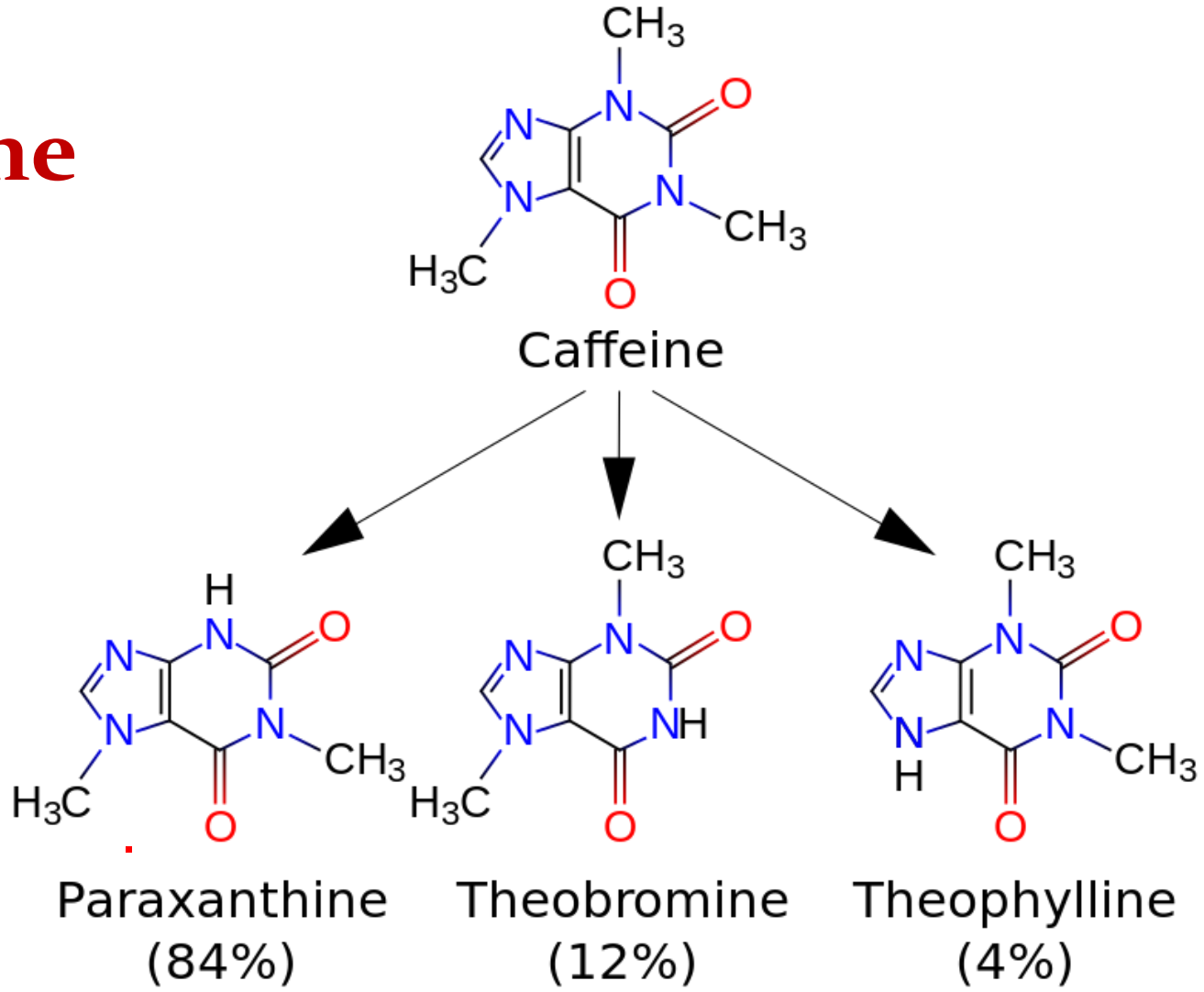


Caffeine (1,3,7-trimethylxanine)



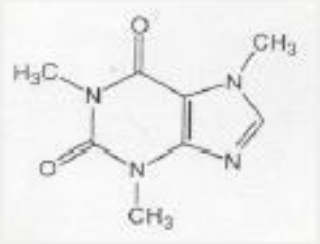


Caffeine

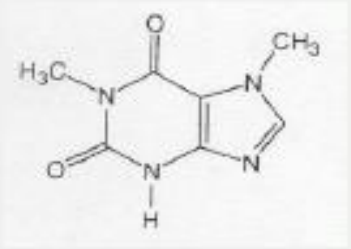


- Caffeine is metabolized in the liver via a single demethylation, resulting in three primary metabolites, paraxanthine (84%), theobromine (12%), and theophylline (4%), depending on which methyl group is removed.

Caffeine



CYP1A2



Paraxanthine

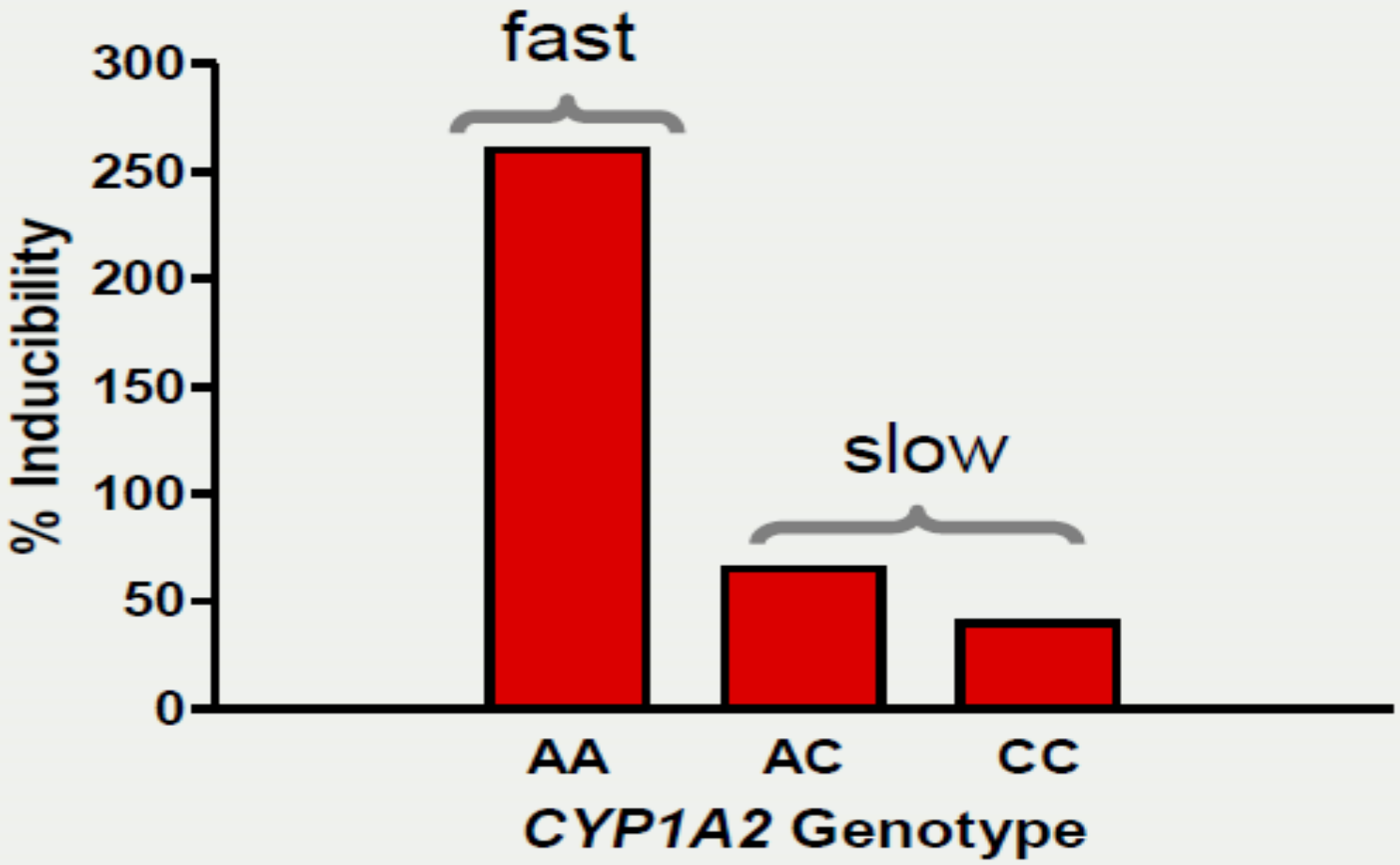
1,7-dimethyluric acid

1-methylxanthine

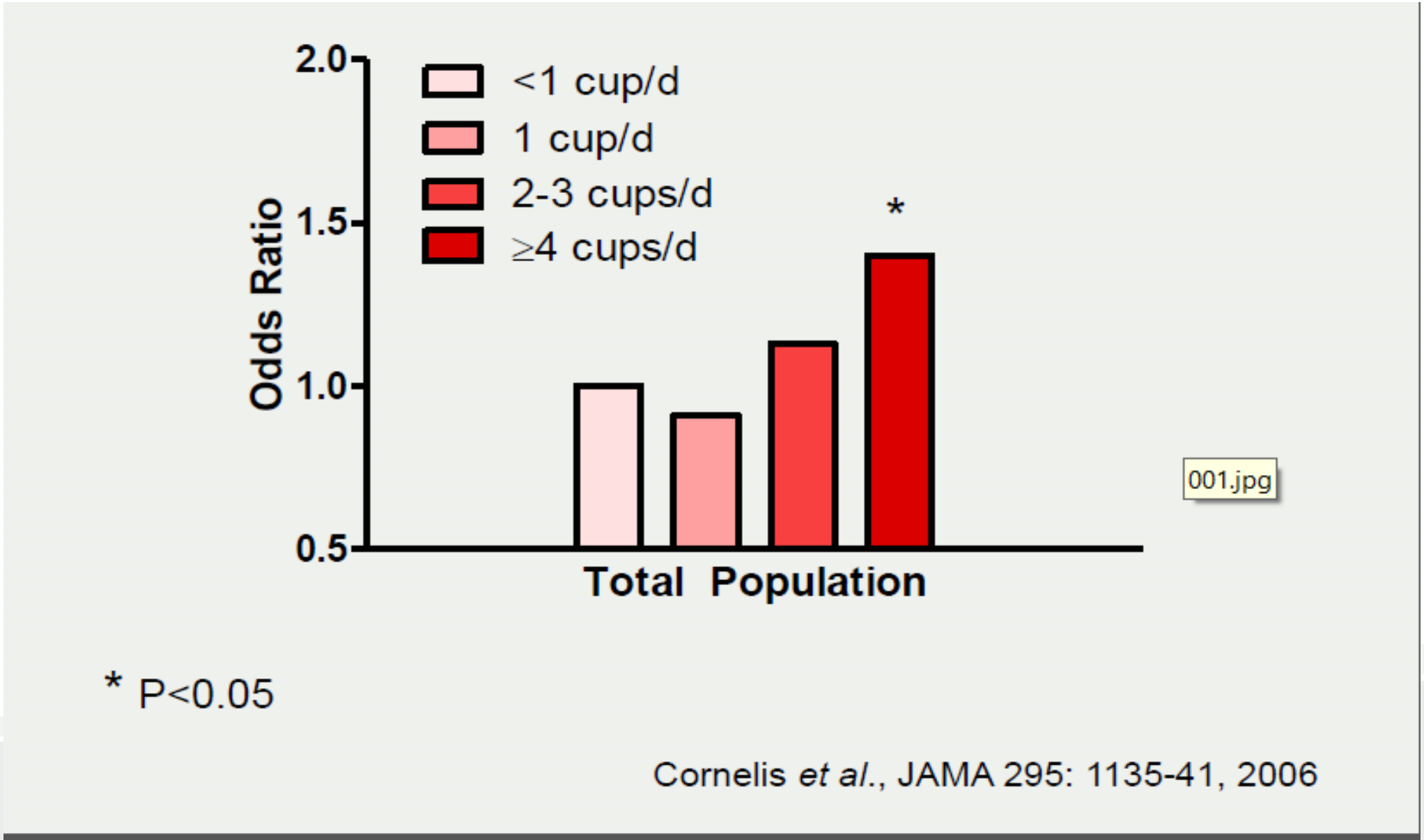
5-acetylamino-6-formylamino-3-methyluracil

1-methyluric acid

Genetic Variation in CYP1A2 -163 A- C



Coffee Intake and Risk of Myocardial Infarction



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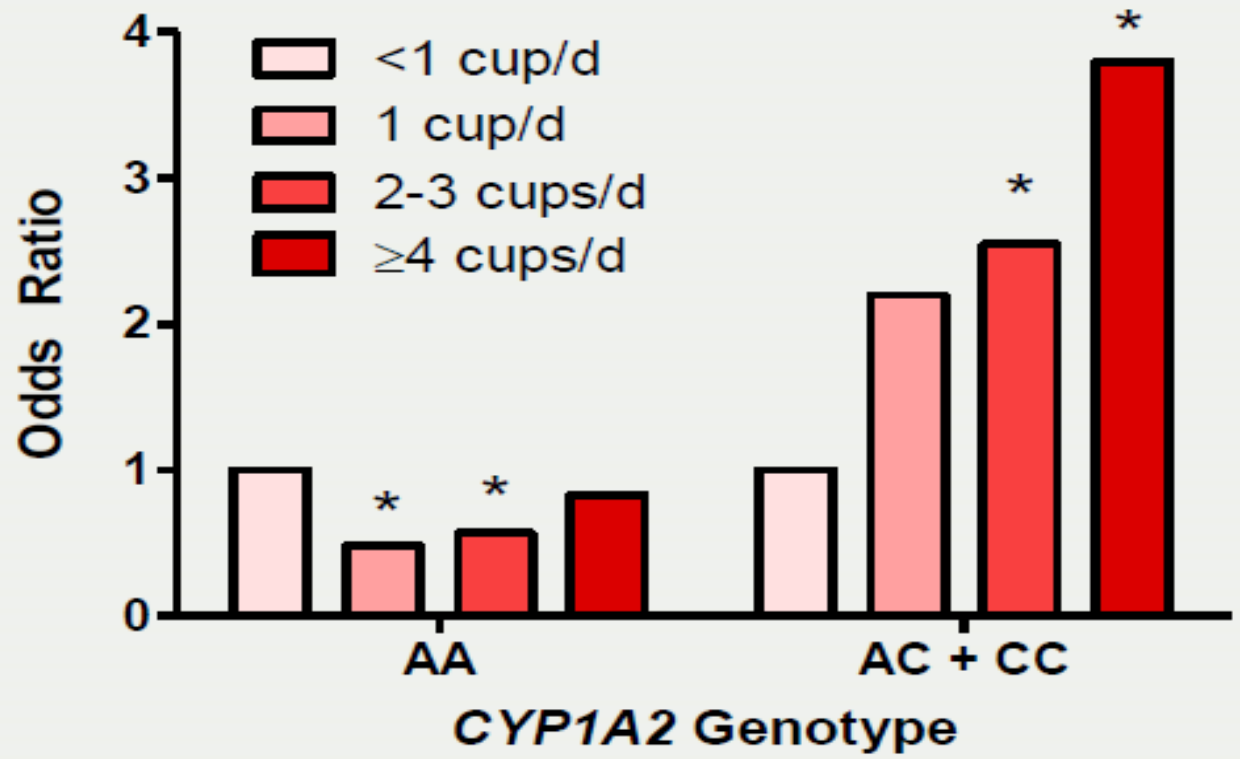


* P<0.05

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

THE TIMES 60p

No 68643 ■ WEDNESDAY MARCH 8 2006 ■ NEWSPAPER OF THE YEAR

Gene that could make your next coffee your last

New research suggests that some people cannot process caffeine as quickly as others and may therefore be more vulnerable to a heart attack, **Sam Lister** reports

High amounts of caffeine can be dangerous, but some doctors suggest coffee also has benefits

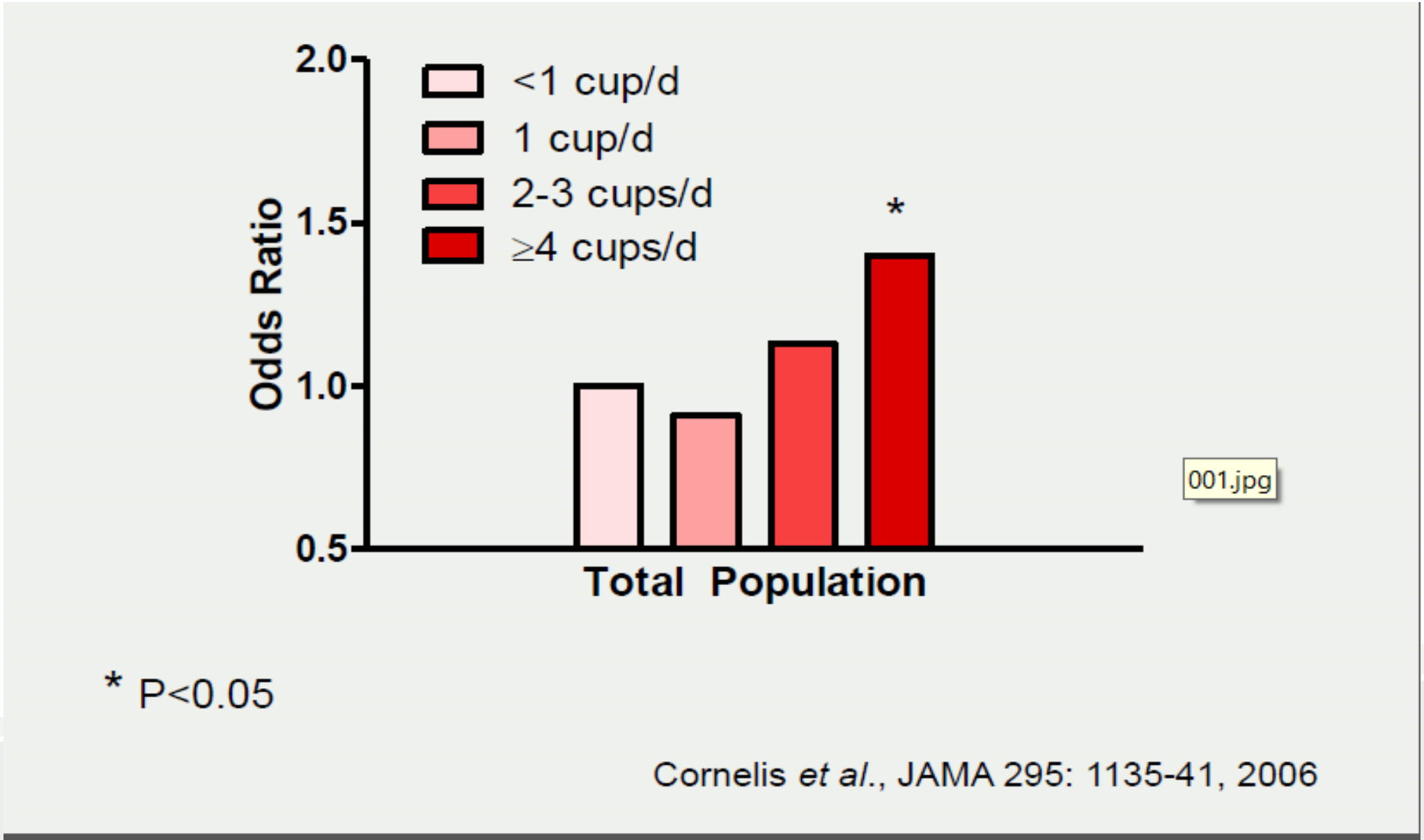
COFFEE drinkers who have more than three cups a day could significantly increase their chances of suffering a heart attack.

New research suggests that people who carry a particular variation of a gene cannot process caffeine as quickly as other people. Such individuals could be up to 64 per cent more likely to have a heart attack if they drink large amounts of coffee.

long be a source of controversy, with high amounts of caffeine long blamed for over-stimulating the nervous system. It contains ditrepenes, said to be responsible for raising levels of a stress hormone called homocystine, which can lead to strokes.

Pregnant women have been urged not to drink more than three cups of coffee a day in case it increases the chances of

Coffee Intake and Risk of Myocardial Infarction



Case Scenario: Adolesence: PCOS

- BMI: 32 Kg/m²
- Fat %: 45%
- Waist Circumference: 124cm
- PCOS : Symptoms
- Insulin Resistance
- Cravings
- Inactivity / Fatigue/ Lethargy

Normal Conservative Management:

- Calorie Control
- Glycemic Load of the meal
- Regular Exercise Sensitisation
- Motivation and Follow-up for successful adherence of lifestyle discipline.

Circadian Rhythm

Behaviour Modification

Personalised Nutrition

Avoid Weight Regain

Neuroendocrine

Phenotype
Exposomes
Genotype

Nature of Macros and its %

Exercise Adherence

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Metabolism Vs Gene

Metabolism Factor/ Aspect	Gene
Satiety	FTO
Appettite	MC4R
Circadian Rythm	CLOCK
Insulin Sensitivity	PPARG, TCF7L2, FTO
Fat Absorption	FABP2
Energy Regulation	ADBR2, TNF-A, PLIN
Inflammation	TNF-A
Fat storage	PLIN

All above + Other genes =. 140 genes

Two Meal Pattern and Weight Loss

Case 1	Case 2
Adherence to 2 meal pattern gave weight loss	2 meal pattern gave weight gain
Bodys response with this diet	
1. Satiety with one full meal 2. Does not snack 3. Reduced its calorie intake by cancelling one meal and in between teas/ snacks 4. Discipline was easy with good satiety control	1. Snacking tendency 2. Acidity++ 3. Increased volume of meal

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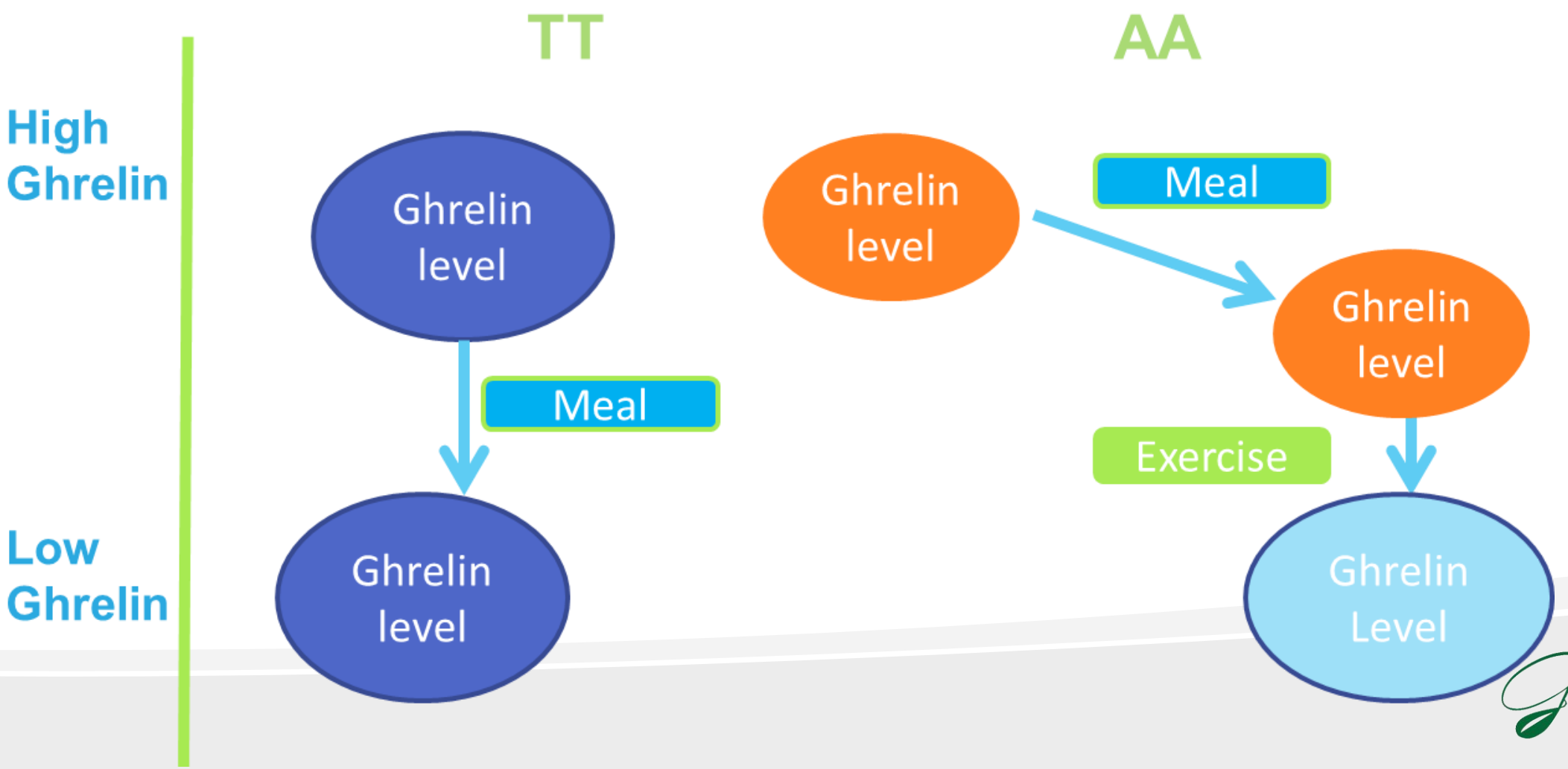
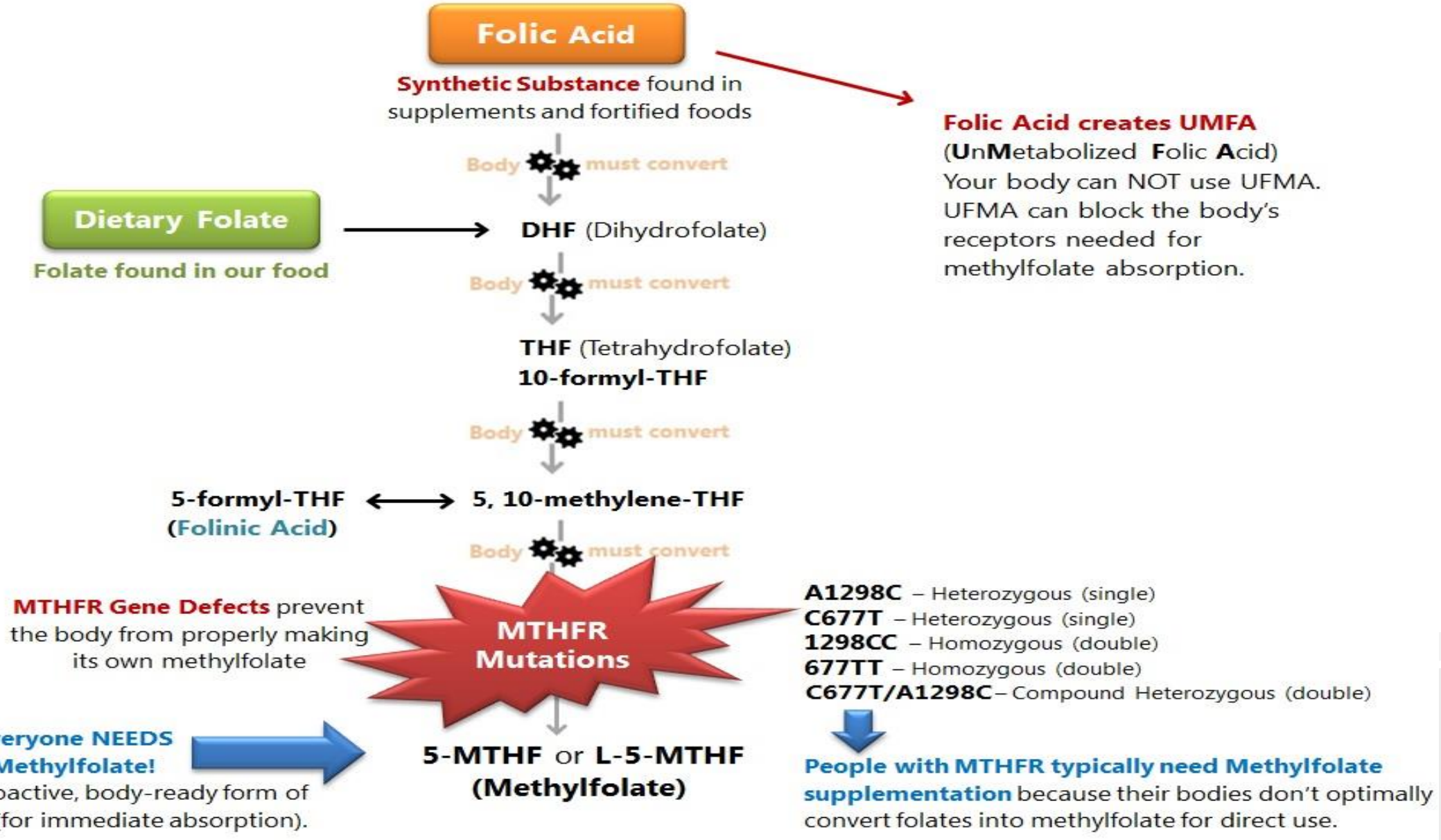
FTO Gene


TT
AA
High Ghrelin
Low Ghrelin
Ghrelin level
Meal
Ghrelin level
Ghrelin level
Meal
Exercise
Ghrelin Level

Folate Metabolism Pathway



Nutrient based Nutrition

Nutrients	Gene Alteration	Deficient Diet-Disease Potential	Food Intake
Folic acid (Vitamin B9)	Chromosome break and hampers DNA repair/methylation	Cancer, heart disease, brain dysfunction, male infertility, leukemia	Liver, kidney, egg yolk, asparagus pea, cowpeas, lentils, peanuts, spinach, beetroot, broccoli, orange
Vitamin B12 (Cobalamin)	Chromosome break and hampers DNA repair/methylation	Same as folic acid, memory loss	Liver, sardines, salmon, clam, beef, milk, cheese, yoghurt
Vitamin B6 (Pyridoxine)		Same as folic acid	Spinach, potato, bell peppers, turnip, mushroom, garlic, cauliflower, banana, chicken, pork, beef, salmon, tuna, turkey
Niacin (Vitamin B3)	Hampers DNA repair	Nerve problem, memory loss	Pork, tuna, prawns, kidney, liver, poultry, carrots, turnips and celery, mushrooms, beans, almonds, wheat

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Nutrigenomics as Tool:

Area of Activity	Gene Name (Variation)	Your Result	Gene Impact	Your Genotype Summary
Insulin Sensitivity & Energy Regulation	PPARG (C>G)	CC	🔴	Increased obesity tendency due to dietary saturated fat intake
	FTO (T>A)	AT	🟡	Dietary fats may cause IR
	TCFL2 (C>T)	CC	🟢	Low tendency of Insulin Resistance (IR) due to weight gain.

⚪ Low Impact 🟡 Medium Impact 🔴 High Impact – No Impact 🟢 Beneficial

Way Forward

- Identification of Biomarkers
- Developing food for specific use
- Prevention and Wellness
- Personalised health
- Supplementation / Fortification

What Nutrigenomics Holds in India ?

- More research work will enhance consumer confidence, awareness and a better future, which in turn will upgrade the country's status.
- Convincing evidence needs more research back ground
- NGx make sense but far from personalized Nutrition
- Various database literature concludes high hope and need in India.

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- Early identification of at risk individual
- Changes in dietary pattern
- Increased physical activity
- Preventive tool for good health and wellness.

Hippocrates - Father of Medicine (460–360 BC), "Leave your drug in the chemist's pot if you can heal the patient with food".

J Food Sci Technol 2013 Jun; 50(3): 415–428.

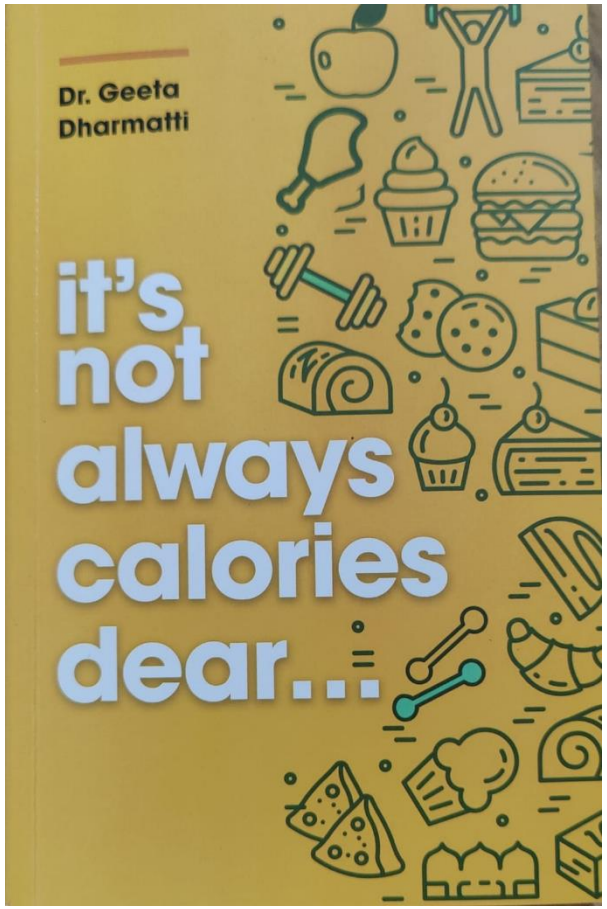
Challenges by Nutrigenetics and Nutrigenomics

1.The "**personally tailored diet"** may be perfect in theory, but will people be motivated to follow it?
Personal motivation is fast becoming recognized as the single most important factor in weight loss and exercise – and the most difficult to influence.

2. Will specific information created by the study of nutrigenetics and nutrigenomics overshadow public understanding of general healthy diets by focusing on specific micronutrients?

3. Will the cost of tailored diets be too high?

Mark McCarthy, of the Department of Epidemiology and Public Health, University College London, London, UK, in a report entitled, "Research for food and health in Europe: themes, needs and proposals." (2011),



Thank you