

Nutrigenomics - Nutrigenetics :

What, Why and How



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ภาควิชาชีวเคมี

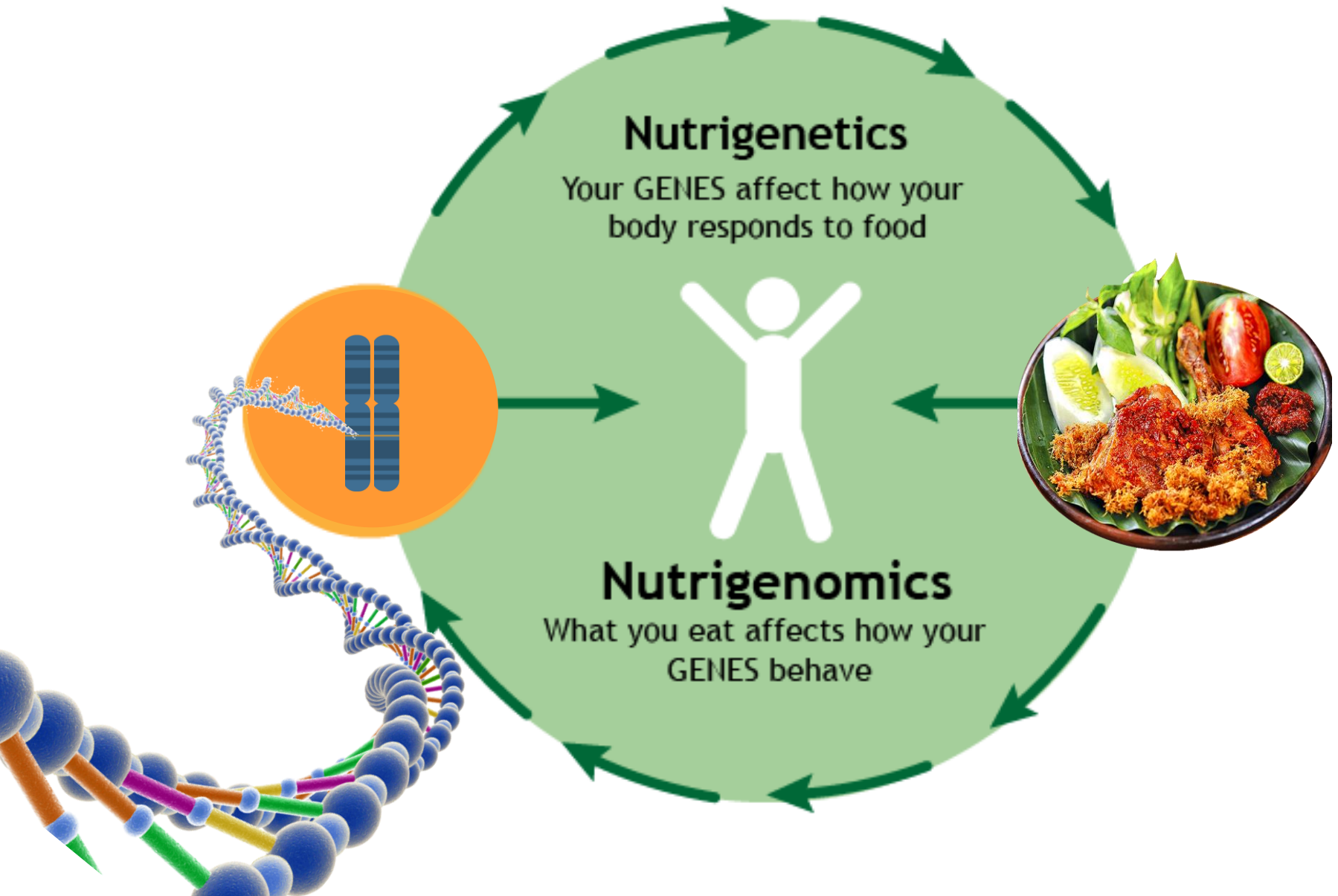
คณะวิทยาศาสตร์การแพทย์ มหาวิทยาลัยนเรศวร

Out line

- **Nutrigenetics and Nutrigenomics**
- **DNA and Chromosome**
- **Genetic variations and foods**
- **Nutrigenomics for daily life**



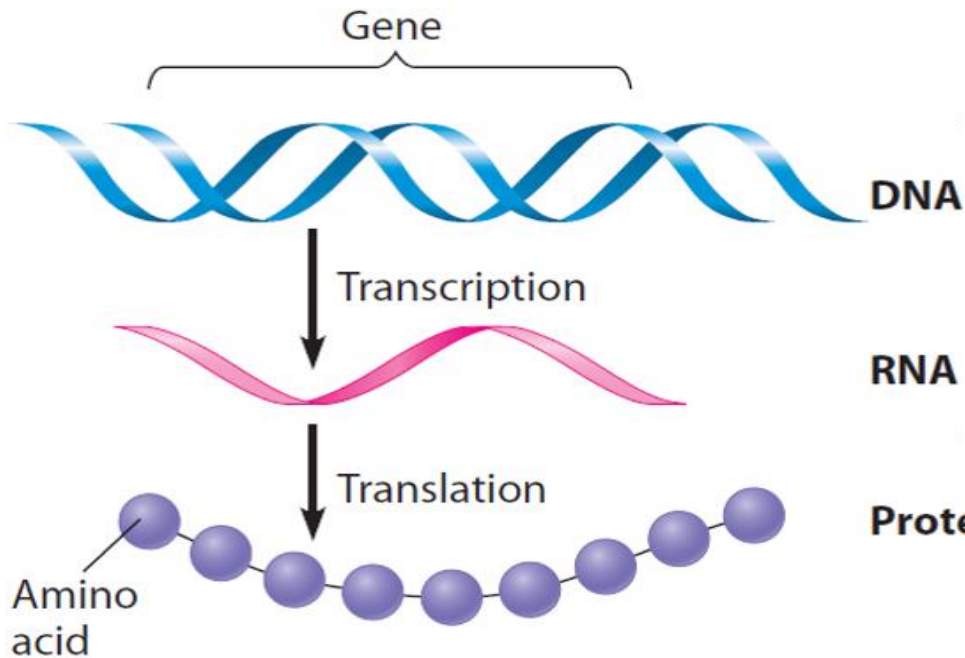
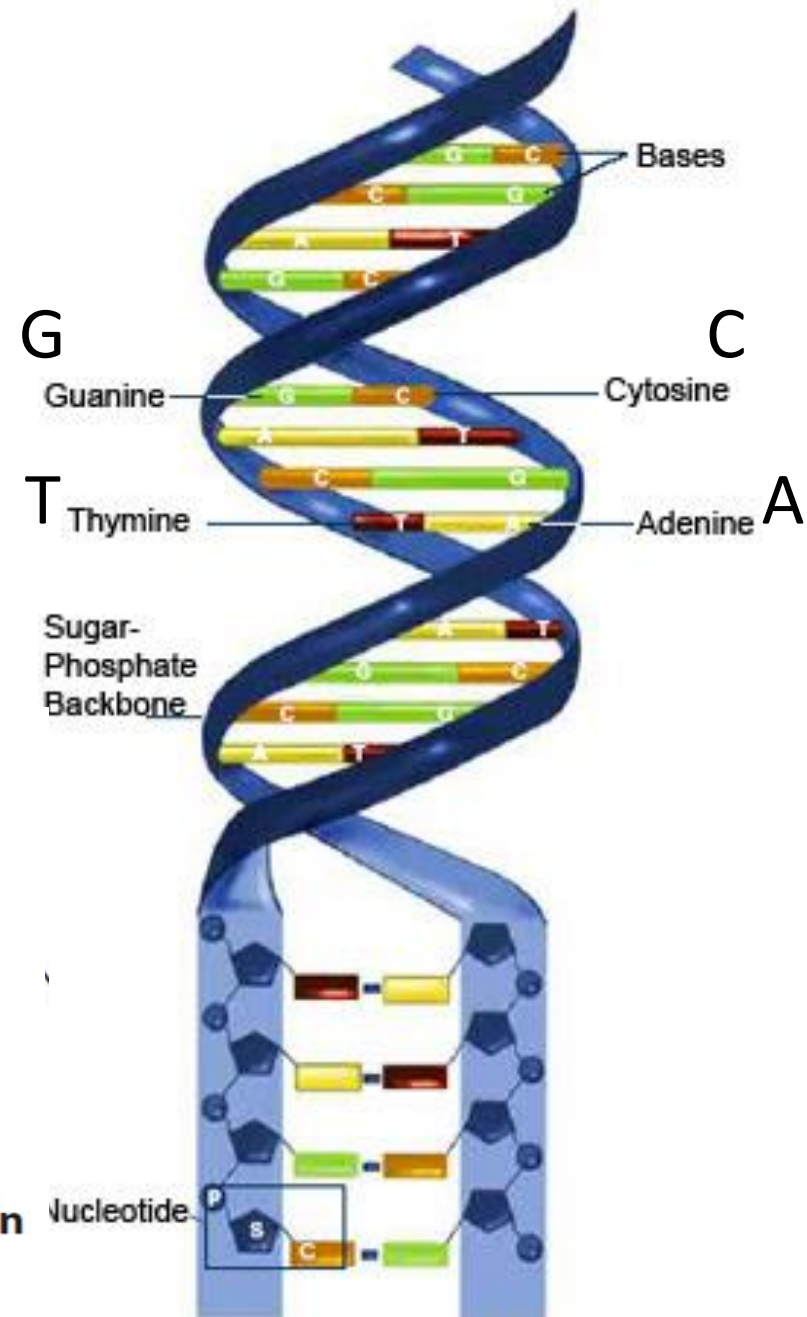
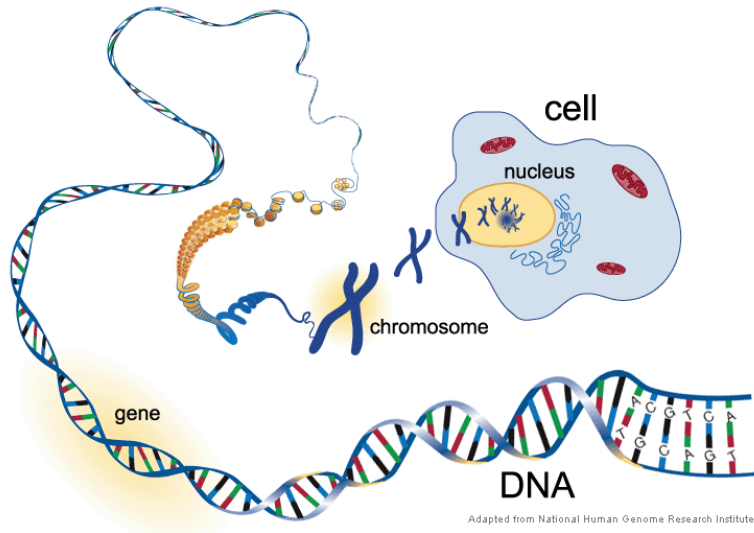
Genome –Food interface



Nutrigenetics and Nutrigenomics

- Nutrigenetics : the branches of science dealing with the effect of genetic variation on nutritional response
- Nutrigenomics : the function of nutrients and bioactive food compounds in influencing gene expression
- Genomic diversity with respect to ethnicity that affects nutrient bioavailability and metabolism, choice and availability of food depending on cultural, socioeconomical, geographical and sense of taste of an individual and malnutrition that can affect gene expression and pose threats to genome stability by paving the way for mutations in gene sequences or causing chromosomal aberrations resulting into abnormal gene dosage and corresponding adverse phenotypes.

DNA to Protein

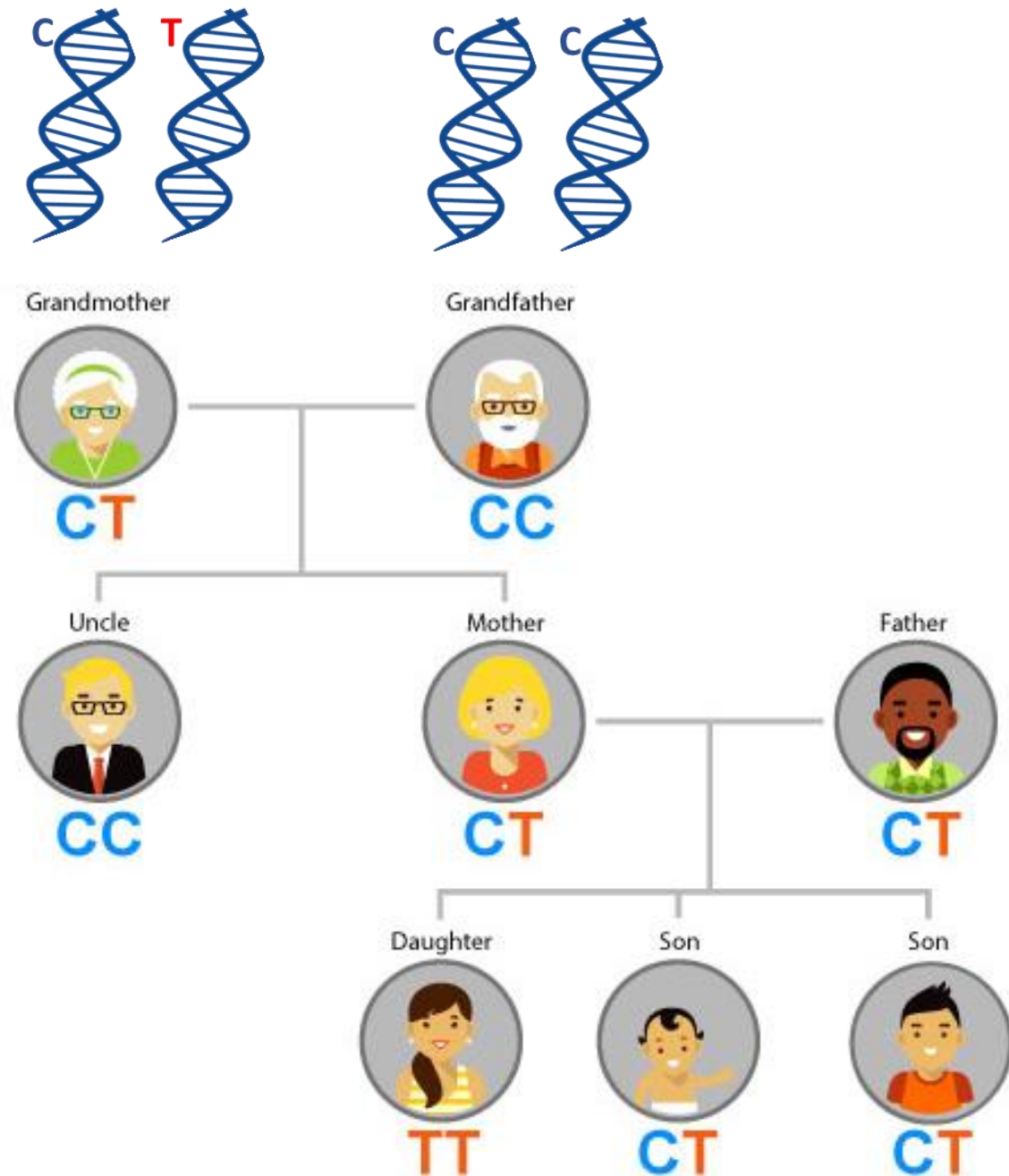


Variation



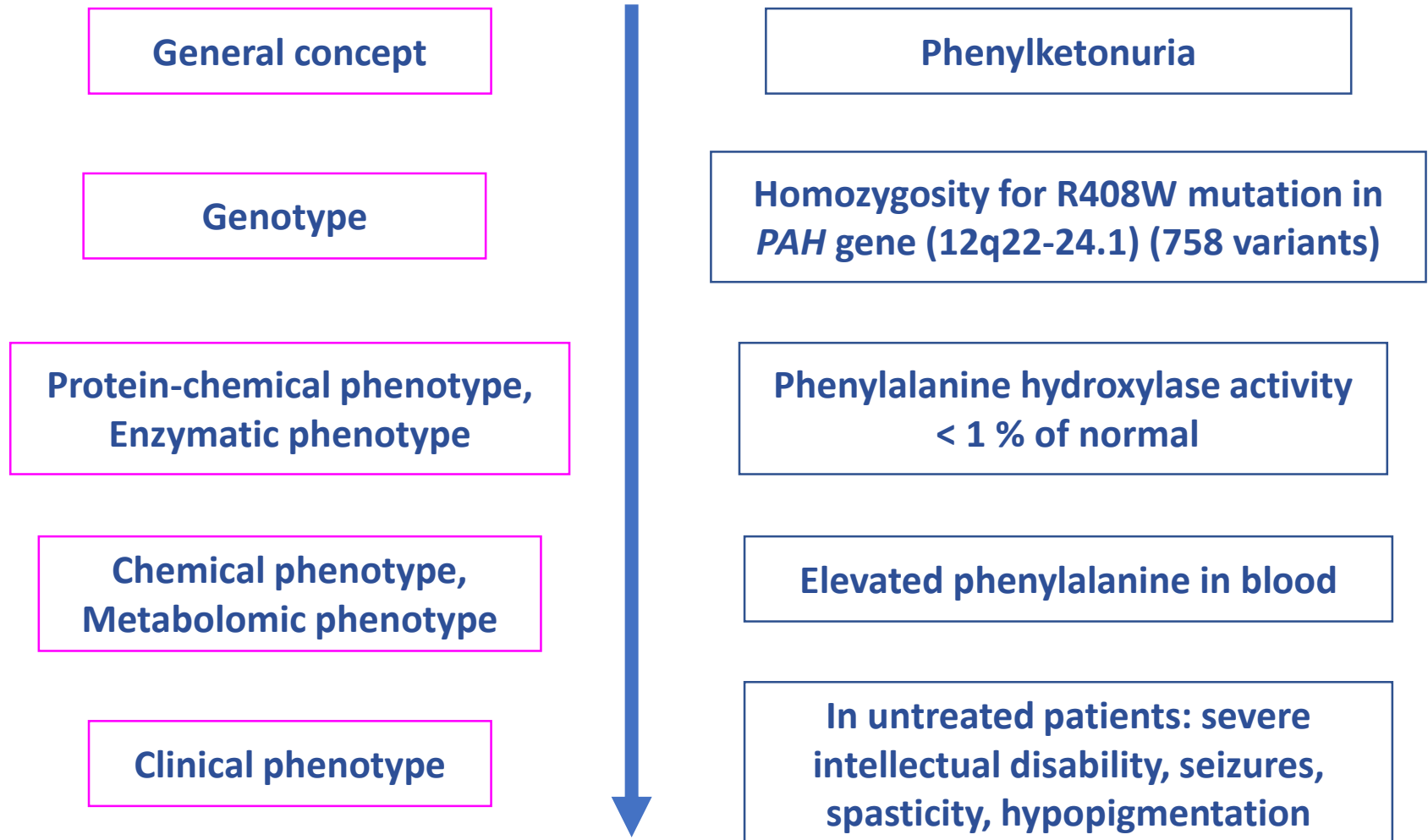
Genotype

- Pair of alleles at the same locus
- รูปแบบของยีนที่อยู่เป็นคู่กันที่ตำแหน่งเดียวกันในสายดีเอ็นเอจากพ่อและแม่
- Homozygous: CC / TT
- Heterozygous: CT

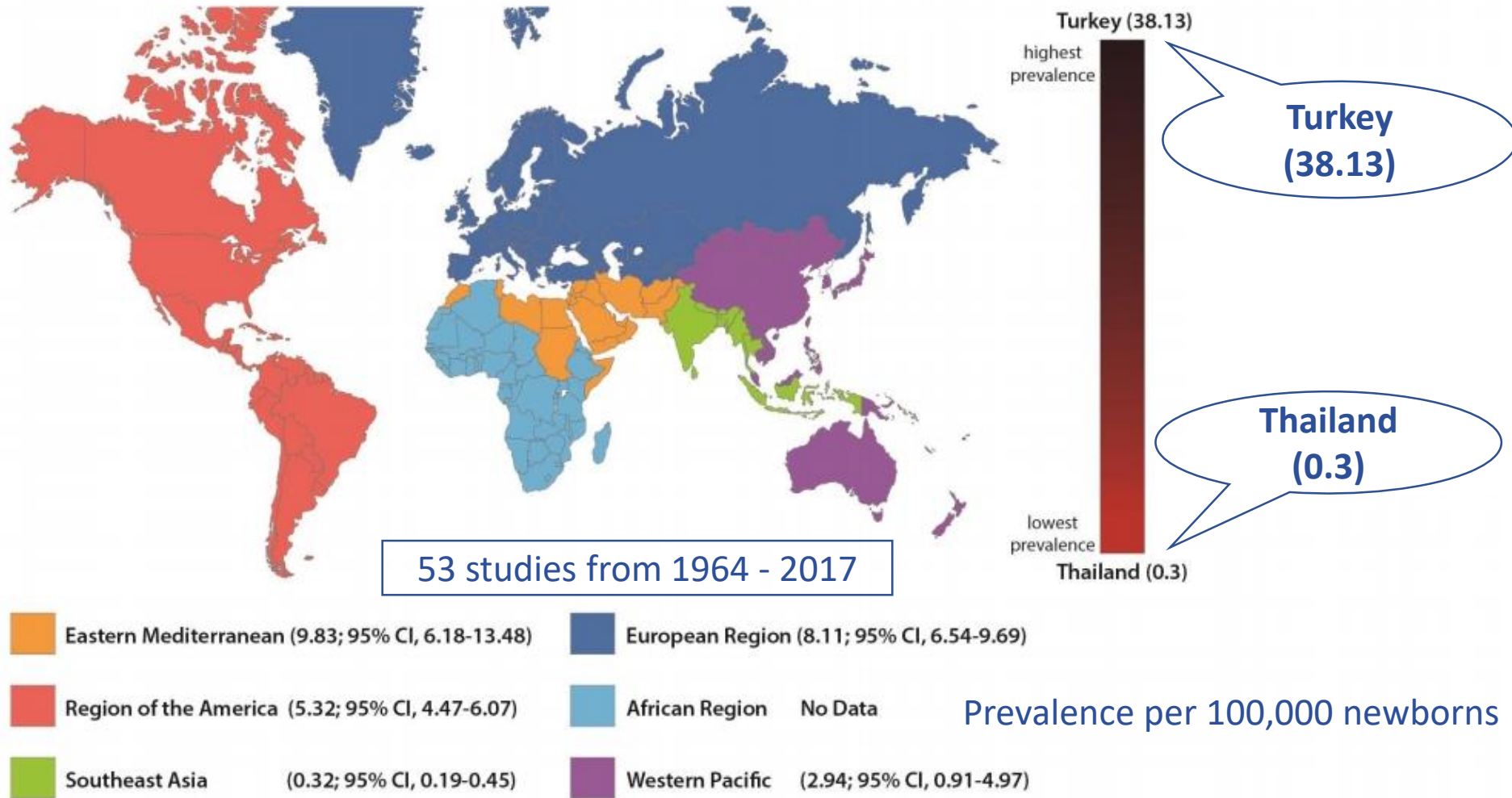


From Genotype to Phenotype

- Phenotype results from multiple factors, both genetics as well as non-genetics.



Phenylketonuria: PKU

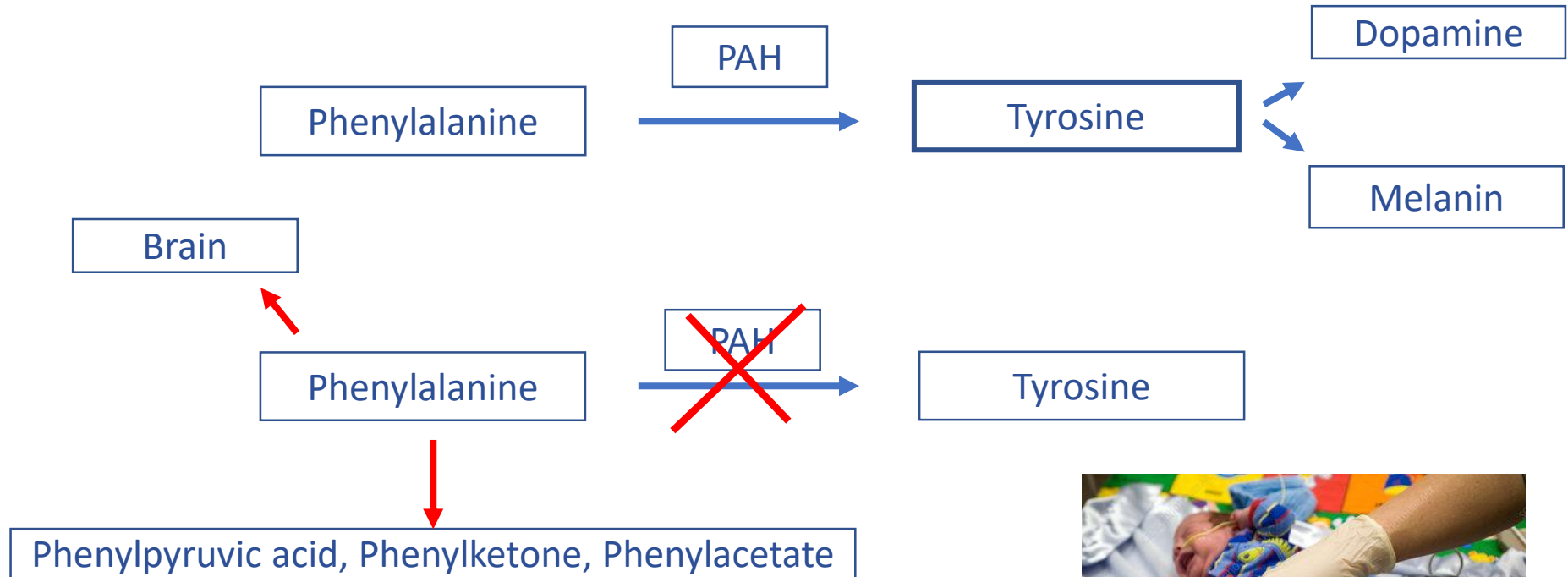


The pooled prevalence of classic PKU in the World Health Organization Regions

Shoraka et al., Clin Exp Pediatr 2020; 63(2), 34-43.

From Phenotype to Food

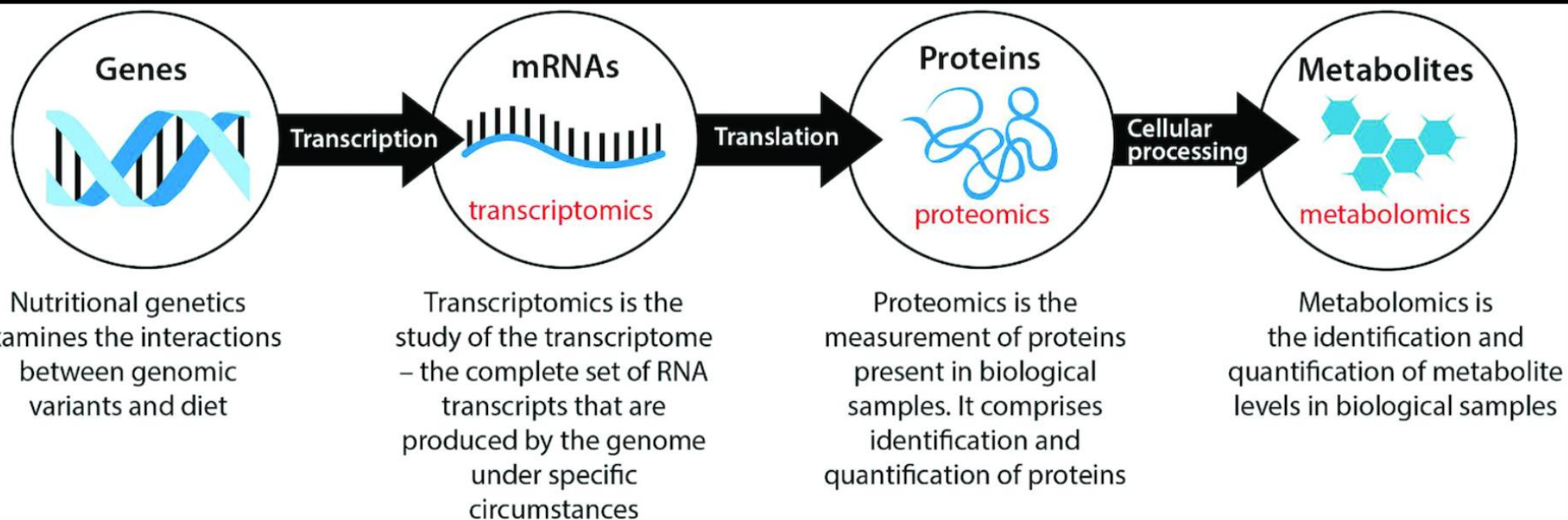
- Phenylketonuria : In born error of amino acid metabolism



- PKU is not curable, genetic disease.
- Newborn detection
- Dietary treatment, Nutritional supplement, Enzyme substitutes

Nutrition and Omics

- a branch of science investigating the interactions between nutrition and the host (genome) through omics technologies.



An overview of nutrigenomics: investigating the interactions between nutrition and the host (genome) through omics technologies.

Brennan and Roos, Am J Clin Nutri 2021; 113(3), 503-516.

Nutrigenomics at transcriptomic level



Volume 84, Issue 5
November 2006

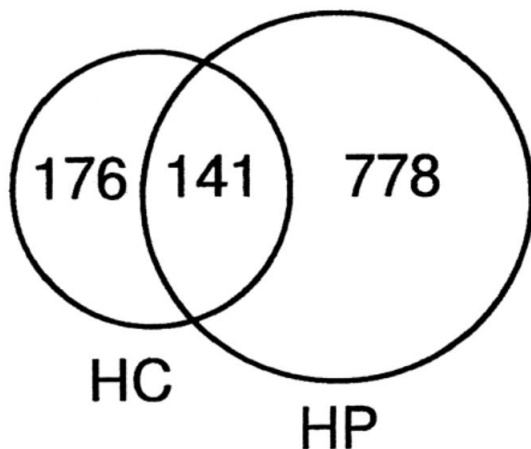
High-protein and high-carbohydrate breakfasts differentially change the transcriptome of human blood cells FREE

Marjan J van Erk ✉, Wendy AM Blom, Ben van Ommen, Henk FJ Hendriks

The American Journal of Clinical Nutrition, Volume 84, Issue 5, November 2006,
Pages 1233–1241, <https://doi.org/10.1093/ajcn/84.5.1233>

Published: 01 November 2006 **Article history** ▼

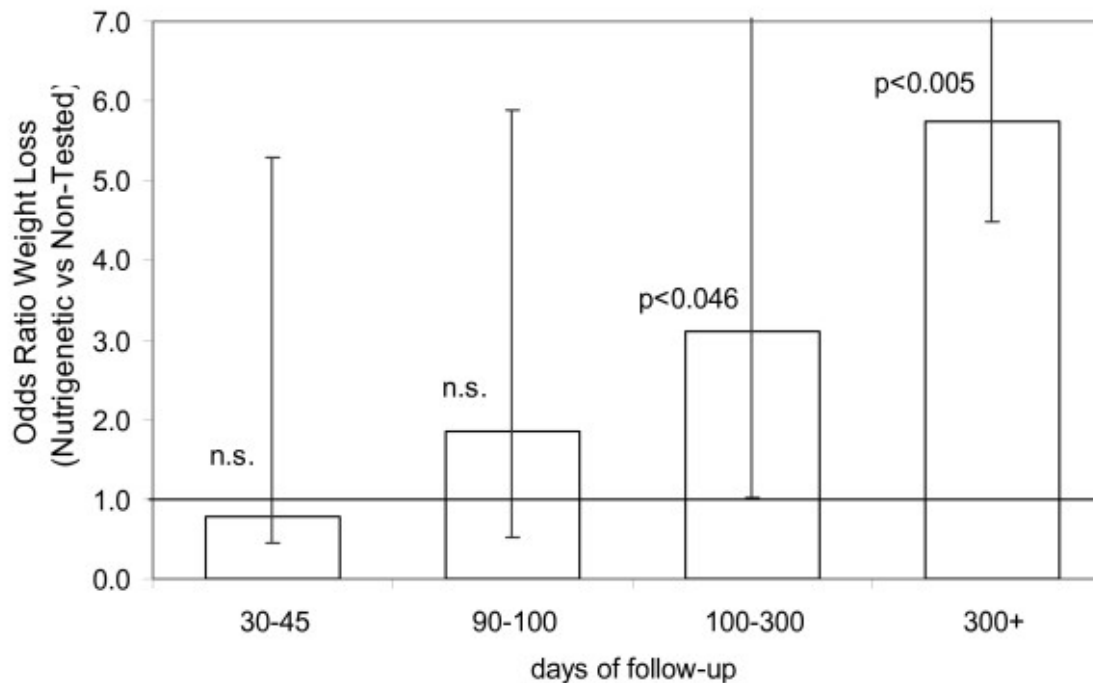
Blood samples taken before
and 2 h after breakfast
consumption.



- HC intake - lower expression of genes involved in glycogen metabolism
- HP intake - lower expression of genes involved in protein biosynthesis
- Breakfast consumption - differentially expressed genes, 317 for the HC breakfast and 919 for the HP breakfast.
- Immune response and signal transduction, specifically T cell receptor signaling and nuclear transcription factor κ B signaling, were the overrepresented functional groups in the set of 141 genes that were differentially expressed in response to both breakfasts.

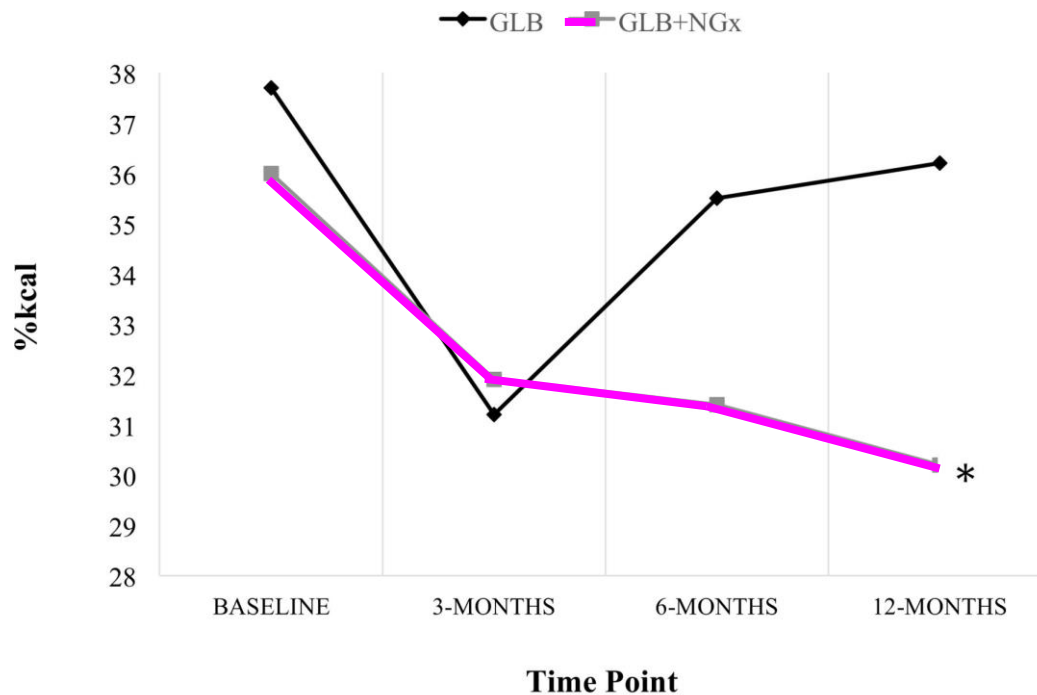
Nutrigenomics: personalized nutrition

- Genetic profiles improved health and prevent diseases.
- Improved weight management
 - 93 patients with history of failures at weight loss
 - 50 patients : genetic test screening 19 genes
 - 43 patients : not genetic test



Nutrigenomics : long-term dietary change

- Subjects: 140 patients: Group Lifestyle Balance (GLB) program
 - 70 Standard GLB
 - 70 GLB + Nutrigenomics (6 genes relates to dietary metabolism)

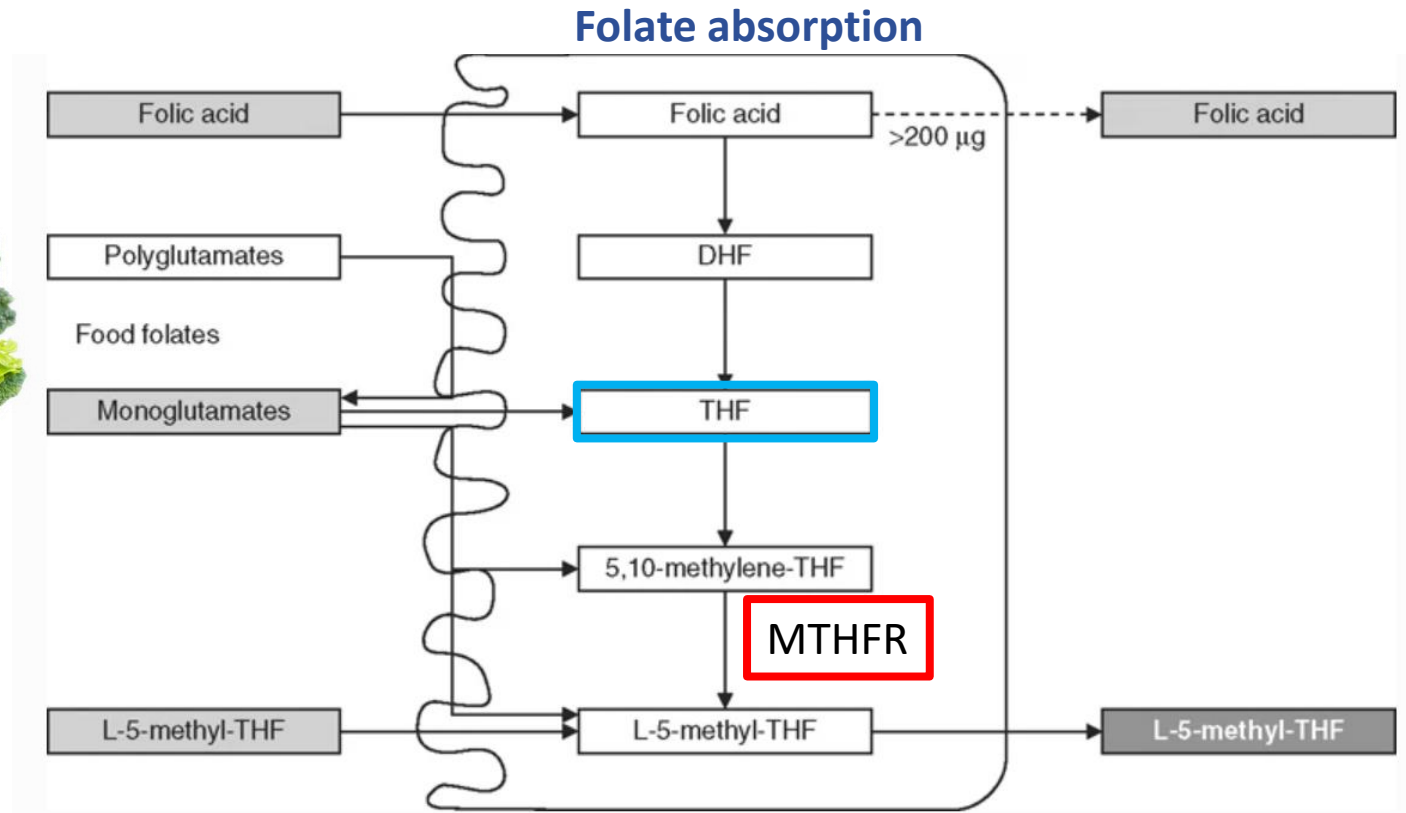
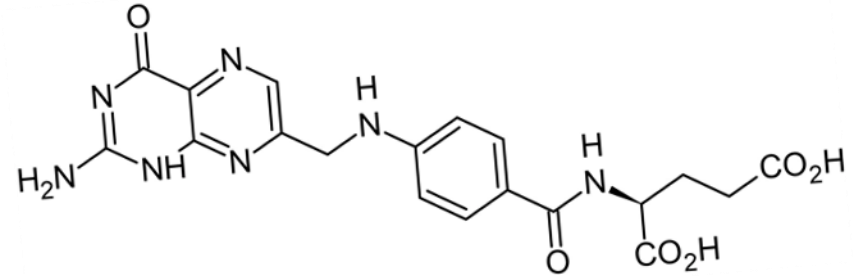


* $p = 0.02$

- Participants dropped out, may be due to low incomes

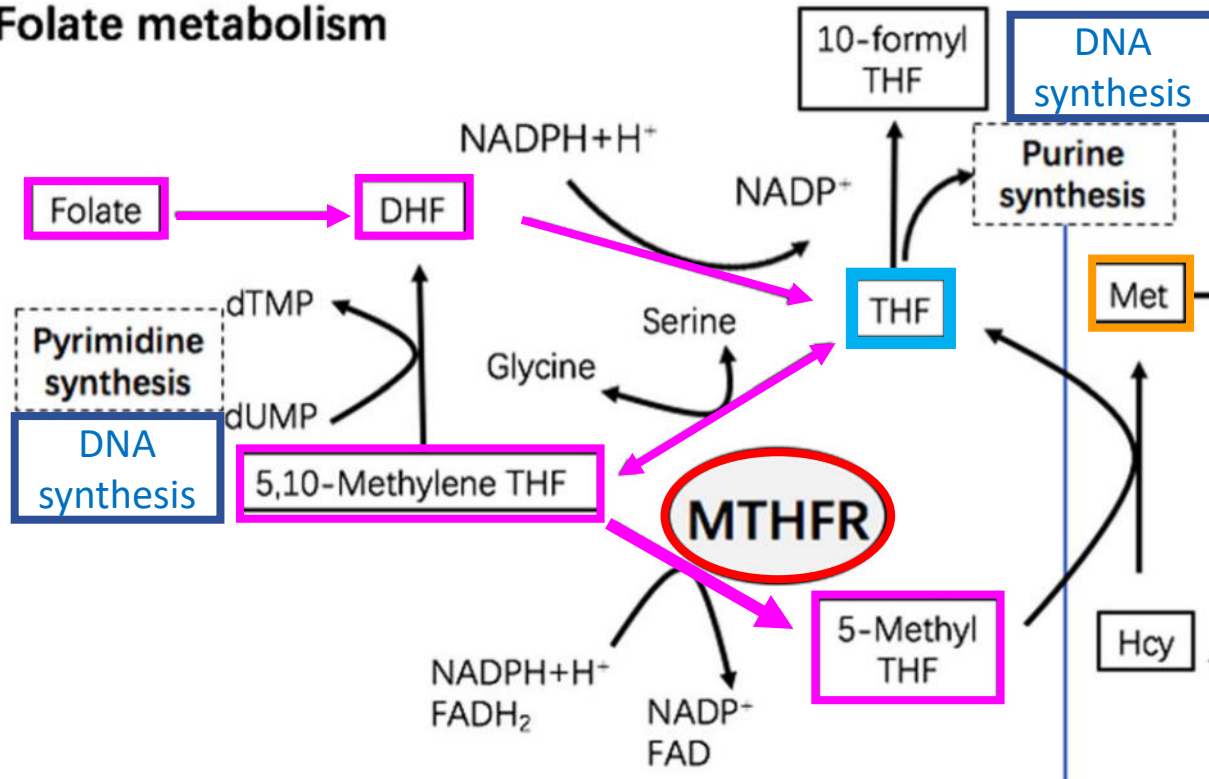
Folate pathway

- Folate (folic acid) : Vitamin B9
- 1 carbon metabolism (-CH₃)
- Nucleic acid synthesis
- Amino acid synthesis
- Methylation

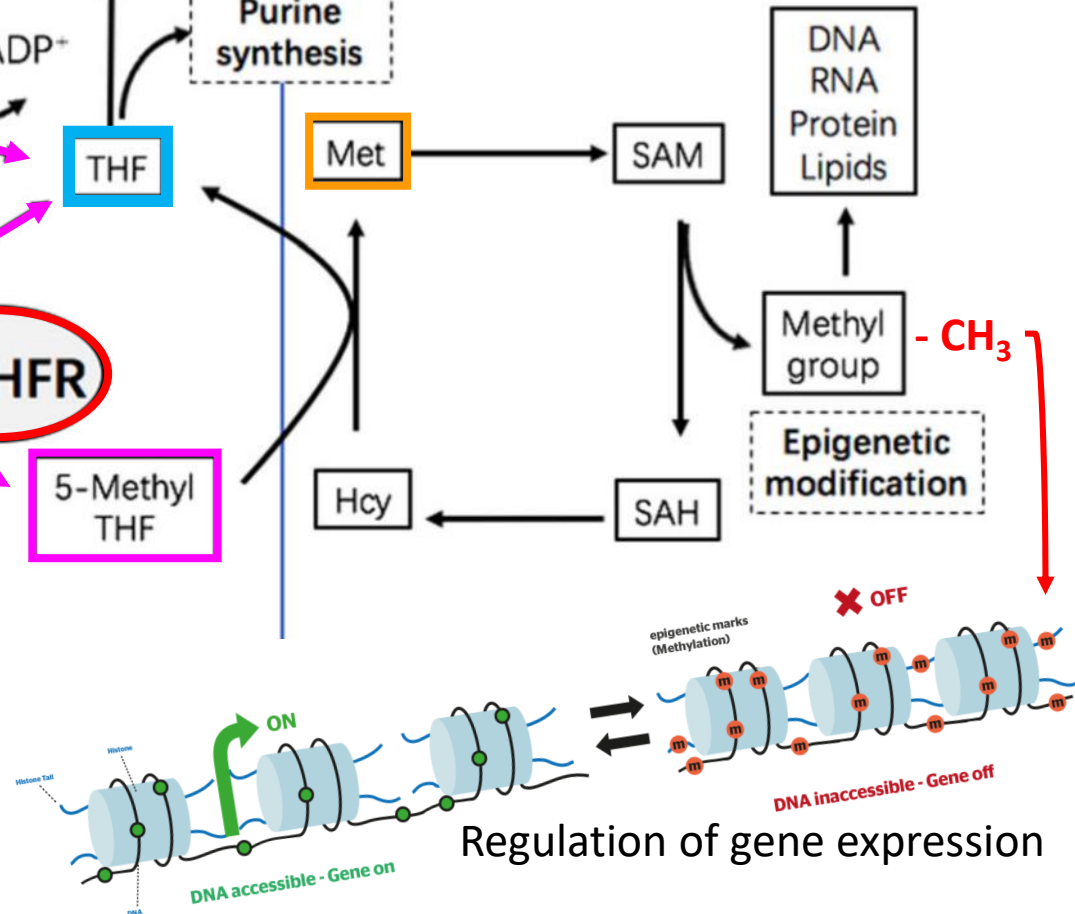


Folate pathway

Folate metabolism



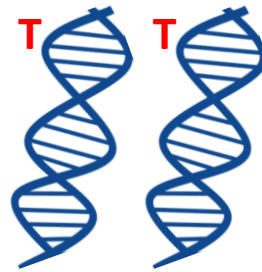
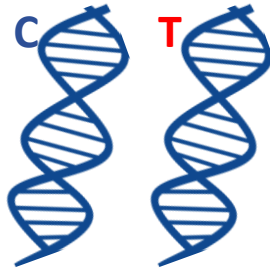
Carbon metabolism



Regulation of gene expression

MTHFR: methylenetetrahydrofolate reductase

- 5,10-methylene THF → 5-methyl THF
- Variant: *MTHFR* (C677T)

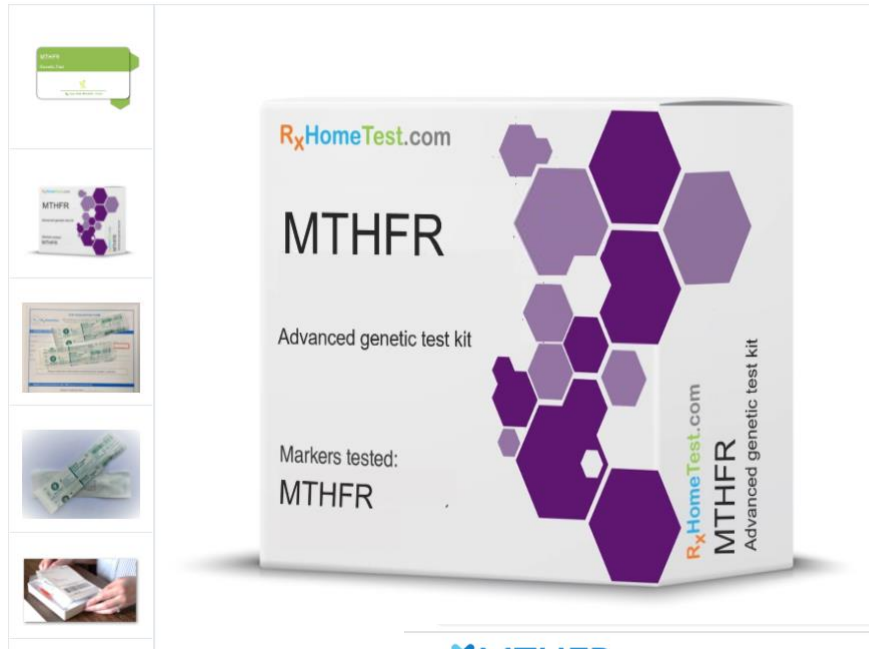


CC : 100 % activity CT : 67 % activity TT : 25 % activity

- *MTHFR* (C677T)
 - Cardiovascular
 - Cerebral vascular
 - Thrombosis
 - Psychiatric
 - Pregnancy and Neural tube defect
 - Cancers
 - DNA stability

- Prevalence of *MTHFR* TT genotype

- | | | |
|-------------------------|--------|---|
| • North, Han Chinese | 19.8 % | |
| • South, Han Chinese | 8.1 % | |
| • Whites, Australia | 8.0 % | |
| • Whites, USA Atlanta | 10.7 % | |
| • Hispanic, USA Atlanta | 17.7 % | (Wilcken et.al., J Med Genet 2003; 40(8), 619-625.) |
| • Thai | 1.4 % | (Angchsuksiri et.al., Acta Haematol 2000; 103(4), 191-196.) |



MTHFR Genetic Test

Categories: [Genetic Tests](#)

Sample Type: [Buccal \(cheek\) swab](#)

Markers: MTHFR genes

Available across Canada and US - except in NY, NJ, MD, RI

FREE Shipping

~~\$129.99~~ \$99.99

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\$0.00



Our MTHFR Home Test Kits test the two most important genes: MTHFR C677T and MTHFR A1298C. A simple cheek swab. Safe for men, women and children of all ages... even babies.

Purchase as many as you want for friends and family.

We do not sell or share your results with any third party or insurance company for any reason. Your information is 100% safe and confidential.

Price is in US Dollar.

MethyleneTetraHydroFolate Reductase

**Instructions for purchases from New York and Maryland.*

If you do not have an account with us please [create one now](#). When purchasing this product use the email address associated with your account. Results will be placed in your account's dashboard.

\$129.99

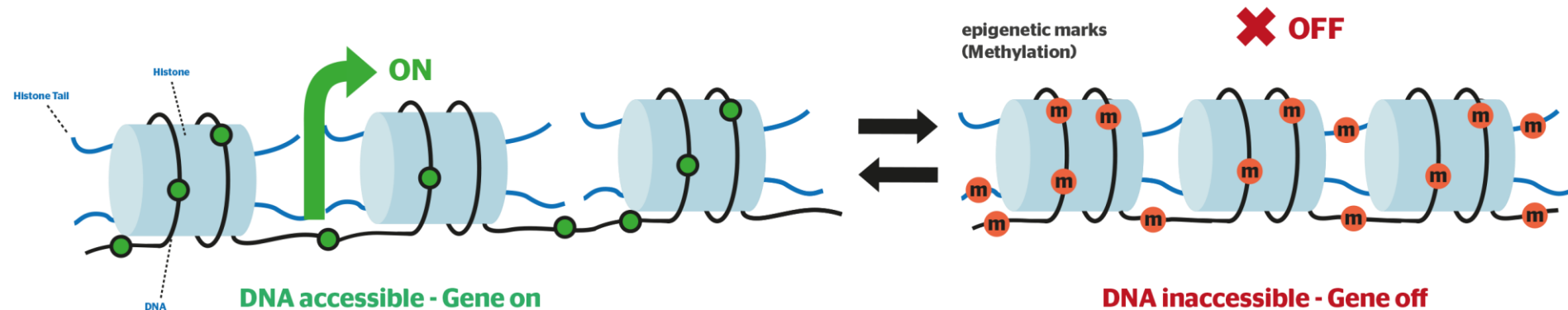
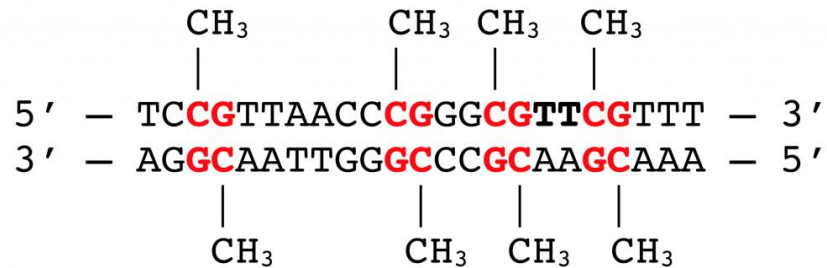
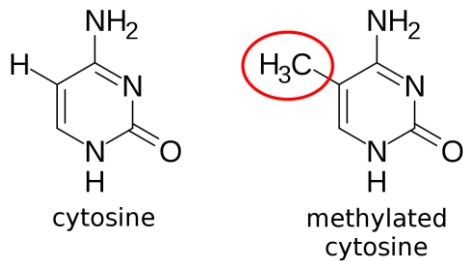
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Nutrigenomics: Food regulates gene expression

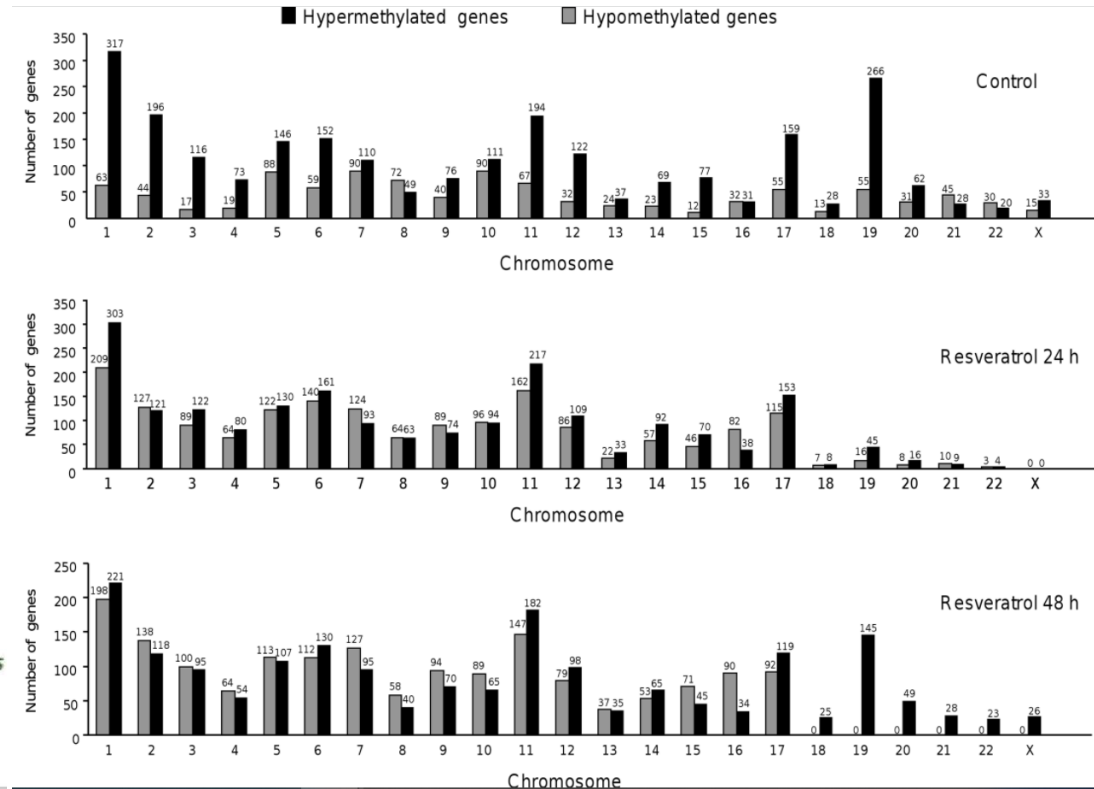
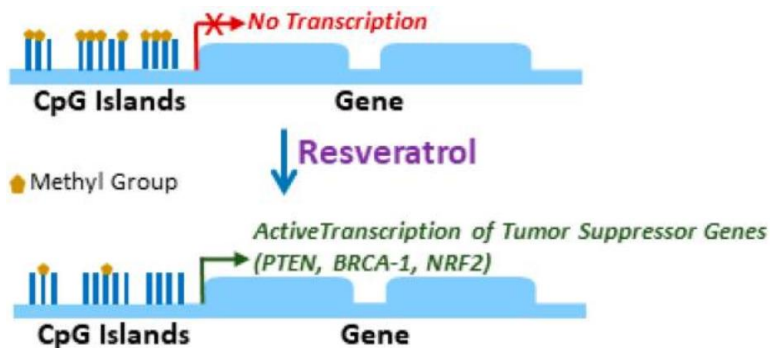
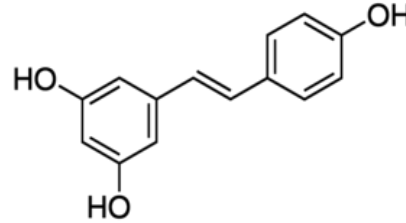
- DNA methylation : the addition of a methyl (CH_3) group to the DNA strand itself, often to the fifth carbon atom of a cytosine ring



Active compounds: Resveratrol, Curcumin, Quercetin, etc.

Resveratrol

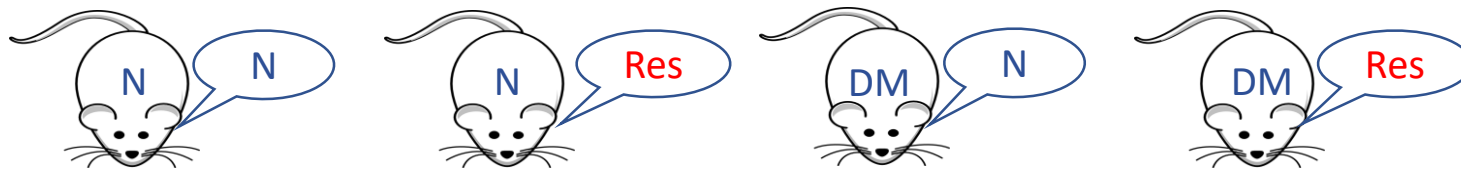
- Berries, grapes, wine, peanuts
- Chemopreventive and therapeutics effects
- In culture of breast cancer cells, resveratrol modifies DNA methylation profiles.
- hypomethylated status of key tumor suppressor genes
- hypermethylated status of and oncogenes



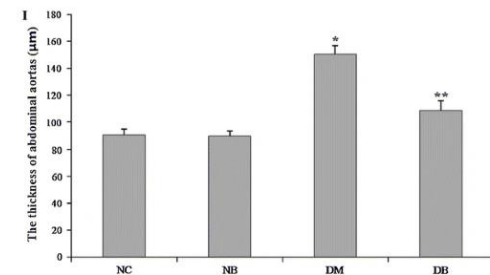
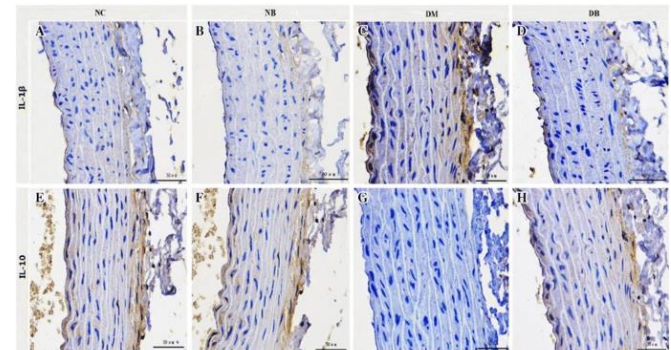
Resveratrol



- Resveratrol protects inflammation of diabetic rat aortas.
 - Proinflammatory cytokines : IL-1 β , IL-6, TNF- α , and IFN- γ
 - Anti-inflammatory cytokines : IL-10

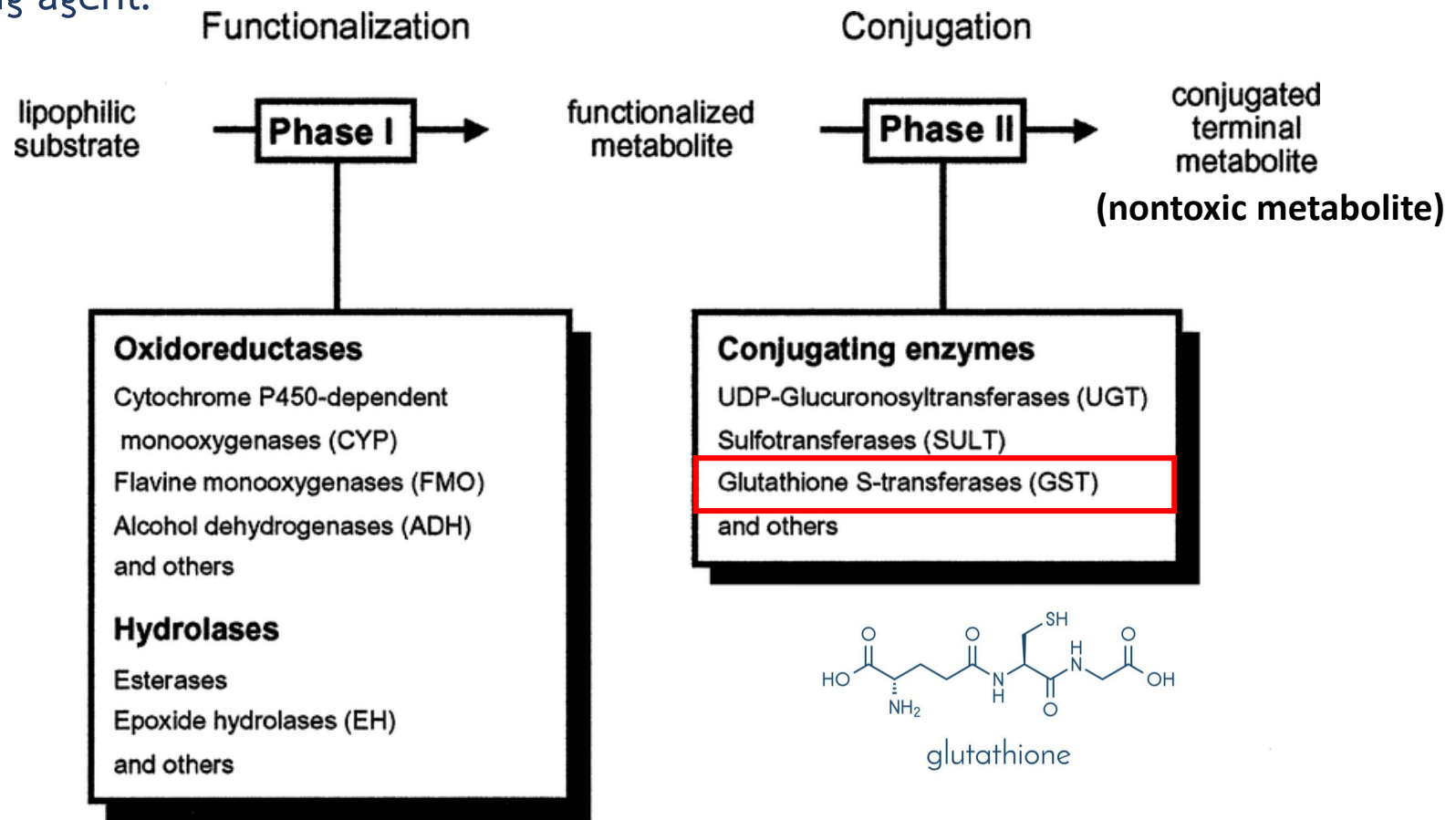


- 3 months later
- Resveratrol inhibits proinflammatory cytokines, but induces anti-inflammatory cytokine.
- Resveratrol affects on DNA methylation of inflammation related genes.



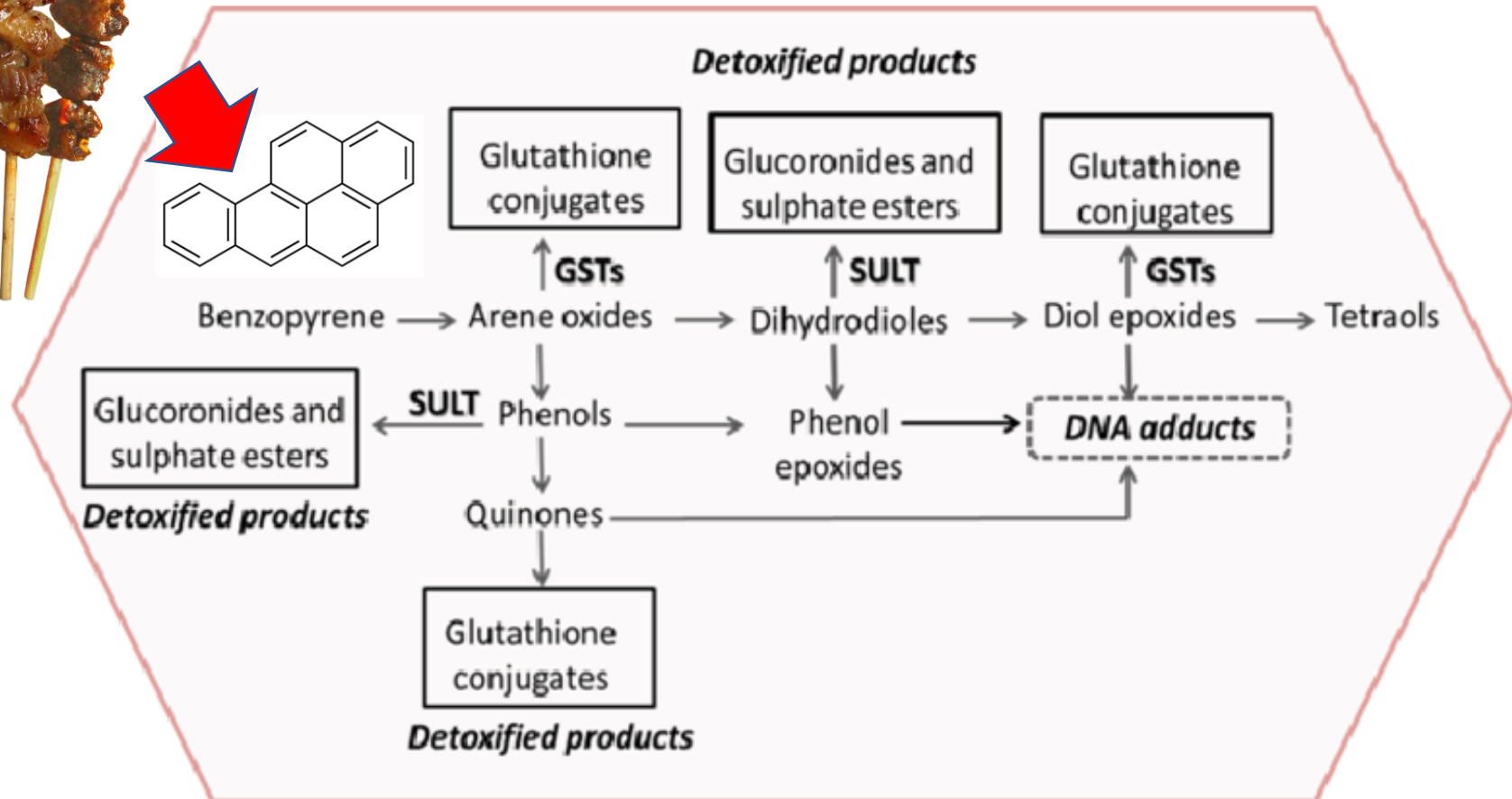
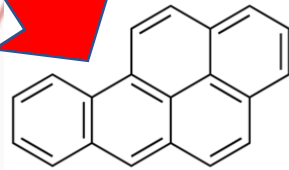
Xenobiotic detoxification

- The combined operation of two phases converts lipophilic compounds into water-soluble compounds that can be excreted in urine or bile.
- Glutathione plays an important role in phase 2 reactions and is also an intracellular reducing agent.

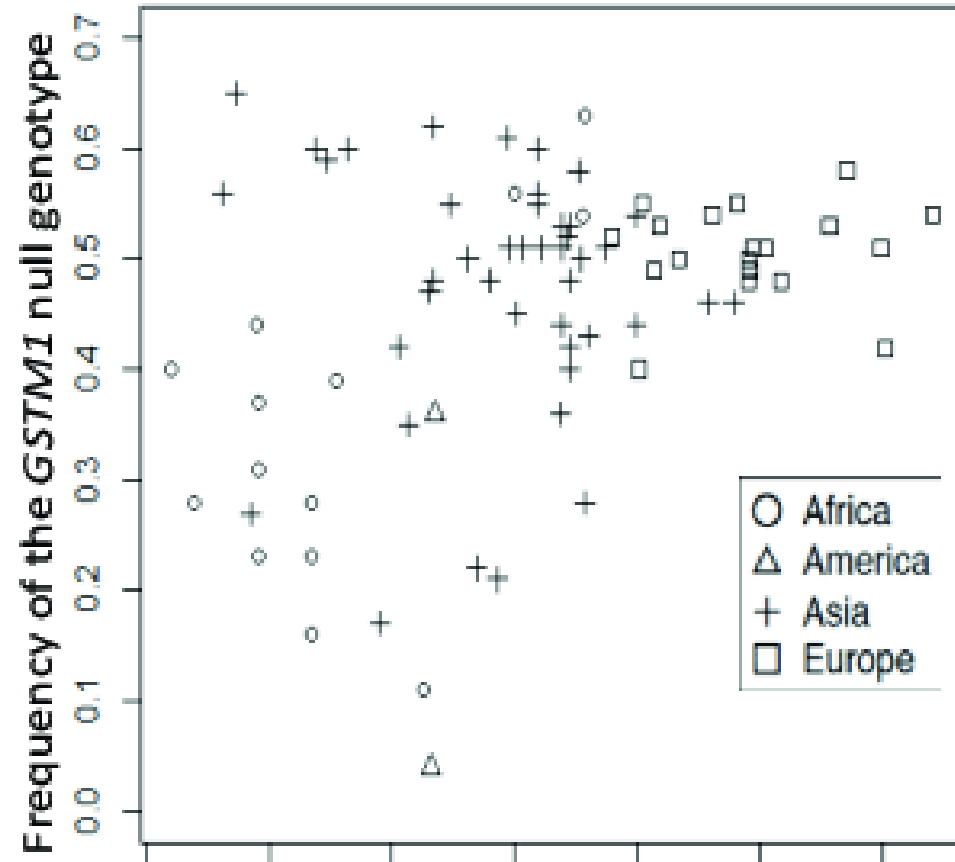
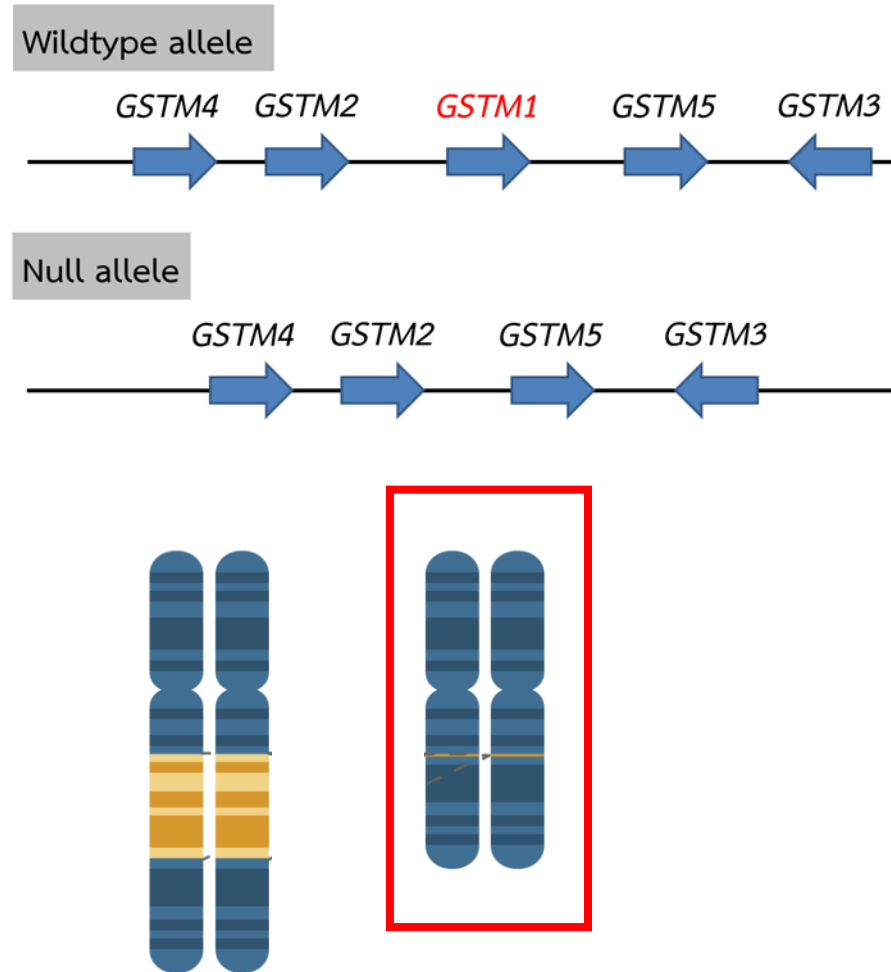


Glutathione S Transferases: GSTs

Benzopyrene (BAP) is one of the polycyclic aromatic hydrocarbons (PAHs). PAHs can be generated by incomplete combustion of fuel and organic substances. Dry heat cooking methods such as roasting and grilling generate PAHs. High fat and high protein food generate more PAHs upon pyrolysis. (Group 1: carcinogenic to human, WHO)



GSTM1 null allele



63 reports, 81 populations

GSTM1: ในประเทศไทย

Populations	Total	Present	Null allele	% Null allele	references
Chiangmai	81	34	47	58.02	Klinchid <i>et al.</i> , 2009
Suratthani	200	116	84	42.00	दन्य तीववेख लेखकनख, 2009
Central	56	32	24	42.90	Pongtheerat <i>et al.</i> , 2009
Northeastern	198	73	125	63.10	Natphopsuk <i>et al.</i> , 2015
Southern	53	37	16	30.20	Kietthubthew <i>et al.</i> , 2001
Phitsanulok	176	87	89	50.57	Sapcharoen <i>et al.</i> , 2019

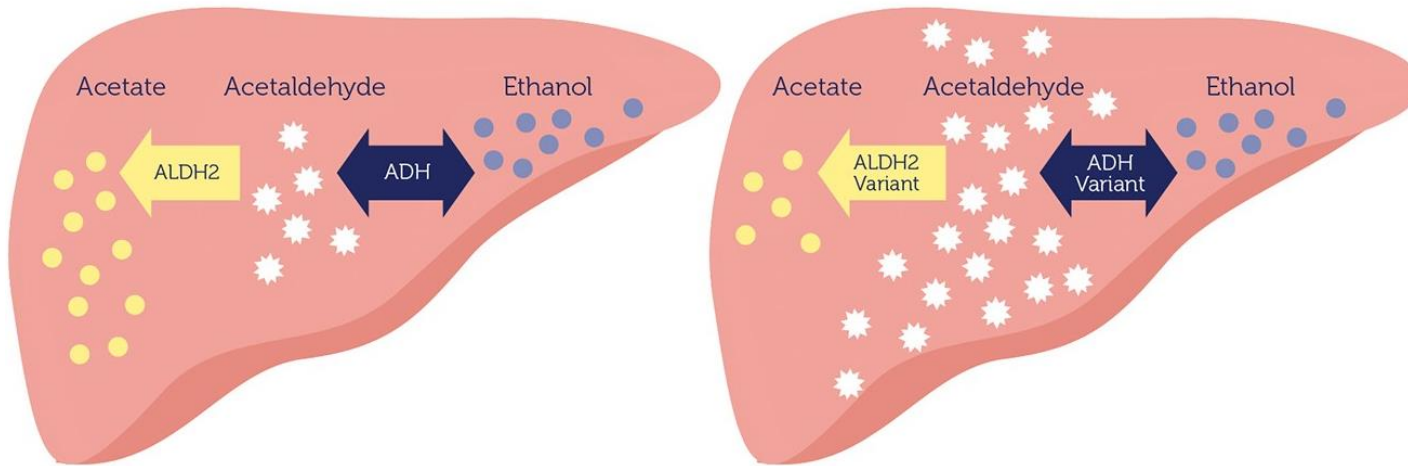
GSTM1 ในชาวไทยพวน



Populations	Total	Present	Null allele	% (Null allele)
Phichit	42	23	19	45.24
Phrae	37	11	26	70.27
Lopburi	27	15	12	44.44
Suphanburi	35	15	20	57.14
Sukhothai	30	17	13	43.33
Udonthani	31	8	23	74.19
Total	202	89	113	55.94

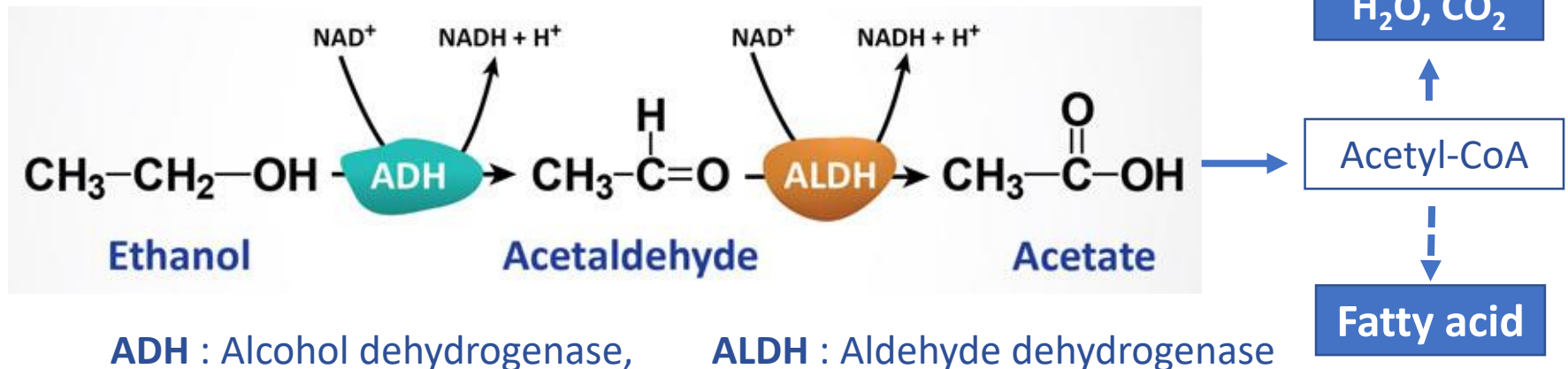
Alcohol detoxification

- Immediate reactions: facial flushing, nausea, dizziness, headaches, increased heart rate, insomnia, severe hangovers

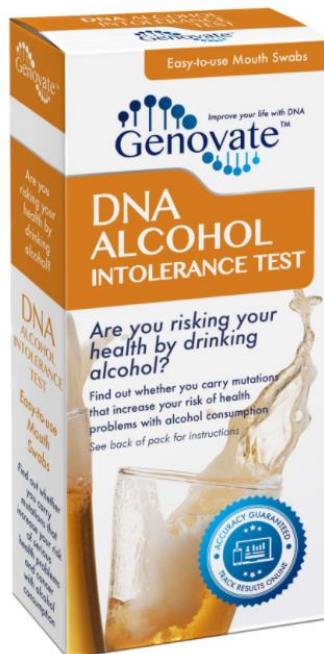


Normal Alcohol Metabolism

Accumulation of Toxic Acetaldehyde



Alcohol intolerance test



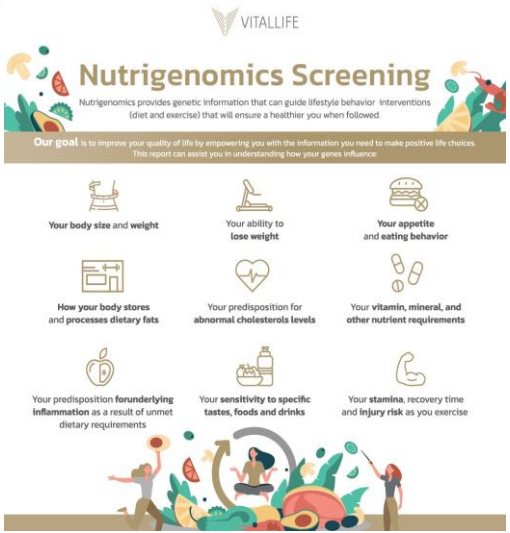
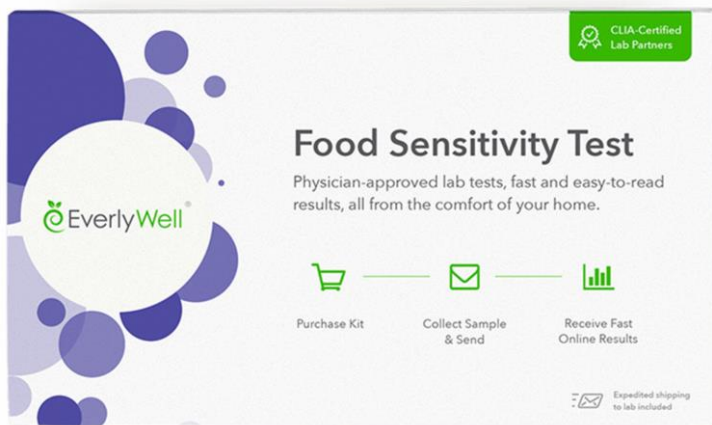
HOME / DIET & FITNESS

DNA Alcohol Intolerance Test

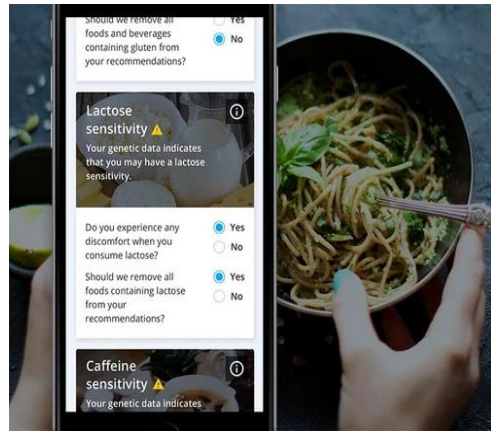
\$149

Does your face turn red when you drink? Do you experience severe hangovers from just one drink? If you answered yes, you may be alcohol intolerant. Find out your risk of alcohol intolerance with this DNA test.

- Includes mutations in *ADH* and *ALDH* genes that affect alcohol metabolism
- Alcohol intolerance is linked to higher risk of esophageal cancer:
 - 10X increased risk for moderate drinkers
 - 90X increased risk for heavy drinkers
- People with one or more mutations are harming their health every time they consume alcohol



What should we do ?





Thank You!

