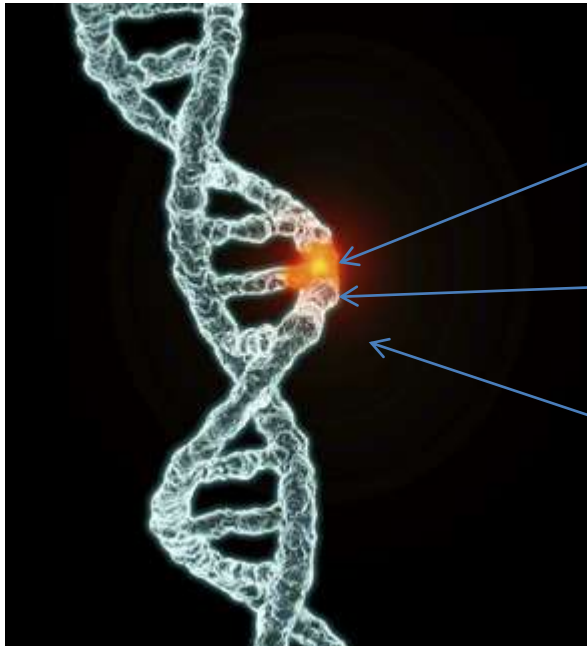


Nutrigenomics :How Food Influence Our Health

Prof Mario La Rosa ,

Comiso 14 ,febbraio 2020



Greetings from Sicily



• PERSONALIZED NUTRITION BASED ON GENOTYPE

Genetic make-up can determine unique nutritional requirements and responses to different foods and nutrients

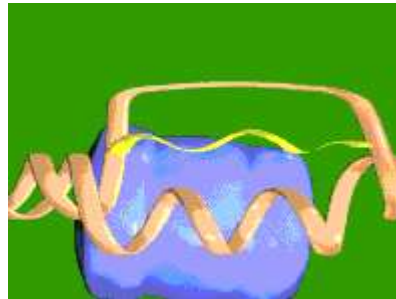
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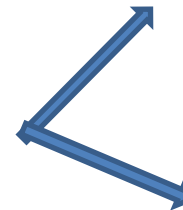
- The sequencing of the human genome,
 - subsequent analyses of human genetic variation,
- studies that associate gene variants with disease markers
- Impact of nutrition/nutrients on gene expression



- NUTRIGENOMIC INTERACTION**



Nutrition



Phenotype

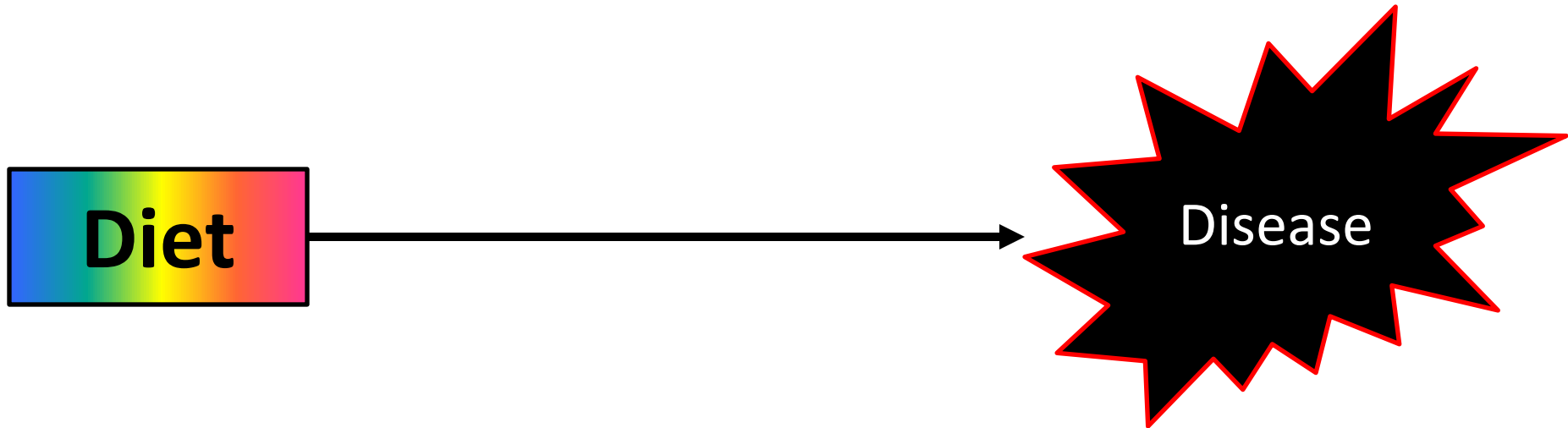


PERSONALIZED WEIGHT MANAGEMENT

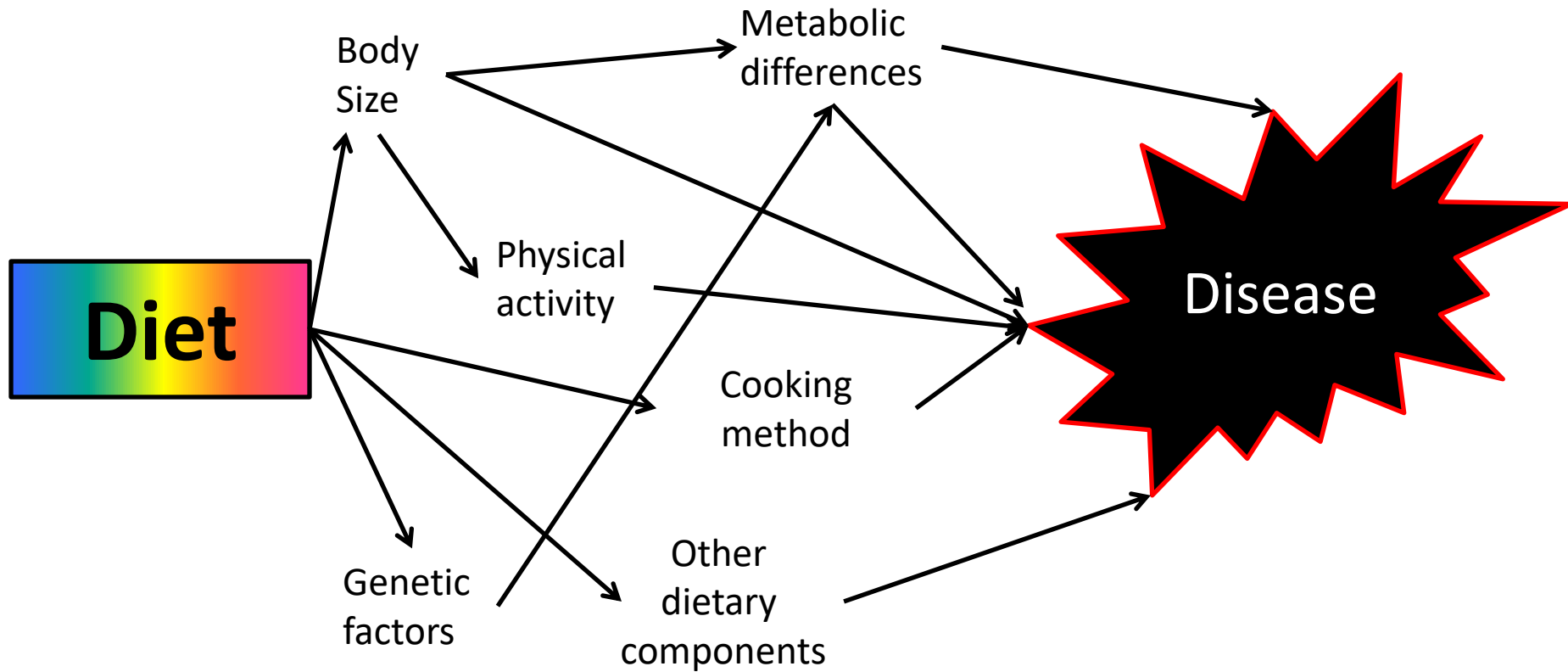


Obesity : a new
social problem

Does diet cause disease?



The road is not smooth!



One diet to fit all?

***not exhaustive!**

- **Body size**

- Protein recommendations based on body size; vitamin C recommendations are not

- **Physical activity**

- Does a high-carbohydrate diet have the same effects on HDL-C and triglycerides in a marathon runner as it does in someone who is inactive and obese?

- **Genetic factors**

- Genetic mutations (*ALDH2*) favour alcohol → acetaldehyde

One diet to fit all?

***not exhaustive!**

- **Metabolic differences**
 - Ability to digest lactose diminishes with age
- **Other dietary components**
 - Polyunsaturated:saturated fat in the diet

Diet

1. Essential nutrients (vitamins, minerals, amino acids, etc.)
2. Major energy sources (carbohydrates, proteins, fats, alcohol)
3. Additives (colouring agents, preservatives, emulsifiers)
4. Microbial toxins (aflatoxin, botulin)
5. Contaminants (lead, PCBs)
6. Chemicals formed during cooking (acrylamide, *trans* fats)
7. Natural toxins (plants' response to reduced pesticides)
8. Other compounds (caffeine)

The link between diet and health is documented by several epidemiological studies



Large epidemiological studies revealed that the “Mediterranean diet” significantly reduced the risk of cardiovascular disease (about -25%), of the same order of magnitude as pharmacological interventions

Higher consumption of whole grain cereals was also correlated with lower incidences of not only cardiovascular disease, but also obesity and type 2 diabetes



Also Fruits and Vegetables are
Important for Our Health



Nutrients in plant foods



- **Macronutrients**

- Proteins
- Oils
- Carbohydrates
- Fibre

- **Micronutrients**

- Vitamins
- Minerals

- **Phytonutrients**

- Alkaloids
- Polyphenols
- Carotenoids
- Organosulphur compounds
- Nitrogen-containing compounds



Many phytonutrients possess biological activity
and are defined as bioactive compounds

Examples of bioactive compounds in plant foods

Polyphenols



Epigallocatechin gallate (EGCG) from green tea



Genistein, an isoflavone from soy



Quercetin, a flavonol from apples and onions



Curcumin from turmeric



Resveratrol from red grape



Cyanidin 3-glucoside, an anthocyanin from blueberry and cherry

More representative example of Bioactive Compound in plant with Polyphenols



Olea europaea L.

Kohler's Medizinal-Pflanzen in naturgetreuen Abbildungen mit kurz erläuterndem Texte : Atlas zur Pharmacopoea germanica, Volume 2 (1887)

- *Olea europaea*

- Family: Oleaceae

- Six **subspecies**

- *Olea europaea* ssp. *europaea* (olives) grows in Mediterranean Basin at the N limit of *Olea* range

- Other 5 subspecies grow in Africa and Asia

- *Olea* fruit gathered 19,000 year BP in E. Mediterranean

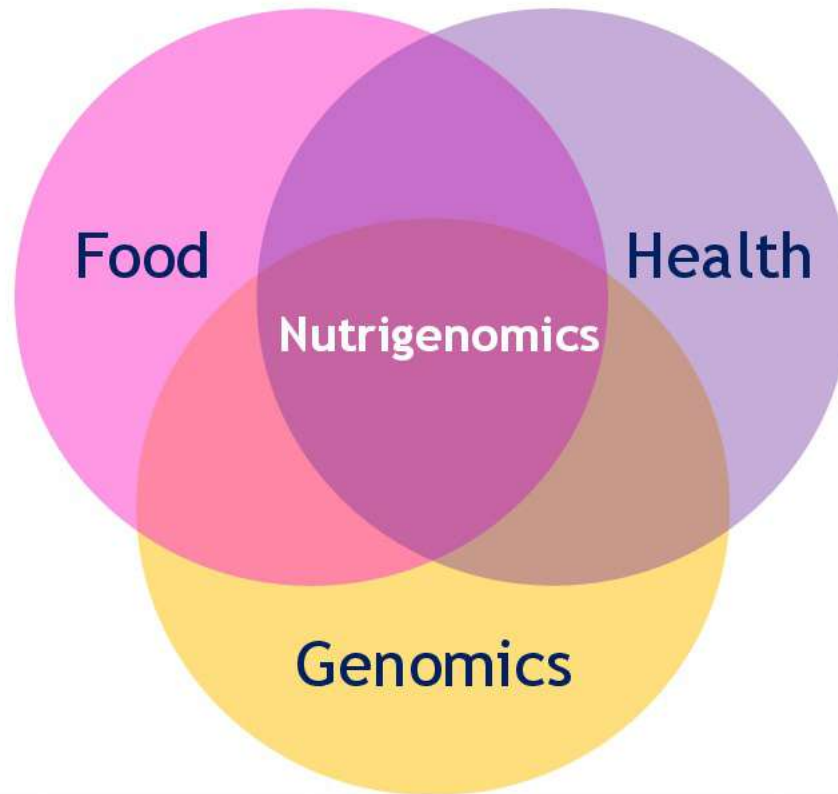
- One of the first plants cited in early literature

- Can live 2000-3000 years

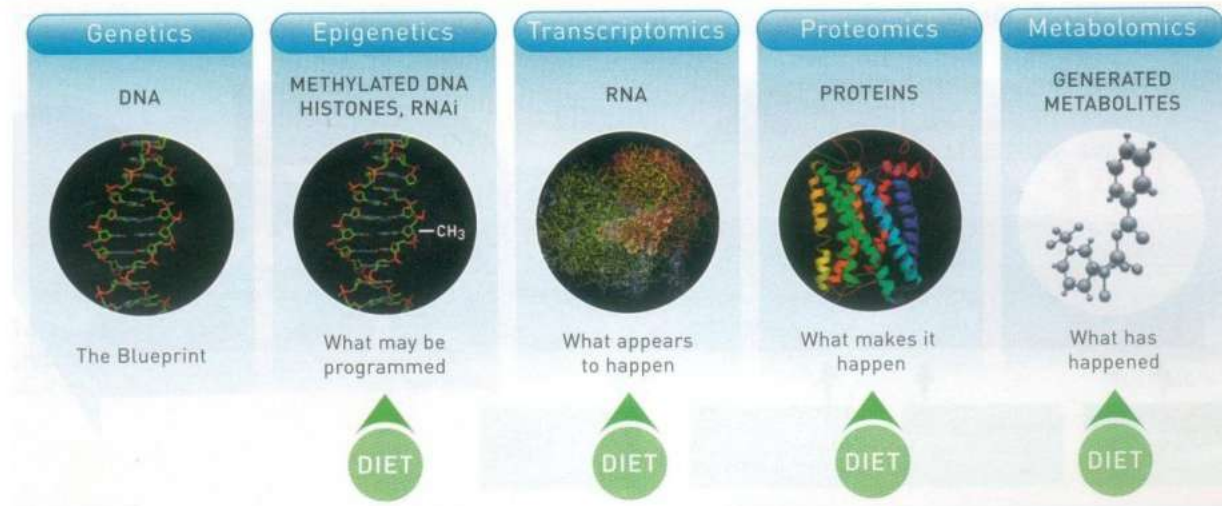
Nutrigenomics

Nutrigenomics studies the *interaction of nutrients with the human genome* and aims to understand how nutrients influence gene expression, metabolism and as a consequence human health

Nutrigenomics is the application of “omic” technologies to nutrition



How does food influence health?



Dietary signals
Macronutrients
Vitamins and Minerals
Phytonutrients



Epigenetics
Gene expression
Enzyme modifications
Antioxidants
Anti-inflammatory

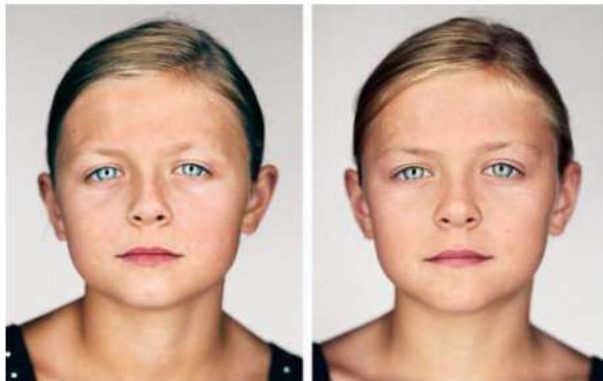
Health Outcomes
Health
Longevity
Chronic disease

What does “epigenetics” mean?

Epigenetics: The ability to change gene activity –without changing gene sequence (no mutations involved).

Typically, epigenetic modifications include

- DNA methylation (gene silencing) and
- Histone acetylation (gene activation)



Non-smoker



Smoker



Genetically identical individuals may have different gene expression and phenotypes due to epigenetic modifications imposed by environmental cues (e.g. lifestyle and dietary habits)

Epigenetic events during development

Epigenetic events during development

pictures © iStockphoto.com

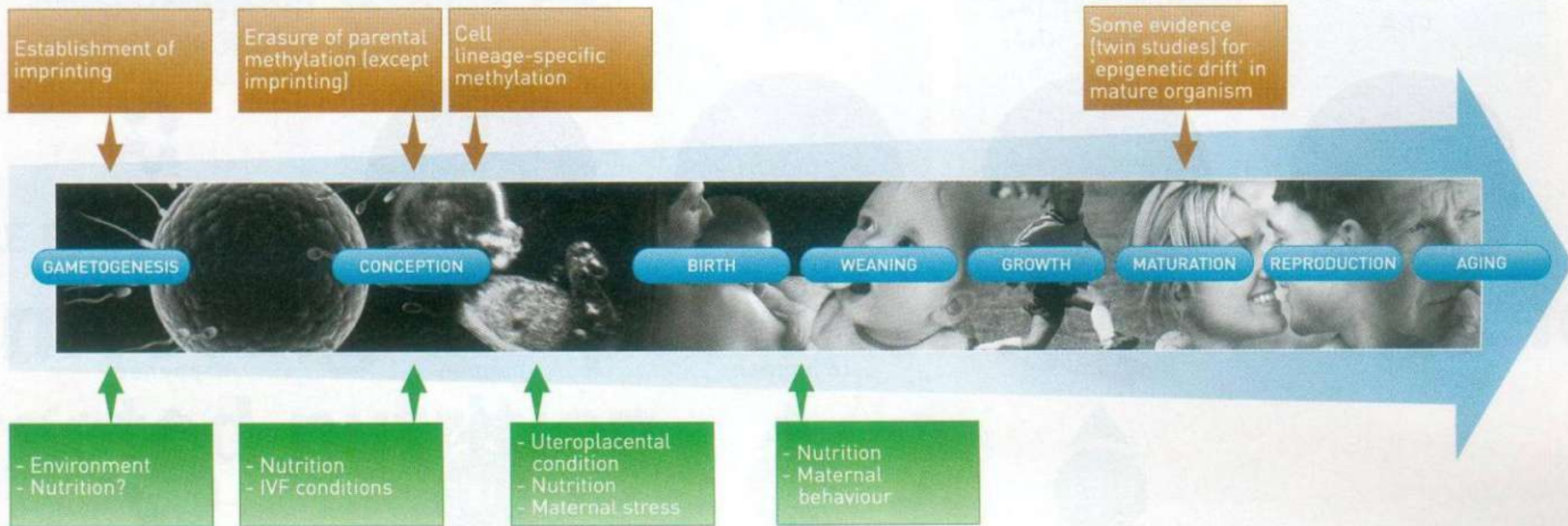


Figure adapted.
Courtesy of Peter Gluckman
[Ref. 8]

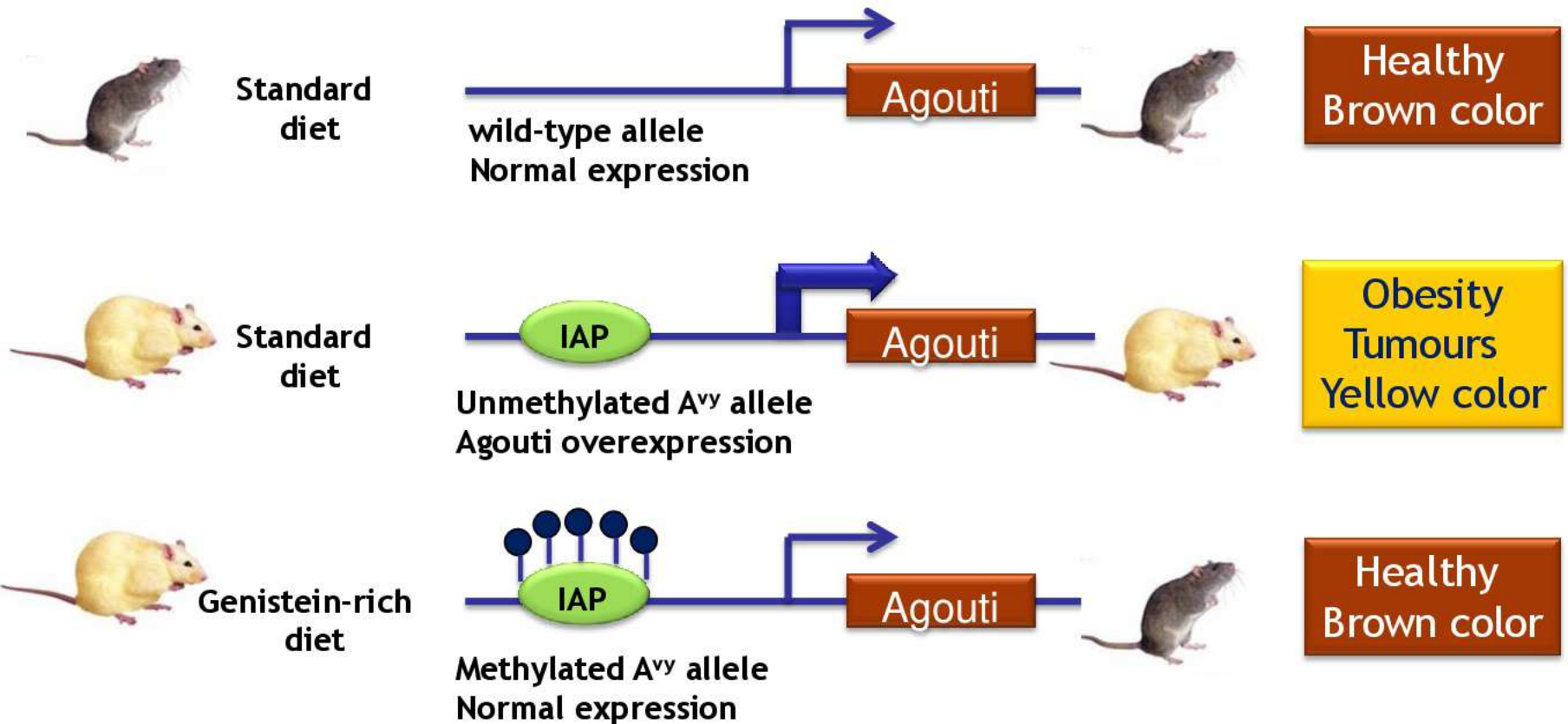
Environmental cues that affect the epigenome

Figure 2 | Environmental sensitivity of the epigenome throughout life. The top row indicates normal reprogramming of the epigenome during gametogenesis, fertilization and development. The bottom row indicates the environmental cues that affect the epigenome and have late-life consequences, and the stages of life at which they act. Sensitivity of the epigenome to the environment (represented by shading of the arrow) is likely to decrease during life as growth slows. Abbreviation: IVF, *in vitro* fertilization.

Mother's diet influences fur color and health of progeny

Mother's diet during gestation

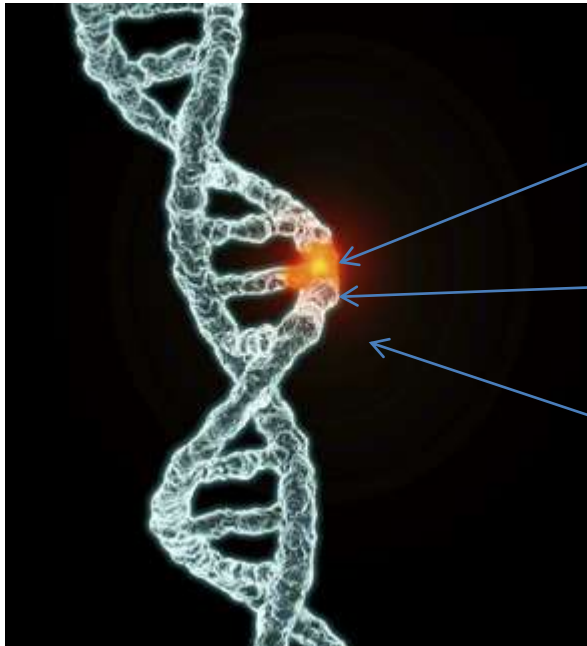
Progeny



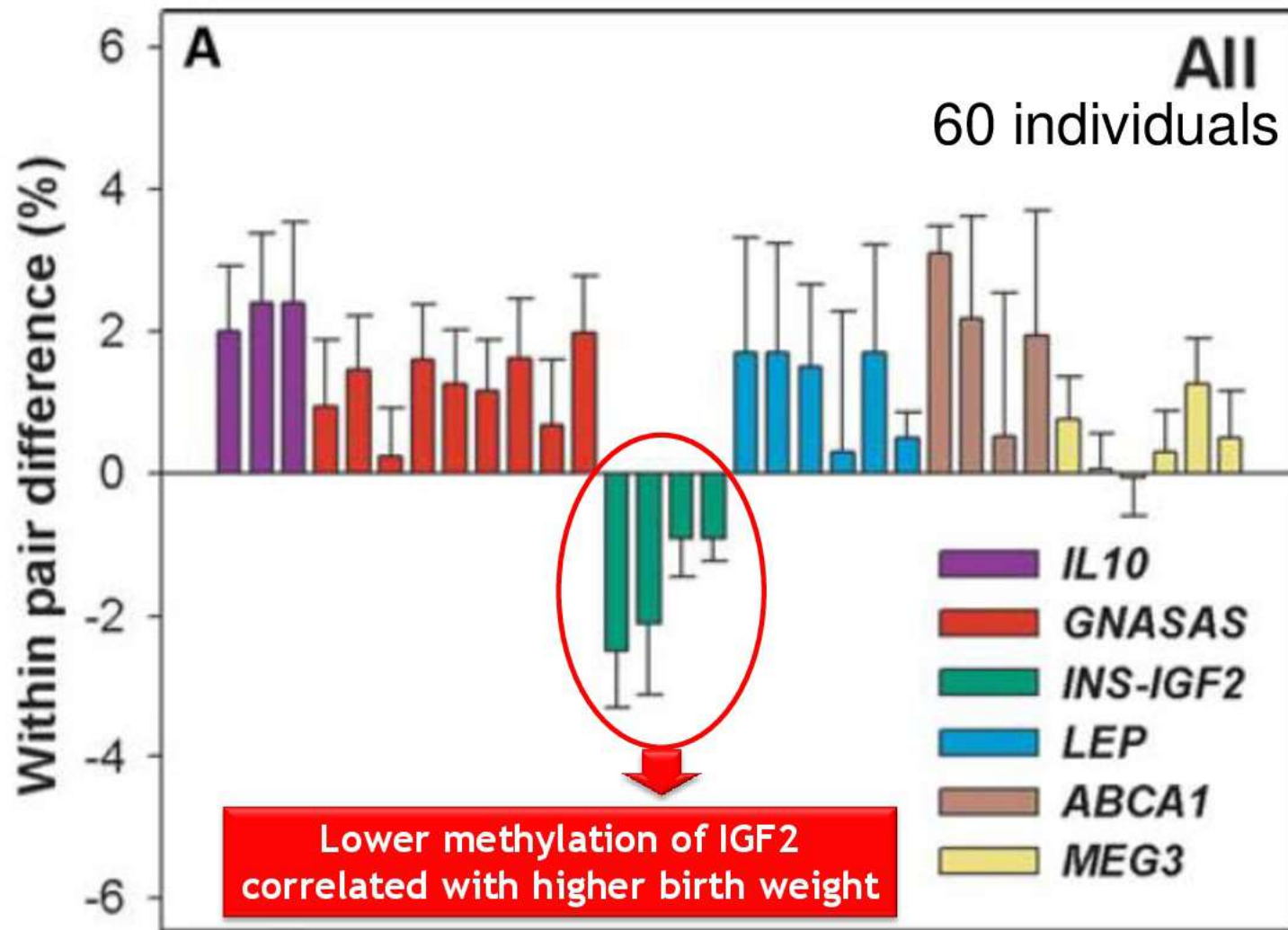
How food Influence our health

NUTRIGENOMICS is the study of molecular relationships between **nutrition** and the response of **genes** , with the aim of extrapolating how such subtle changes can affect **Human**

NUTRIGENETICS: Personalized nutrition based on genotype.



DNA methylation levels were significantly different for 6 out of 15 genes after famine exposure



Epigenetic programming *in utero* affects adult risk factors and disease



Diet can alter the epigenetic state of the genome leading to dramatic ***deprogramming*** or ***reprogramming*** of large numbers of genes in metabolic and physiological pathways.

This ***may affect the incidence of adult age chronic diseases*** such as type 2 diabetes, cardiovascular disease, neurodegenerative disease and cancer.

Epigenetic modifications are reversible!

Importance of diet on epigenetics

Histone modifications



Tomatoes
(Lycopene)



Apples
(Phloretin)



Citrus
(Hesperidin)



Turmeric
(Curcumin)



Soybean
(Genistein)



Coffea
(Caffeic acid)



Cinnamon
(Coumaric acid)



Tea
(EGCG)



Broccoli
(Isothiocyanates)



Cashew nuts
(Anacardic acid)



Grapes
(Resveratrol)

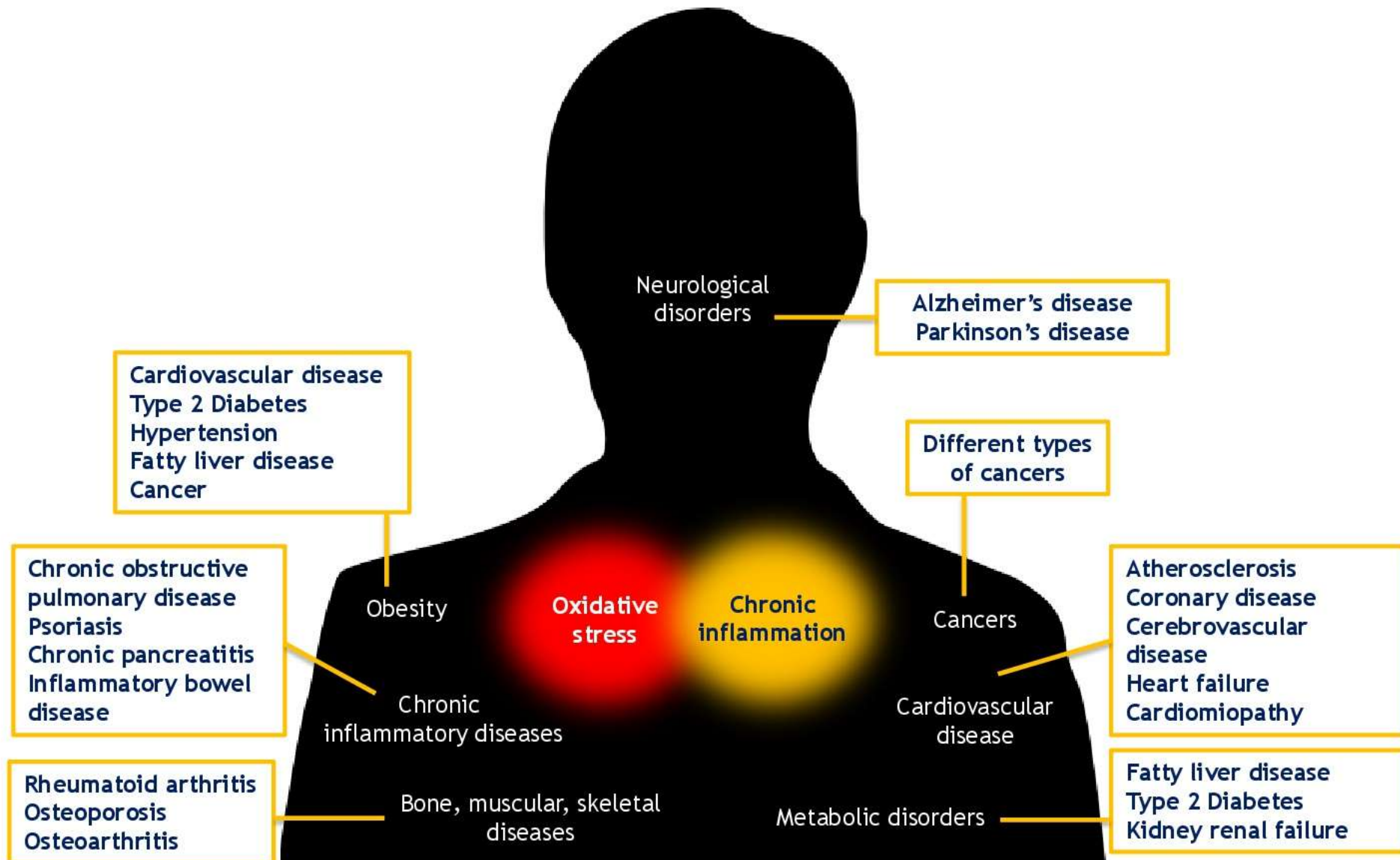


Garlic
(Allyl mercaptan)

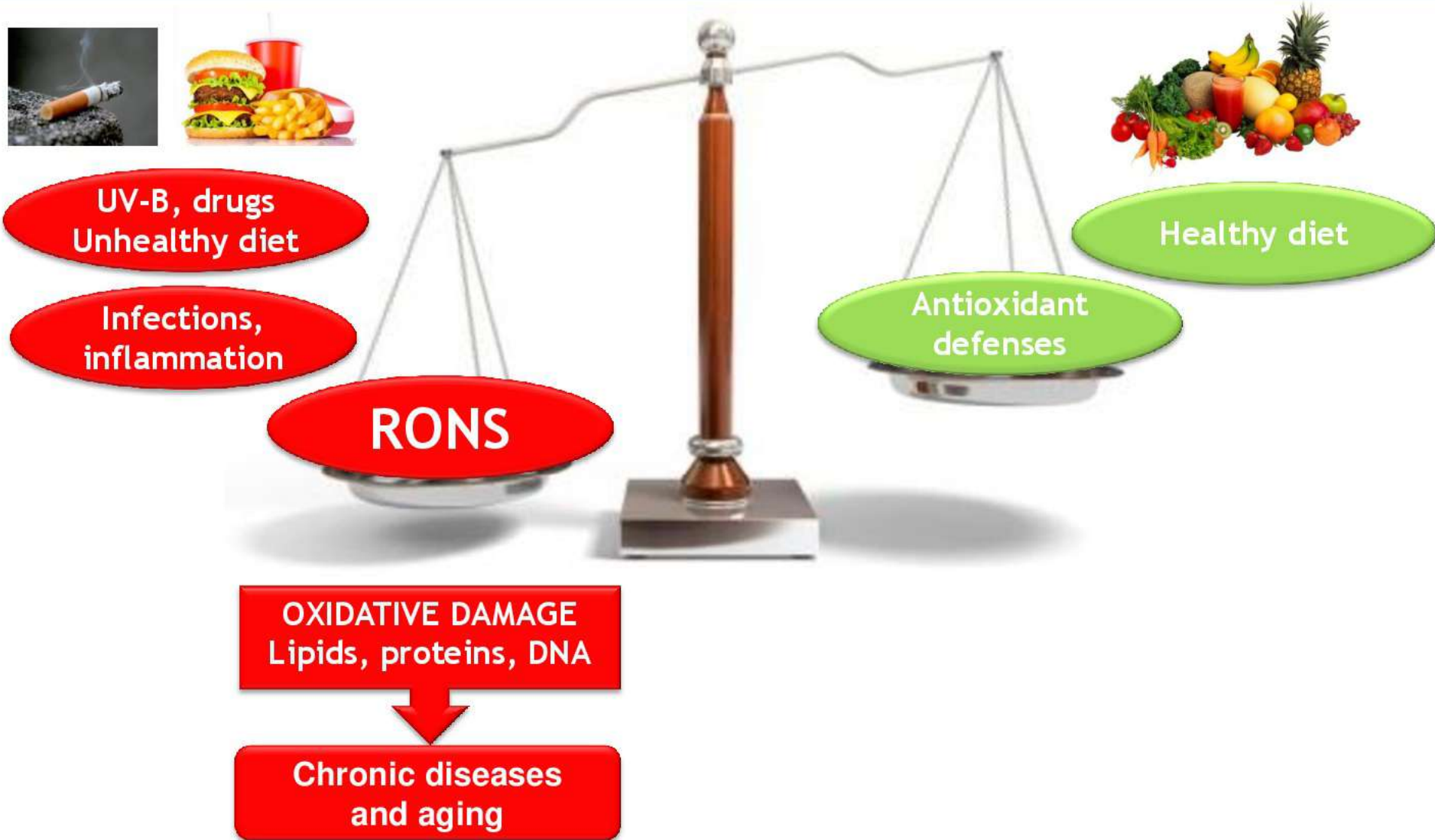
DNA methylation

Foods contain many phytonutrients with **epigenetic and chromatin remodeling properties**, making nutritional intervention a possible way to ***“reprogram” the epigenome*** to promote health and prevent disease

Cumulative damage from oxidative stress and chronic inflammation leads to chronic diseases



Oxidative stress occurs when production of RONS exceeds cellular antioxidant defenses



Many dietary polyphenols are more effective antioxidants *in vitro* than vitamins E or C

Antioxidant Activity (TEAC mM)

Vitamins

Vitamin C 1.0 $\pm$ 0.02

Vitamin E 1.0 $\pm$ 0.03

Flavonols

kaempferol 1.3 $\pm$ 0.08

quercetin 4.7 $\pm$ 0.12

Anthocyanins

delphinidin 4.4 $\pm$ 0.11

cyanidin 4.4 $\pm$ 0.03

Hydroxycinnamic acids

chlorogenic acid 1.3 $\pm$ 0.02

caffeic acid 1.3 $\pm$ 0.01

ferulic acid 1.9 $\pm$ 0.02

coumaric acid 2.2 $\pm$ 0.06



Our diet plays an important role in the balance between pro-inflammation and anti-inflammation

SAFFLOWER, SUNFLOWER,
CORN OIL



FRIED FOOD



SALMON AND COD



SOYBEAN AND
SOY-DERIVED FOOD



DAIRY, EGGS



CHEESE



OLIVE OIL



WALNUTS AND
FLAXSEEDS



Omega-3

Omega-6

15:1

VEGETABLES AND FRUITS



BERRIES



Pro-inflammatory eicosanoids

Anti-inflammatory eicosanoids

Our diet plays an important role in the balance between pro-inflammation and anti-inflammation

SAFFLOWER, SUNFLOWER, CORN OIL



FRIED FOOD



SALMON AND COD



SOYBEAN AND SOY-DERIVED FOOD



DAIRY, EGGS



CHEESE



OLIVE OIL



WALNUTS AND FLAXSEEDS



RED PROCESSED MEAT



SOFT DRINKS



VEGETABLES AND FRUITS



BERRIES



Omega-6

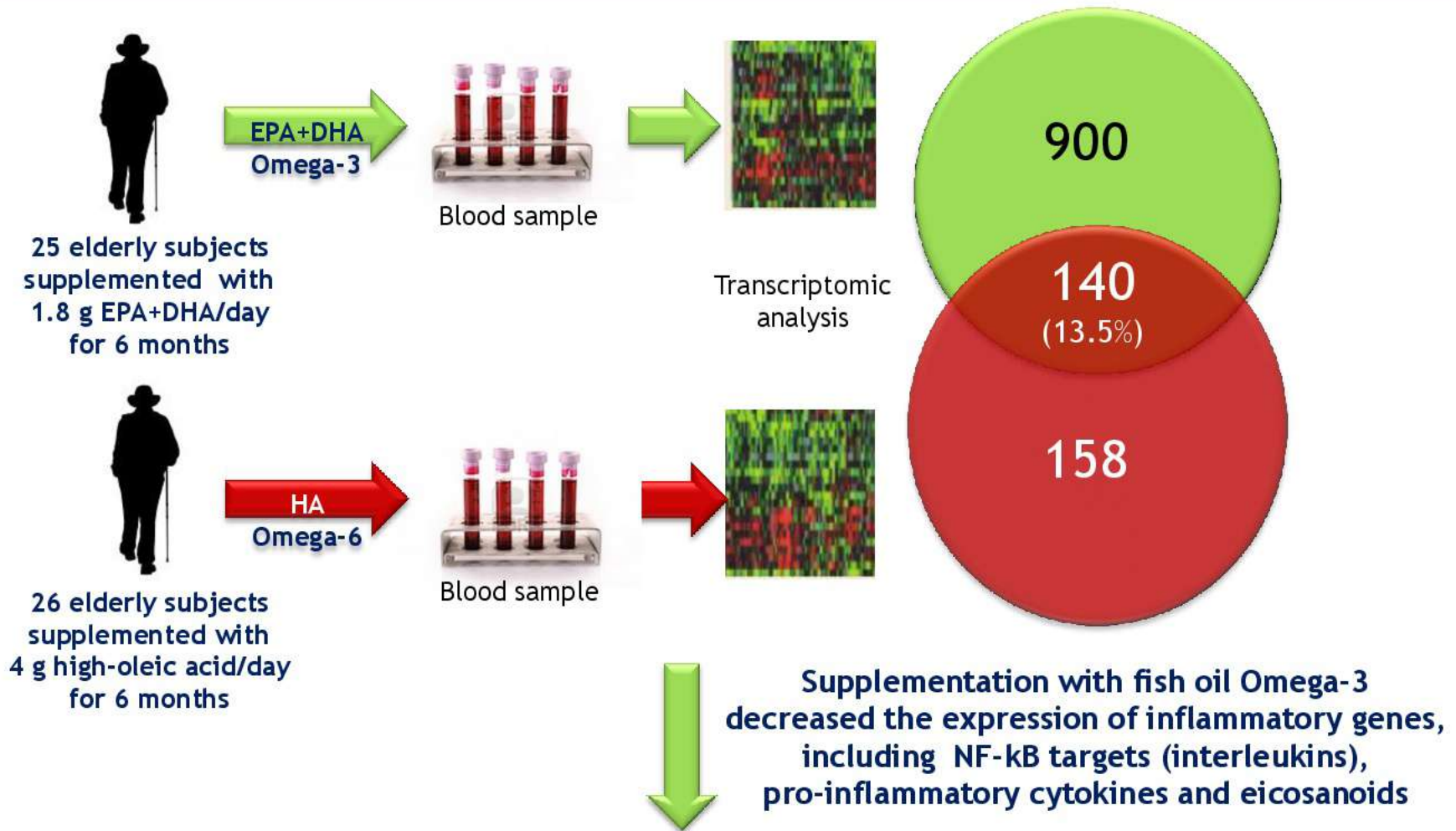
Omega-3

1:1

Pro-inflammatory eicosanoids

Anti-inflammatory eicosanoids

Fish-oil supplementation for 6 months reduces inflammatory gene expression profiles



More representative example of Bioactive Compound in plant with Polyphenols



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Kohler's Medizinal-Pflanzen in naturgetreuen Abbildungen mit kurz erläuterndem Texte : Atlas zur Pharmacopoea germanica, Volume 2 (1887)

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OLIVE OIL BENEFIT ON HUMAN HEALTH

Body Weight control

Anti-aging : potent inhibitor of oxidation

Lowering of Blood lipids and lipoproteins

Blood pressure control

Blood level control of insulin and glucose

Control of inflammation

Cancer protection

Conclusions:

Consistent use of 2 tablespoons per day of extra virgin olive oil will:

- improve health by lowering oxidation, inflammation, blood pressure, and blood glucose and insulin
- improve health and level of blood lipids (LDL, HDL)
- lowering body weight and decrease risk of weight gain
- lower food costs and improve diet (likely increase vegetable intake)

Food & Drug Administration 2005 Visoni et al

The olive oil is :

- a food as well as a drug
for health and wellness

