

# NUTRIMETABOLÓMICA

Hacia una nutrición personalizada



UNIVERSITAT DE  
BARCELONA

*ciberfes*

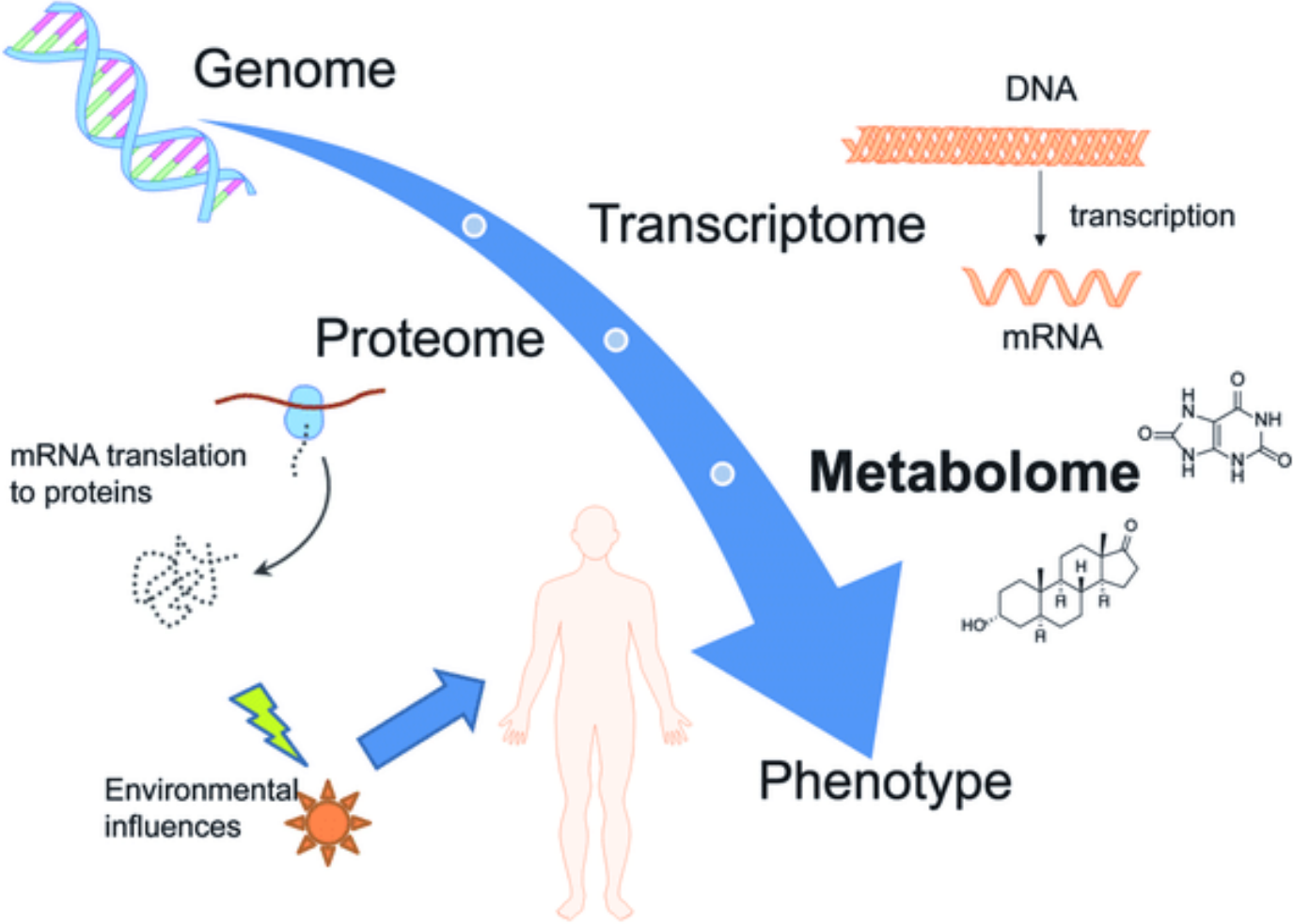
# Ómicas

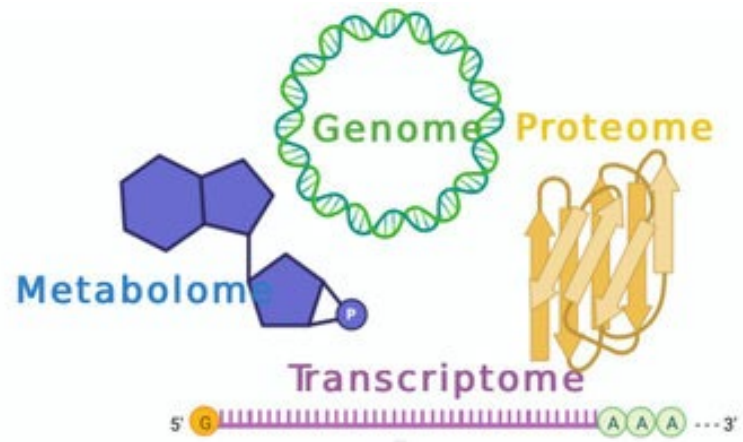
Introducción

Biología de sistemas

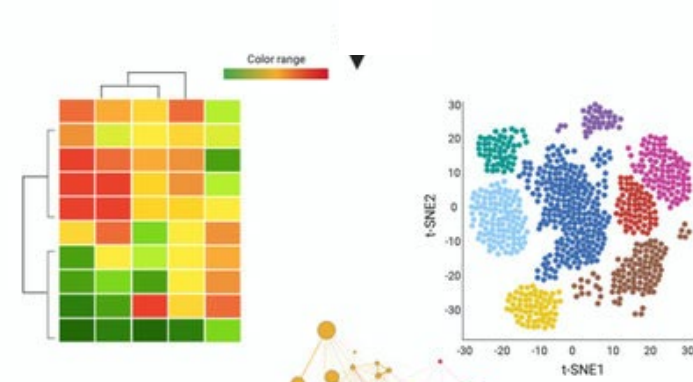


# ÓMICAS





**Data  
Integration**



Biomarkers

Disease  
Phenotype

Virulence  
Factors

Druggable targets

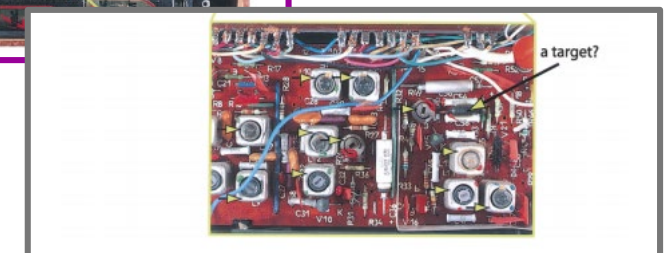
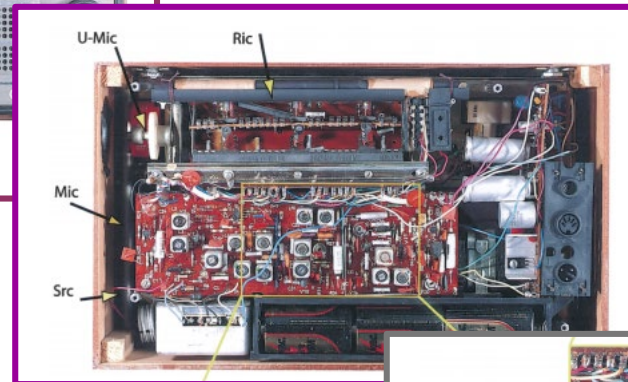
# BIOLOGÍA DE SISTEMAS

Can a biologist fix a radio?—Or, what I learned while studying apoptosis

Lazebnik, Cancer Cell, 2002

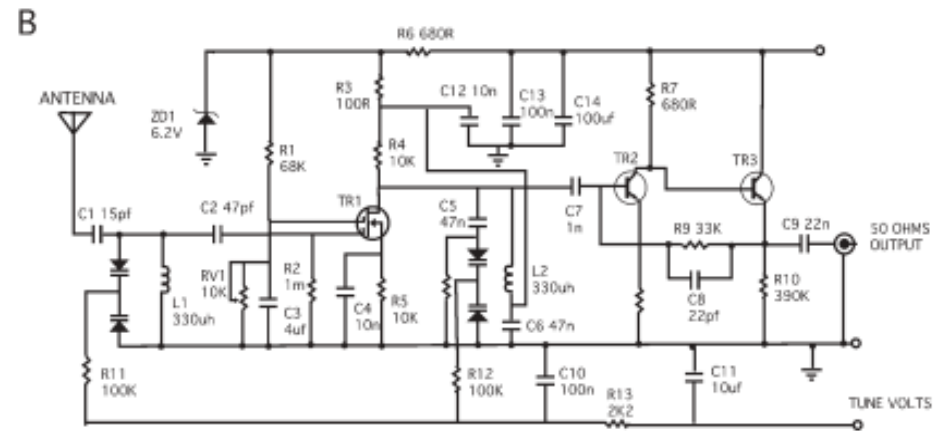
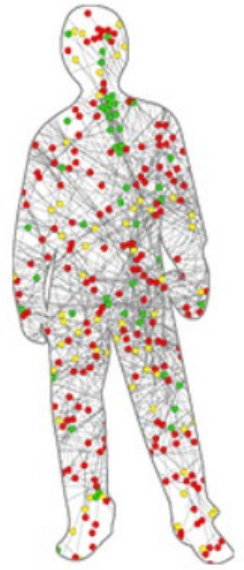
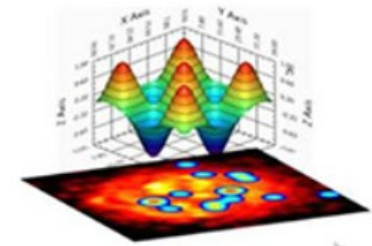
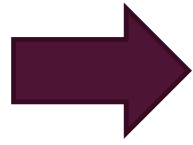
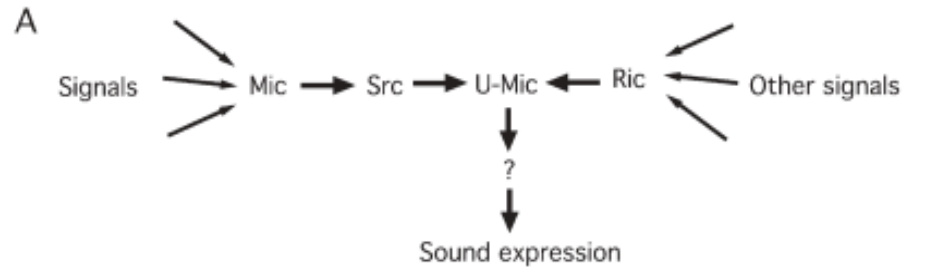


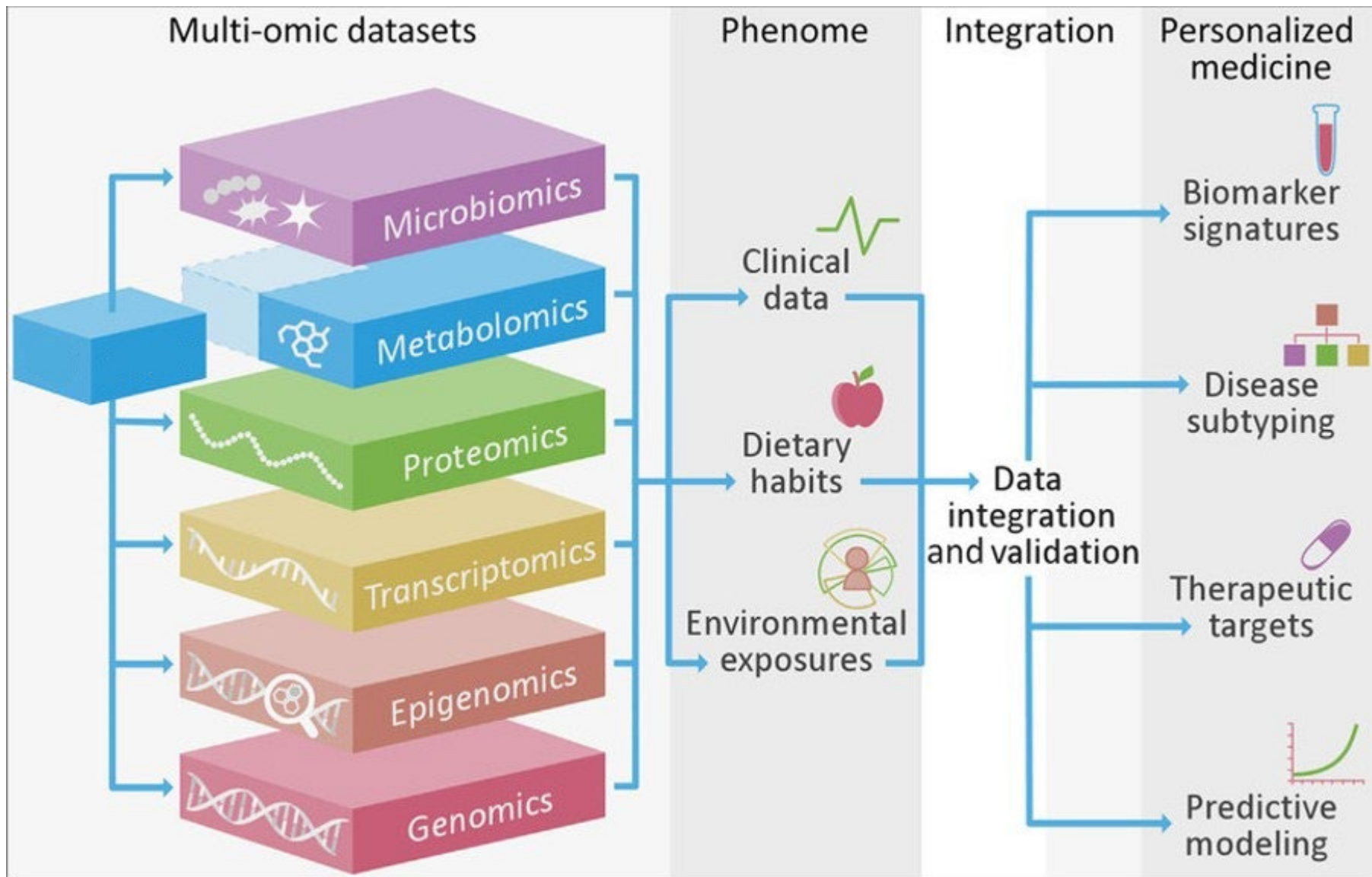
Figure 1. The radio that has been used in this study



# Can a biologist fix a radio?—Or, what I learned while studying apoptosis

Lazebnik, Cancer Cell, 2002





# Ómicas

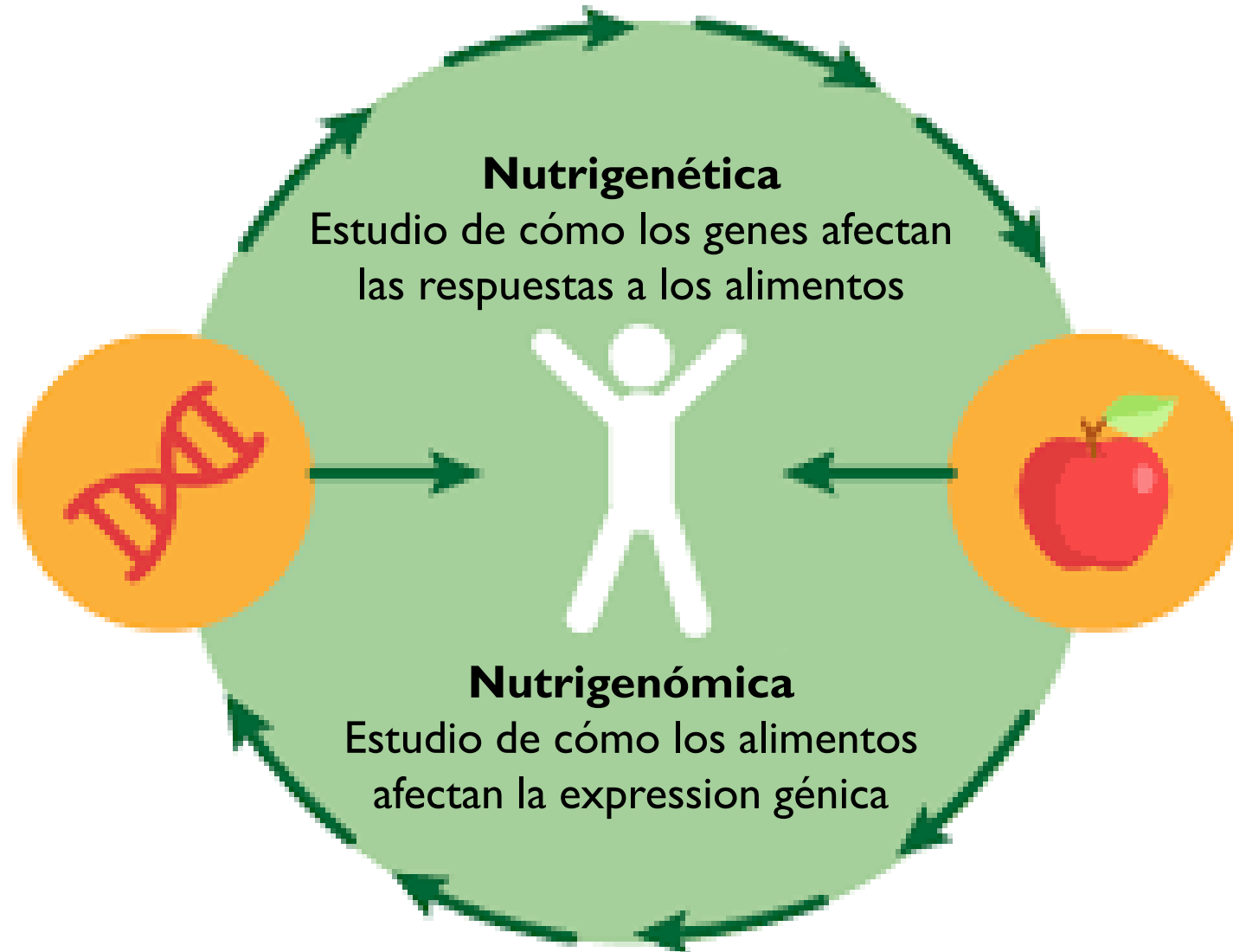
Introducción  
Biología de sistemas

# Ómicas en Nutrición

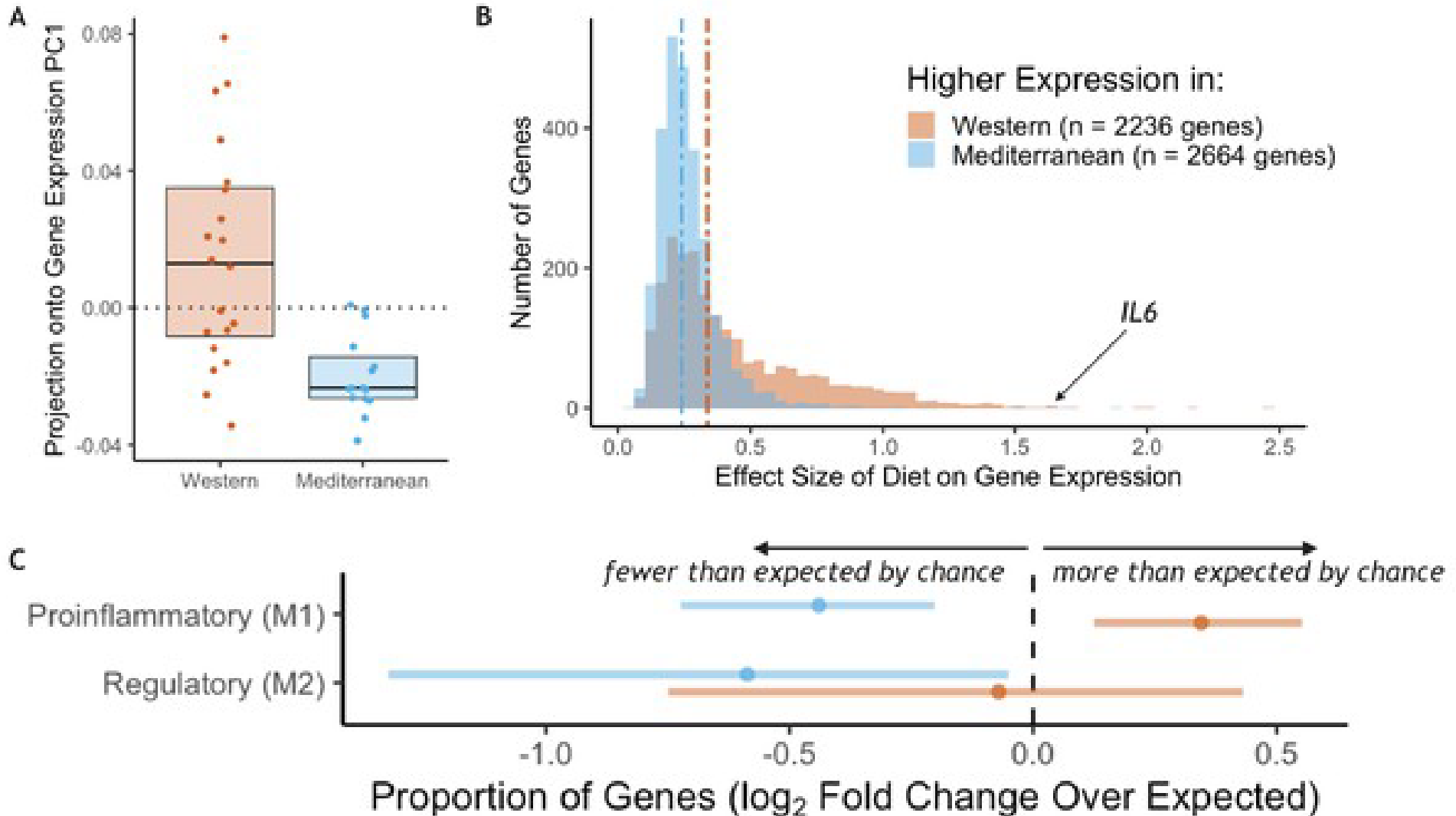
Nutrigenómica  
Metabolómica  
Exposoma



# ÓMICAS EN NUTRICIÓN



La dieta occidental se asoció a una mayor expresión de genes proinflamatorios (n=35)



# PROTEÓMICA

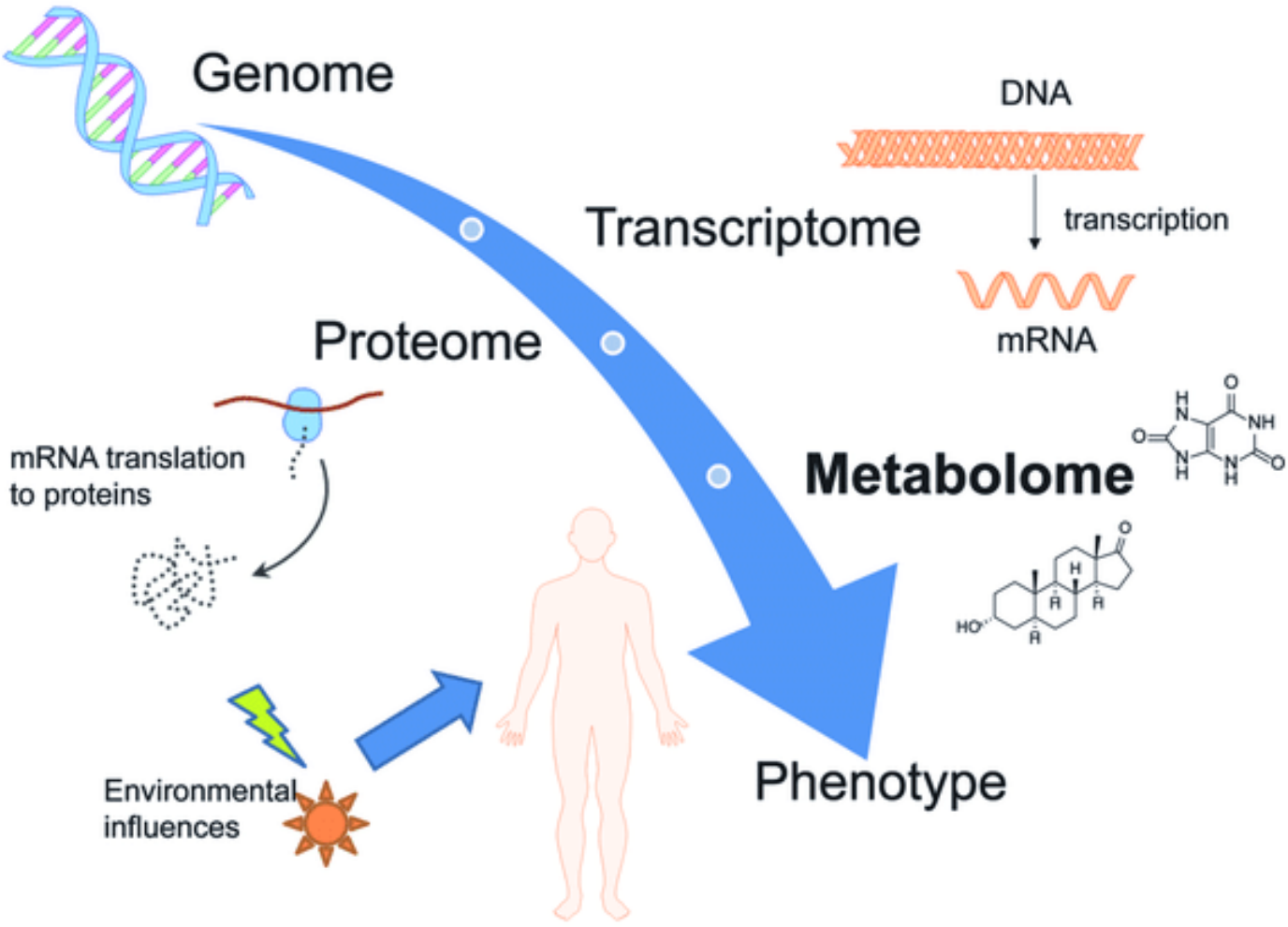
Análisis de biomarcadores de enfermedades nutricionales



Análisis de compuestos bioactivos



# METABOLÓMICA

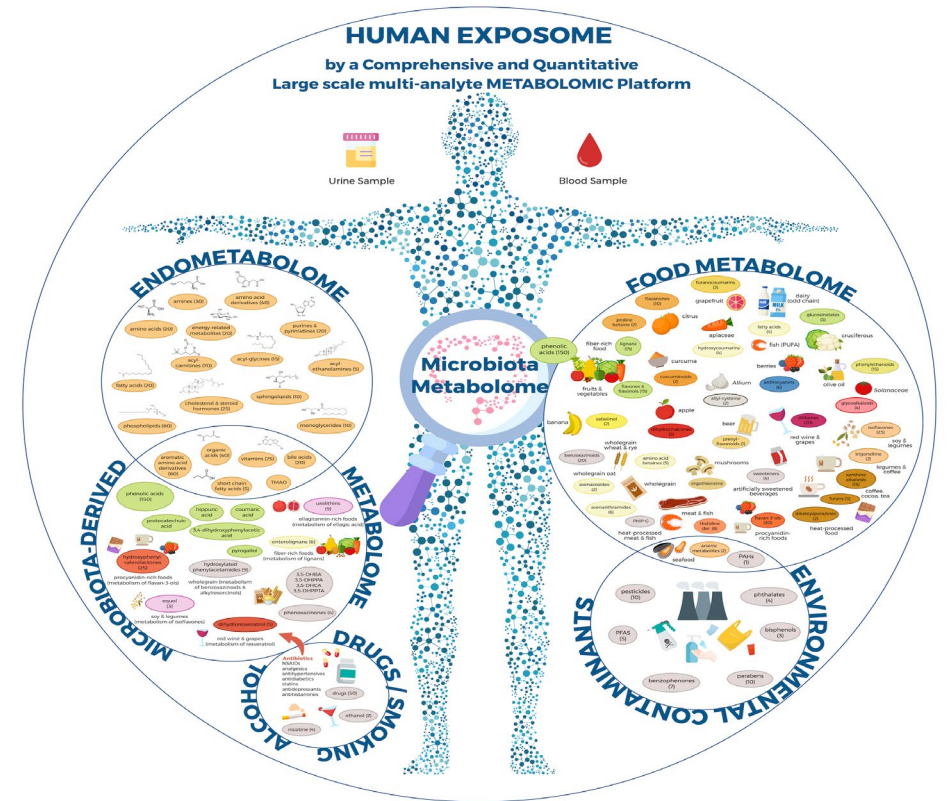


# CARACTERÍSTICAS

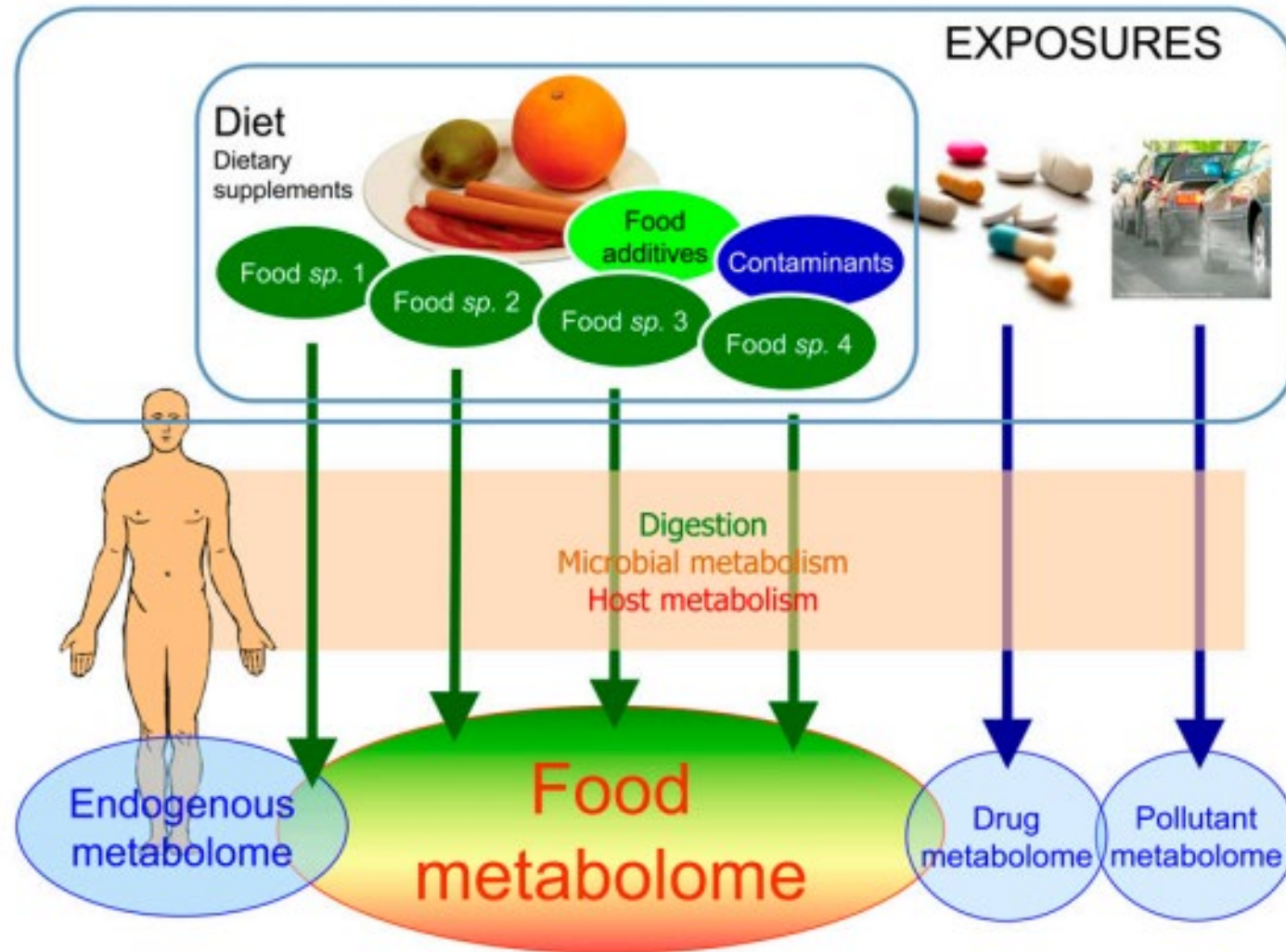
- Análisis de todas las moléculas de bajo peso molecular presentes en una muestra biológica.
- Resultado de la expresión génica, y de la acción de las enzimas sobre diversos sustratos.
- Altamente conservado entre las especies.

# COMPONENTES

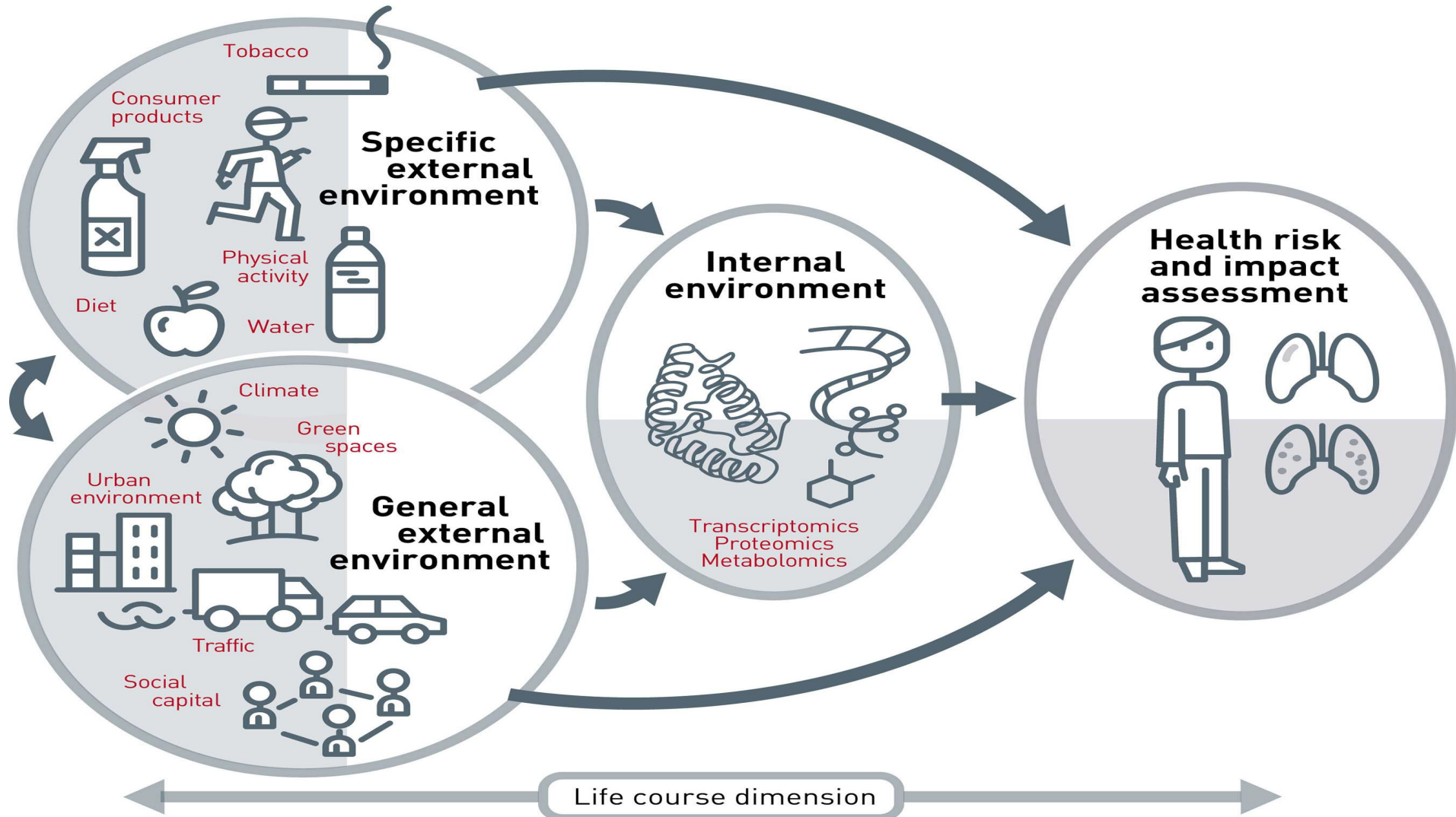
- Endometabolome
- Xenometabolome
- Food metabolome



# METABOLOMA HUMANO



# EXPOSOMA Y DESARROLLO DE ENFERMEDADES



## **Ómicas**

Introducción  
Biología de sistemas

## **Ómicas en Nutrición**

Nutrigenómica  
Metabolómica  
Exposoma

## **Nutrimetabolómica**

Definición  
Áreas de estudio

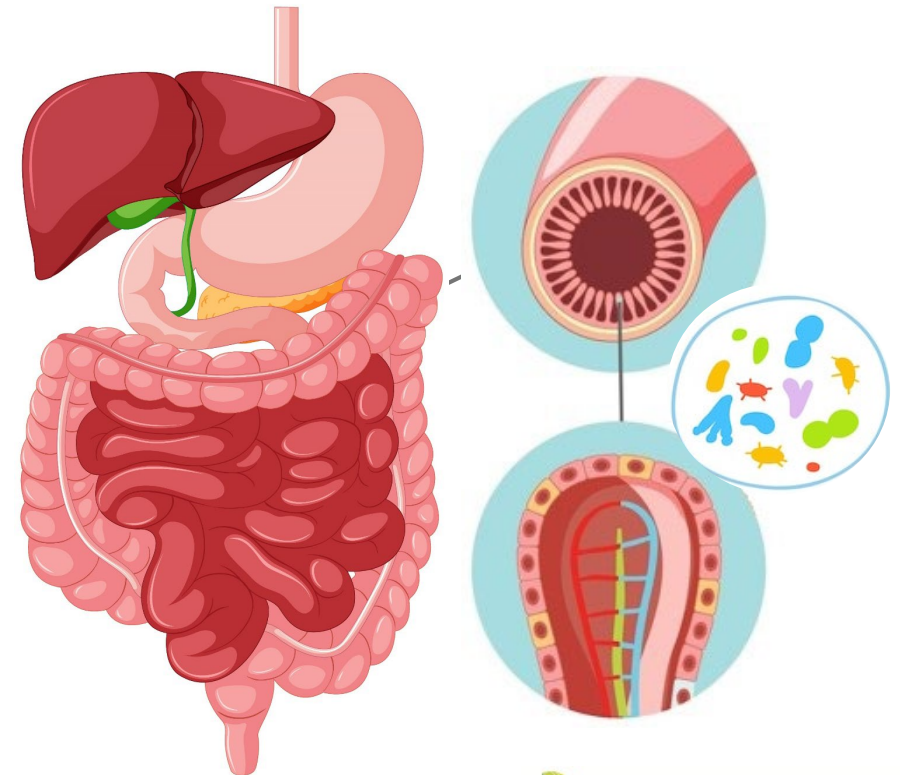


# DESAFÍOS EN NUTRICIÓN

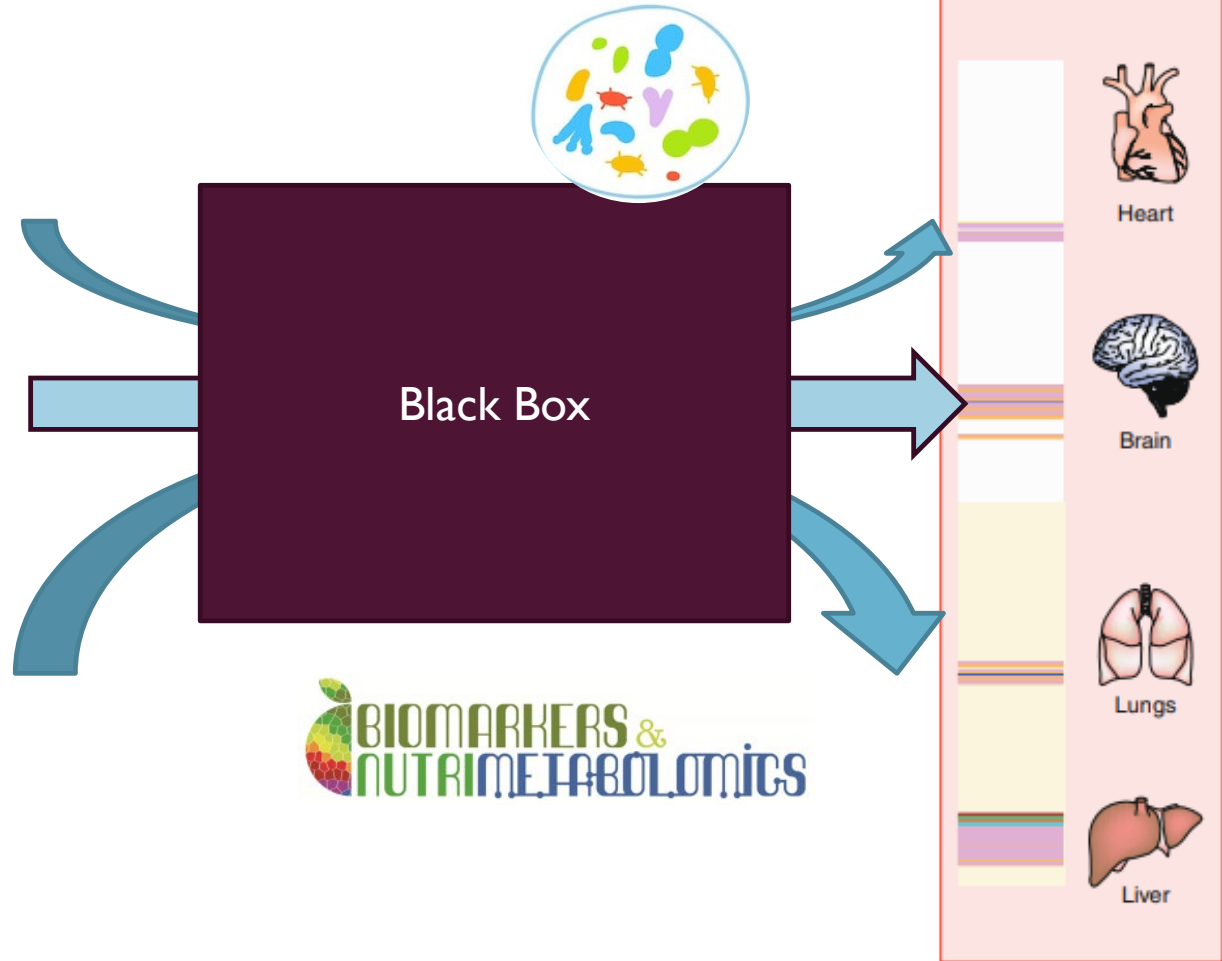
Dietary assessment



Interindividual variability

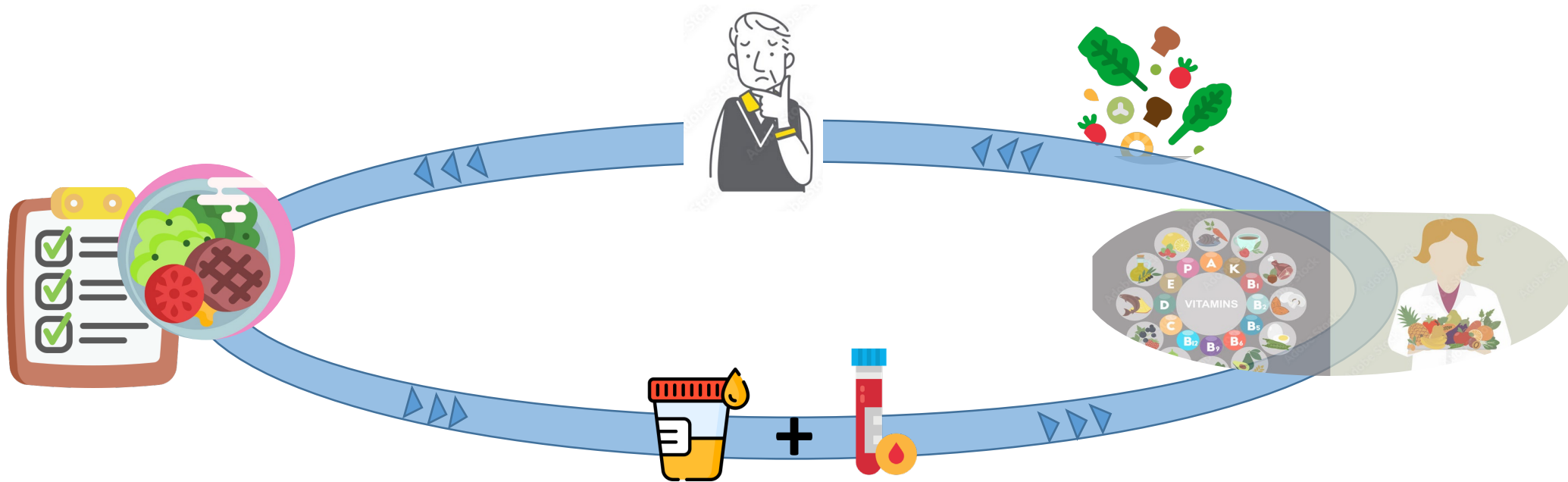


# DESAFÍOS EN NUTRICIÓN



# LÍNEAS DE INVESTIGACIÓN

- Metabolitos específicos podrían ser marcadores objetivos de la ingesta.
- Los metabolitos serían un mejor indicador de las relaciones nutrición x salud al tener en cuenta factores intraindividuales que condicionan los efectos de los alimentos y sus componentes.



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# LÍNEAS DE INVESTIGACIÓN

**Biomarcadores de  
ingesta**

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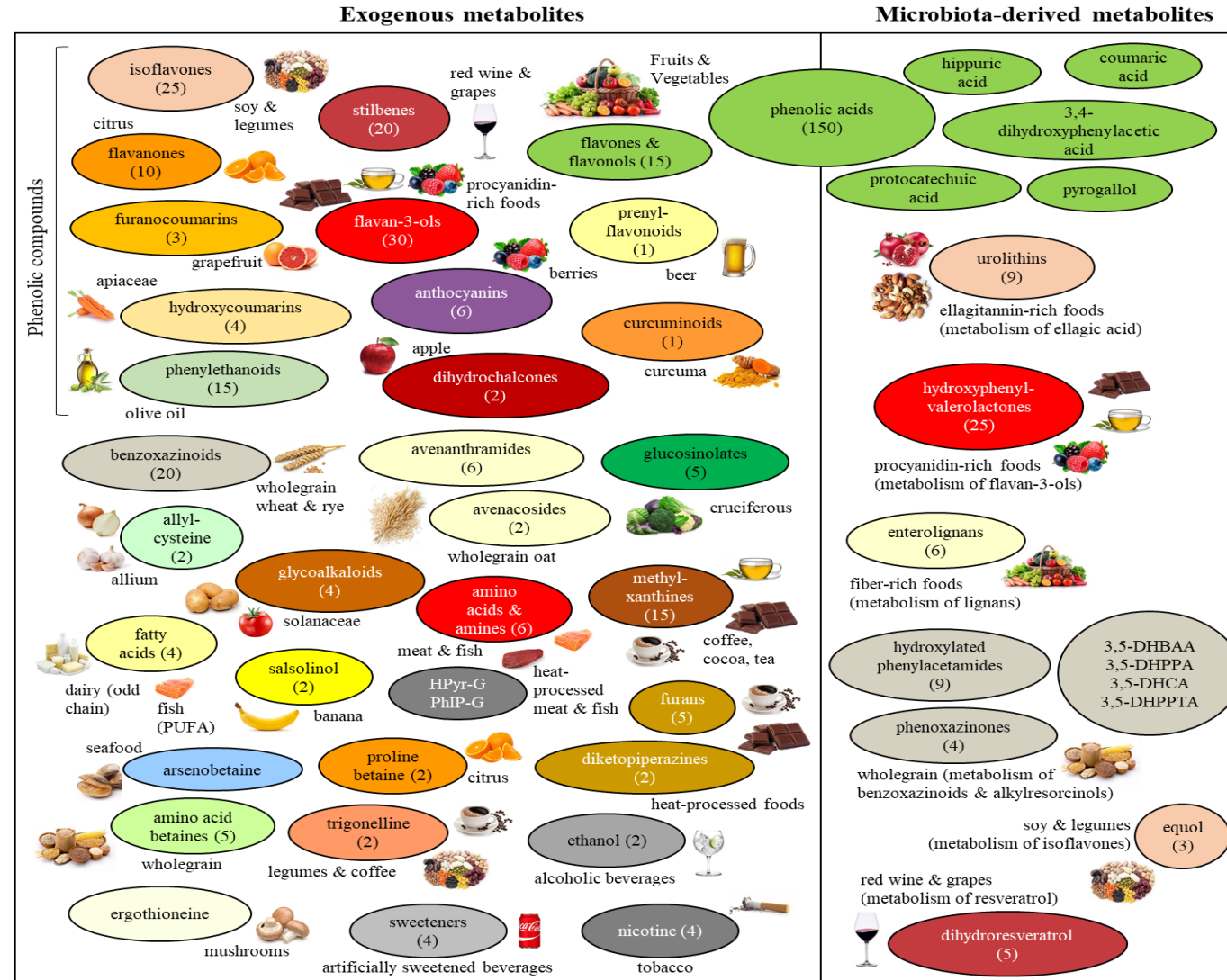
**Epidemiología  
nutricional**

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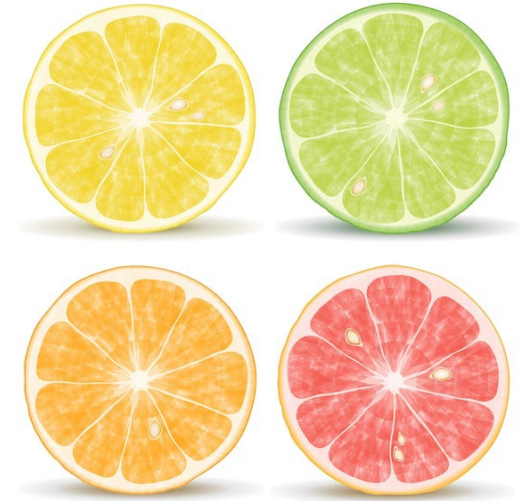
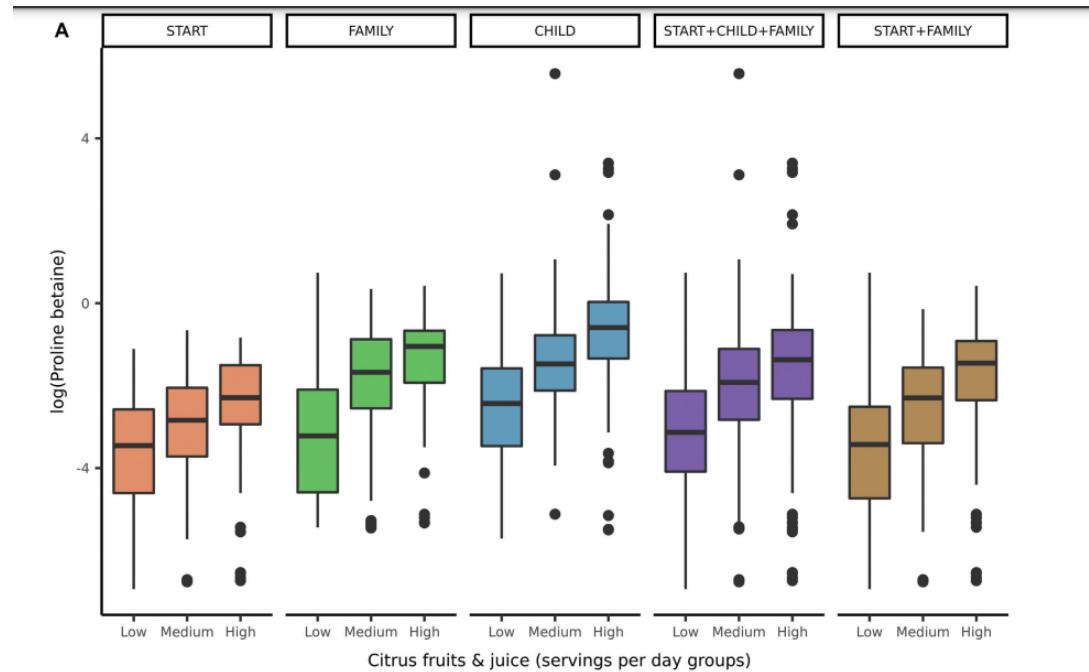
**Nutrición  
personalizada  
(Metabotyping)**

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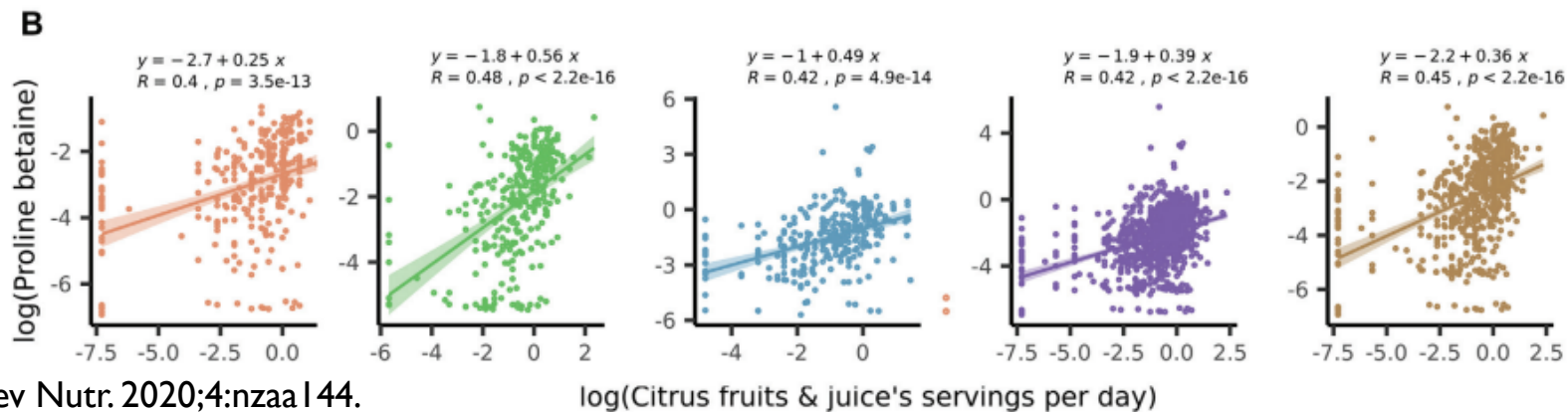
# METABOLÓMICA-BIOMARCADORES DE INGESTA



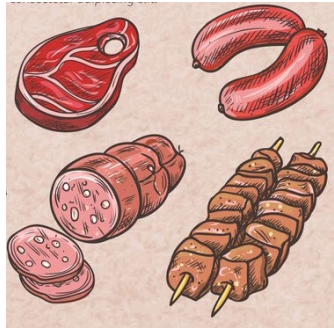
# METABOLÓMICA-BIOMARCADORES DE INGESTA



Proline-betaine



# METABOLÓMICA-BIOMARCADORES DE EFECTO



Arg, BCAA



Trp, Phe, His

**Table 2.** Plasma concentrations of amino acids by habitual diet group<sup>a</sup>

	Geometric mean concentration (95% confidence interval), $\mu\text{mol/l}$ % mean difference compared with meat-eaters				P <sub>difference</sub> <sup>b</sup>
	Meat-eaters (n = 98)	Fish-eaters (n = 98)	Vegetarians (n = 98)	Vegans (n = 98)	
<i>Branched-chain essential amino acids</i>					
Isoleucine	99 (94, 103) Ref.	99 (95, 103) 0	102 (97, 106) +3	96 (92, 100) -3	0.3
Leucine	205 (197, 214) Ref.	208 (200, 216) +1	210 (202, 218) +2	191 (184, 199) -7	0.005
Valine	230 (221, 239) Ref.	233 (225, 242) +1	233 (225, 242) +1	217 (209, 225) -6	0.02
<i>Other essential amino acids</i>					
Histidine	114 (110, 118) Ref.	122 (118, 126) +7	119 (115, 122) +4	117 (113, 120) +2	0.04
Lysine <sup>c</sup>	241 (230, 253) Ref.	242 (232, 253) +1	234 (224, 245) -3	210 (201, 219) -13	< 0.0001
Methionine	29 (28, 31) Ref.	30 (29, 31) +2	31 (30, 32) +5	27 (26, 28) -8	0.0001
Phenylalanine <sup>c</sup>	95 (92, 99) Ref.	101 (97, 105) +6	100 (97, 104) +5	97 (93, 101) +2	0.1
Threonine	164 (158, 170) Ref.	168 (163, 174) +3	167 (162, 173) +2	165 (159, 171) +1	0.7
Tryptophan <sup>c, d</sup>	69 (67, 72) Ref.	71 (68, 73) +2	72 (70, 74) +4	65 (63, 68) -6	0.001
<i>Non-essential amino acids</i>					
Alanine	564 (540, 590) Ref.	644 (618, 671) +14	627 (602, 654) +11	621 (595, 648) +10	0.0004
Arginine	51 (46, 57) Ref.	44 (40, 49) -14	44 (40, 49) -14	44 (39, 48) -15	0.1
Asparagine	92 (89, 95) Ref.	97 (94, 101) +6	96 (92, 99) +4	98 (95, 102) +7	0.07
Aspartate <sup>d</sup>	66 (62, 69) Ref.	64 (61, 67) -6	69 (66, 72) +4	69 (66, 72) +4	0.04

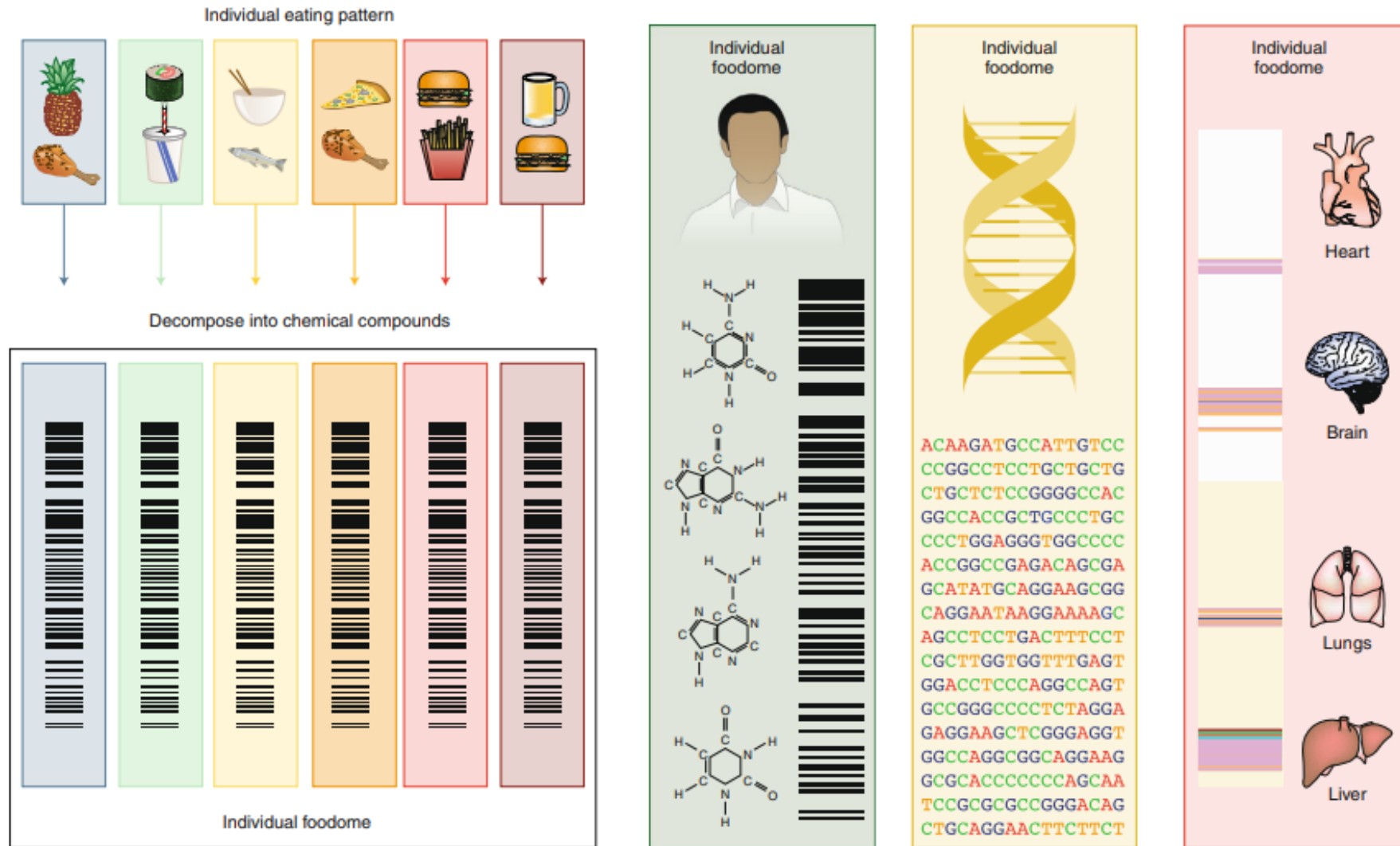


Trp, Phe



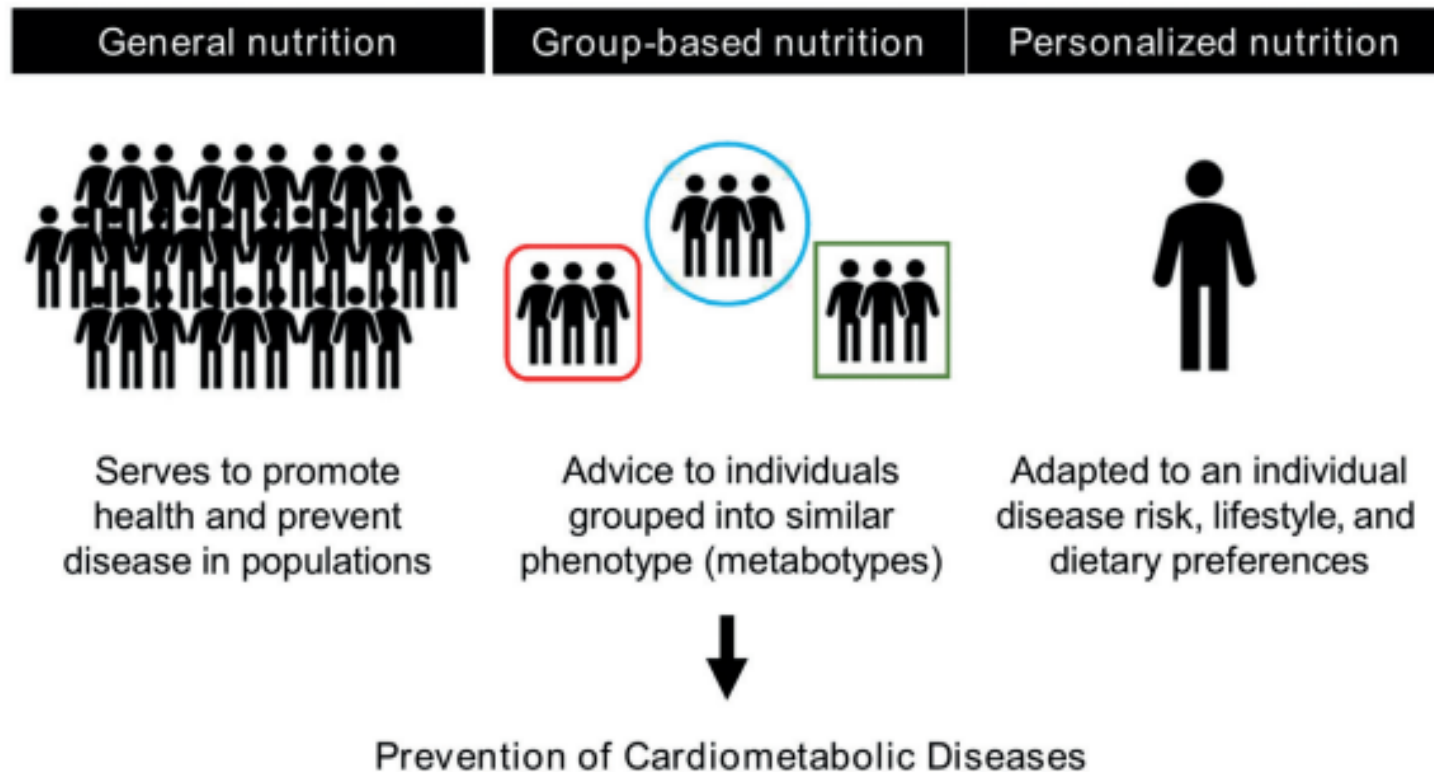
Gly

# EPIDEMIOLOGÍA NUTRICIONAL

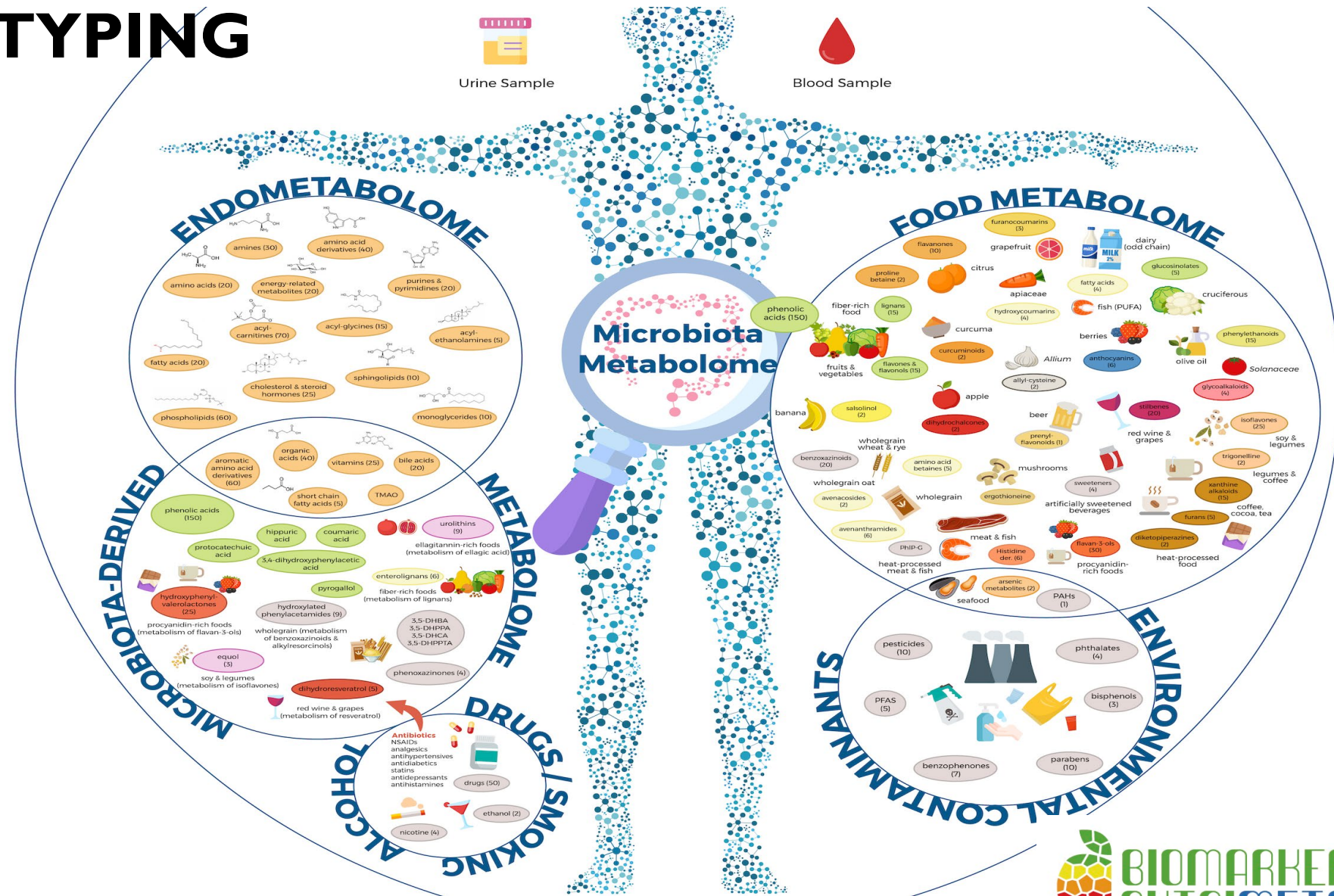




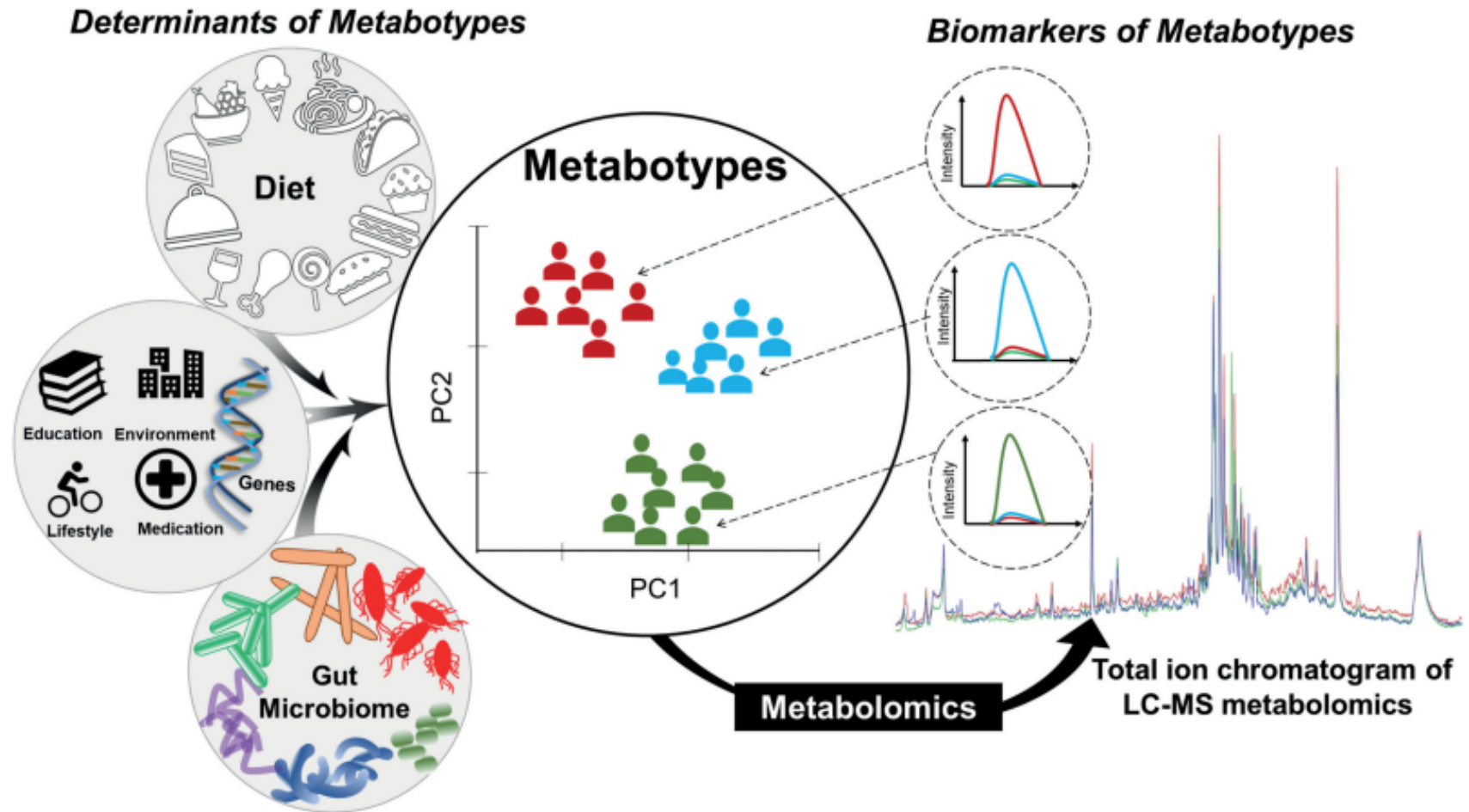
# METABOTYPING



# METABOTYPING



# METABOTYPING



## **Ómicas**

Introducción

Biología de sistemas

## **Ómicas en Nutrición**

Nutrigenómica

Proteoma y nutrición

Metabolómica

## **Nutrimetaboloma**

Componentes

Fuentes de variación

Exposoma

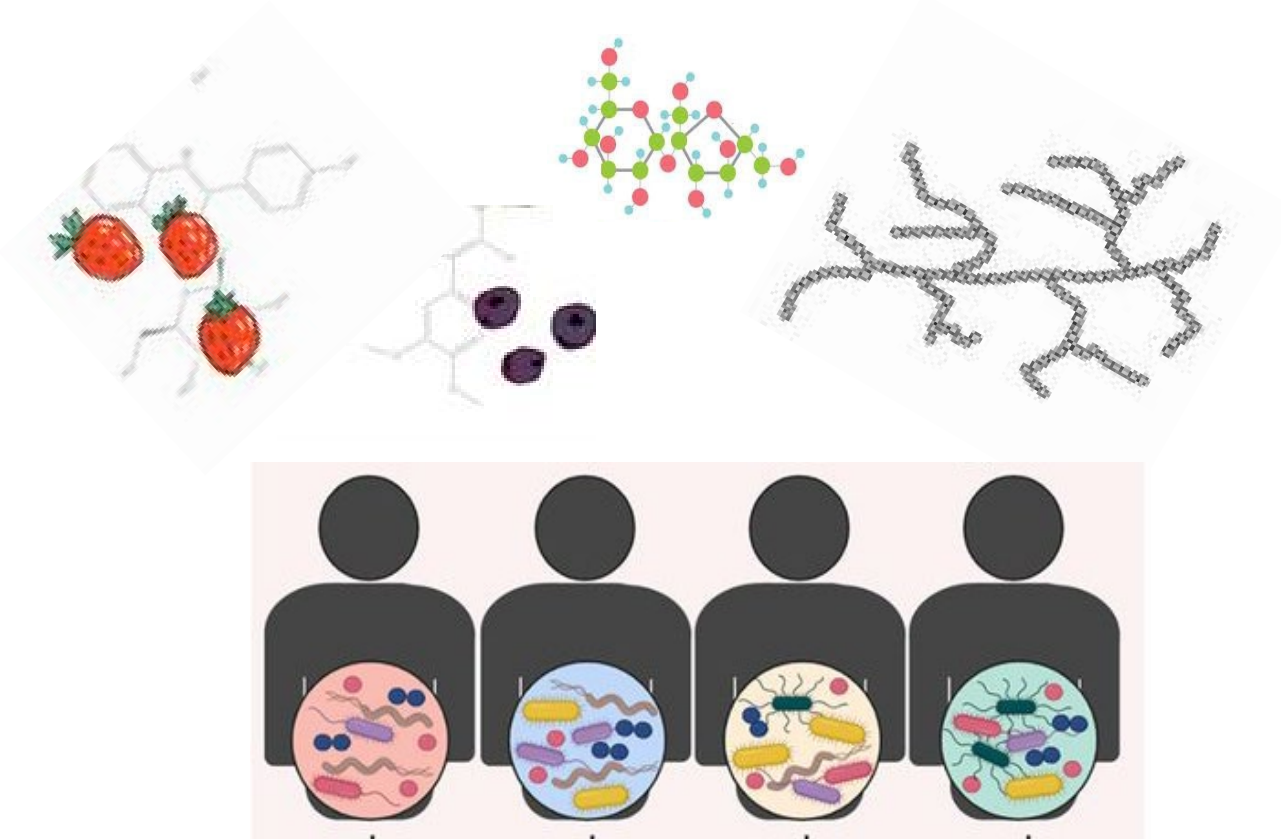
## **Nutrición de precisión**

Necesidad

Fundamento

Aplicaciones

# NECESIDAD



Diferentes respuestas biológicas

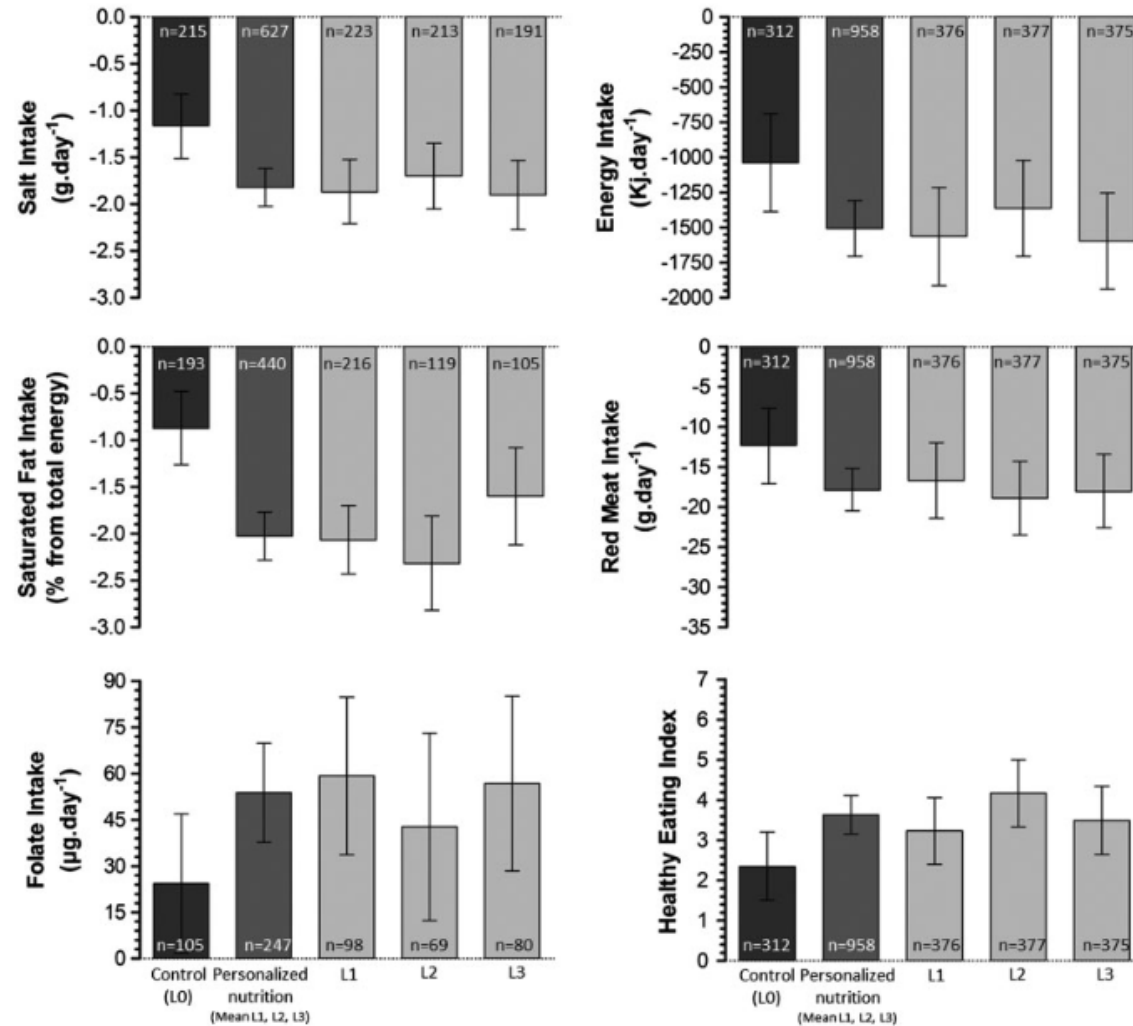
## Determinantes:

- Alimentos y nutrientes
- Microbiota intestinal (composición y funcionalidad)
- Permeabilidad intestinal
- Enfermedades crónicas
- Contaminantes ambientales

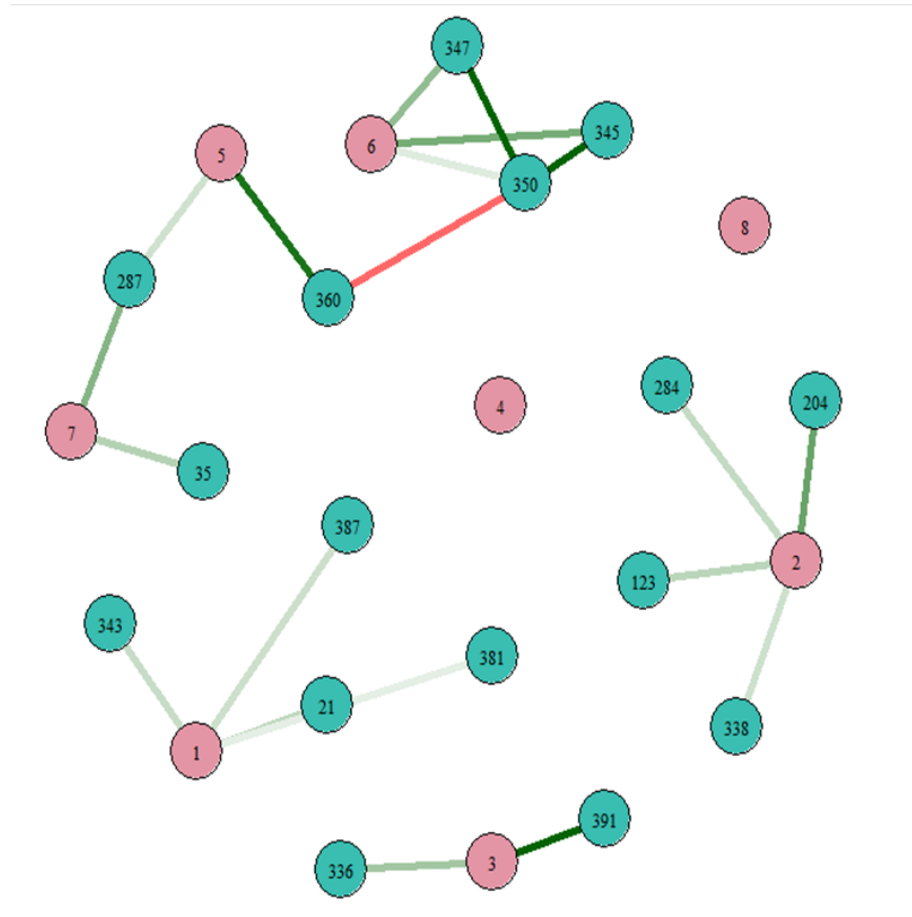
# EFICACIA DE NUTRITION PERSONALIZADA



- Level 0: Control – conventional (non-personalised) dietary advice;
- Level 1: PN advice based on current diet alone;
- Level 2: PN advice based on current diet plus phenotypic information (adiposity and blood metabolites);
- Level 3: PN advice based on current diet plus phenotypic and genotypic information.



# APLICACIONES-BIOMARCADORES DE INGESTA



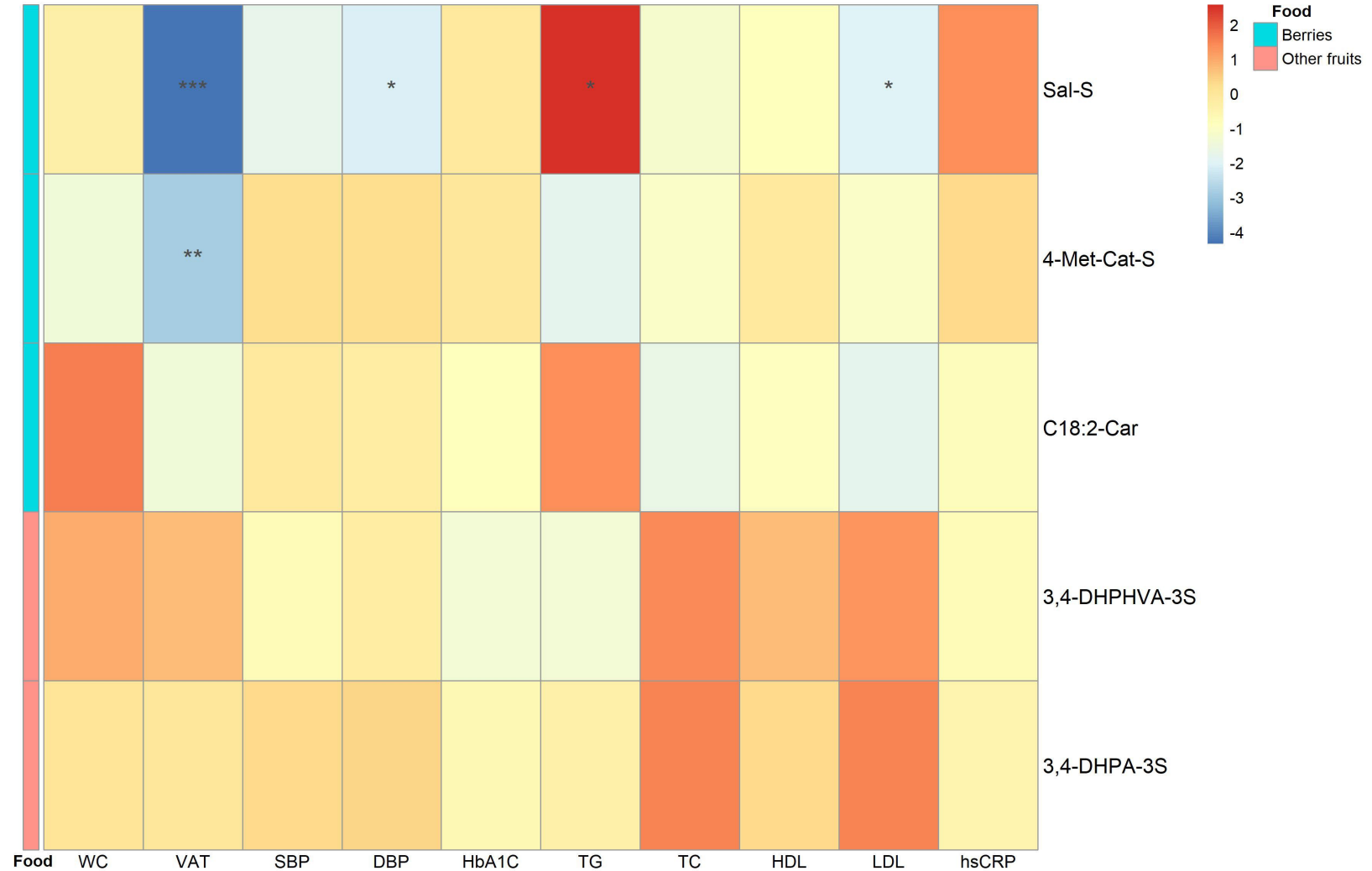
ACN food sources

- 1 Dairy products
- 2 Berries
- 3 Wine
- 4 Drinks
- 5 Vegetables
- 6 Other fruits
- 7 Mixed dishes
- 8 Refined cereals

Metabolome

- |                      |                   |
|----------------------|-------------------|
| 21 Asp               | 343 EpiC-S        |
| 35 1-Methylhistidine | 345 3,4-DHPHVA-3S |
| 123 C18:2-Car        | 347 3-HPV-S       |
| 204 Sal-S            | 350 3,4-DHPA-3S   |
| 284 GCDCA-3S         | 360 Berg-G        |
| 287 2-HBA            | 381 UroC-G        |
| 336 Met-Pyr-S        | 387 Acesulfame    |
| 338 4-Met-Cat-S      | 391 ET-G          |

# APLICACIONES-BIOMARCADORES DE INGESTA/EFECTO

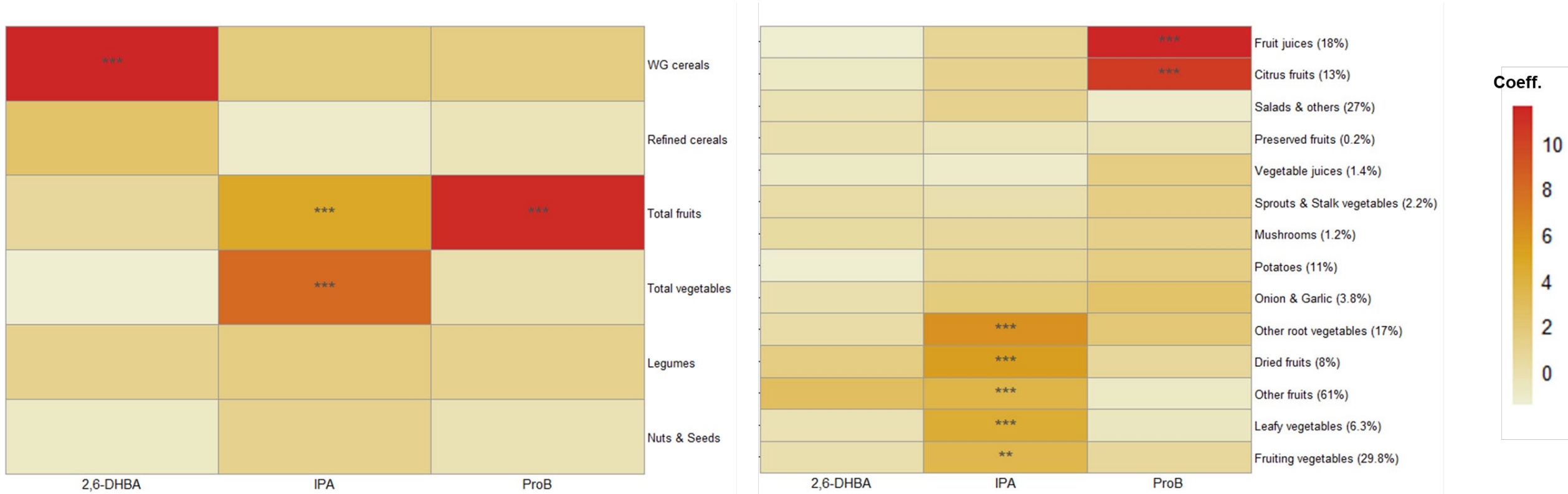




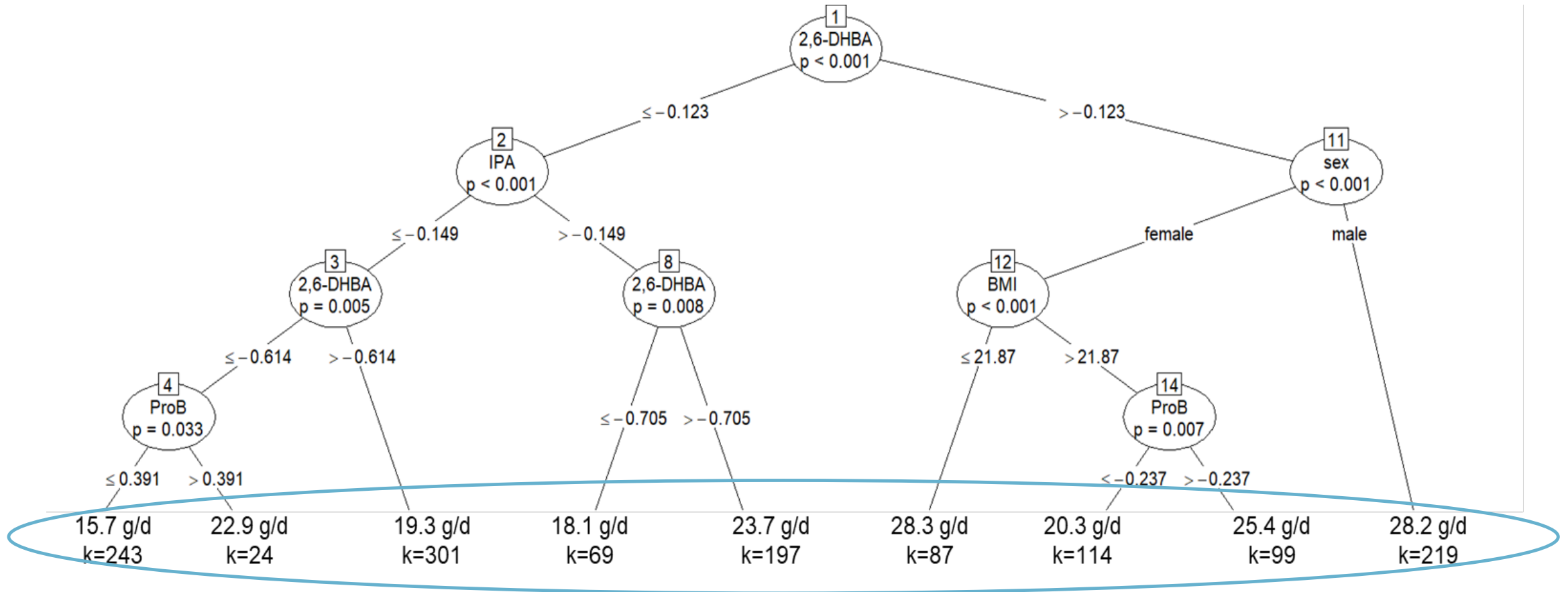


# APLICACIONES-BIOMARCADORES DE INGESTA/EFECTO

- 2,6-DHBA levels are associated with wholegrain cereal consumption
- IPA is associated with the consumption of fruits and vegetables
- Proline betaine is associated with fruit consumption, specifically citrus and juices



# APLICACIONES-BIOMARCADORES DE INGESTA/EFECTO



**Grupos basados en los niveles predichos de ingesta de fibra basada en biomarcadores**

# APLICACIONES-BIOMARCADORES DE INGESTA/EFEECTO

## 1. Fiber intake reported on diet questionnaires (24-HDRs):

Participants in the highest tertile of fiber intake:

	All	Fiber <16g/day (T1)	Fiber: 16-25g/day (T2)	Fiber >25g/day (T3)
	n= 624	k= 451	k= 452	k= 450
	k=1,353			
Dietary fiber (g/d)	21 ± 10	11 ± 4	20 ± 2	33 ± 8 ***

↓ hsCRP

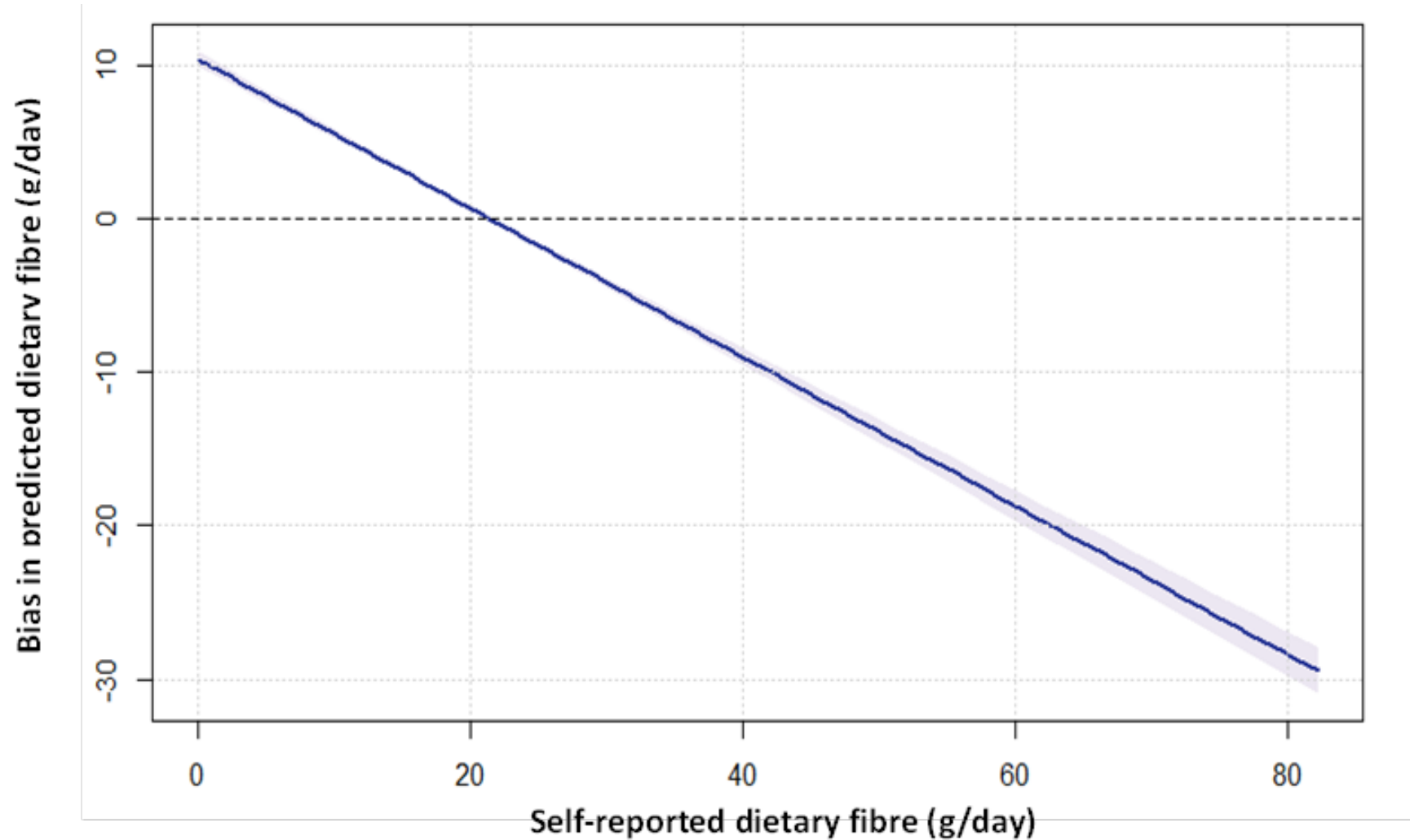
## 2. Predicted fiber intake based on the metabolites selected by the model + clinical variables :

Participants in the highest group of fiber intake:

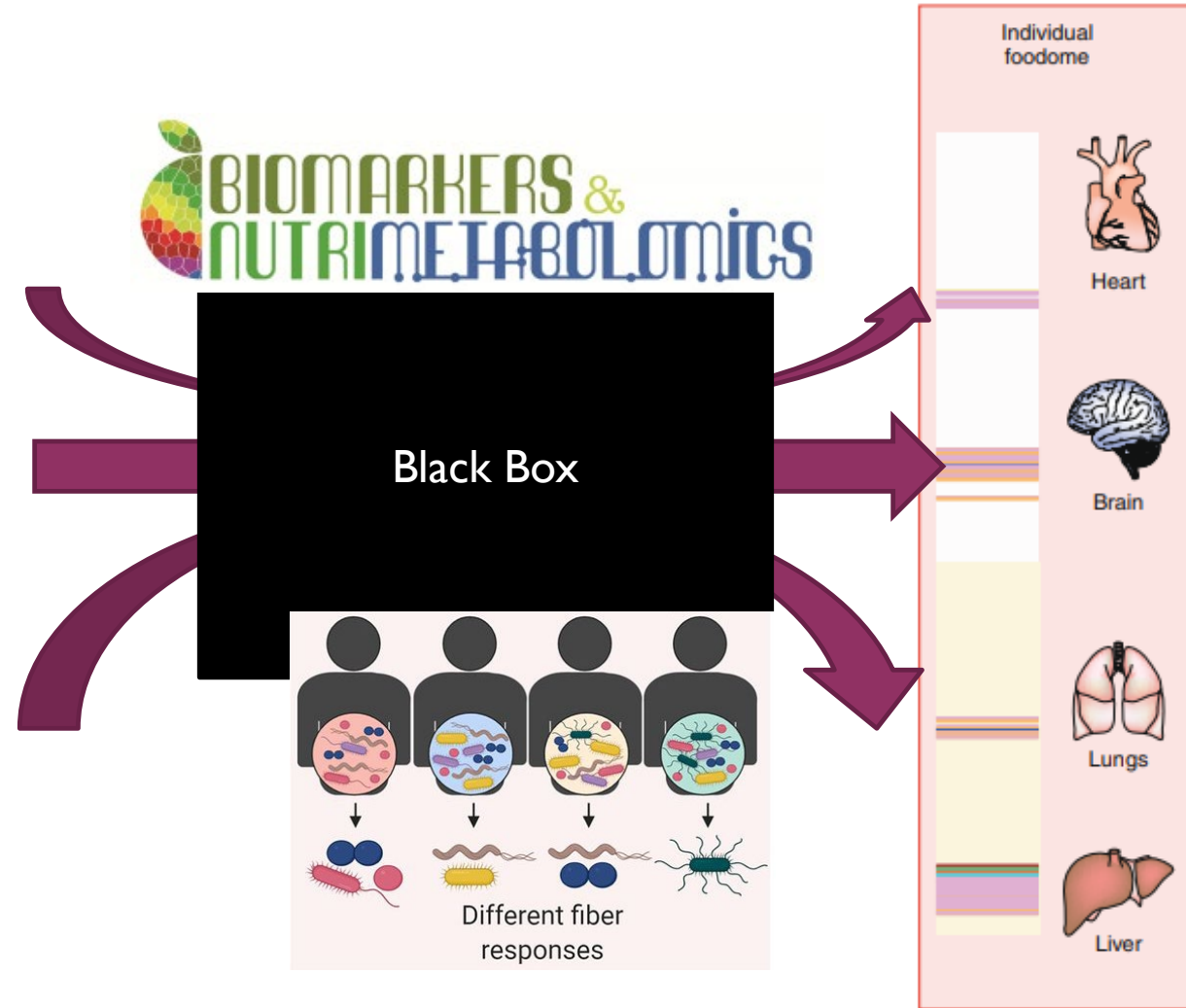
	All	Group 1	Group 2	Group 3
	n= 624	<17g/day,	17-25 g/day,	>25g/day,
	k=1,353	k=243	k=705	k=405
Dietary fiber (g/d)	21 ± 10	16 ± 7	21 ± 10	27 ± 12***

↓ visceral adipose tissue , total colesterol, LDL-C, hsCRP

# APLICACIONES-BIOMARCADORES DE ~~INGESTA~~/EFECTO



# APLICACIONES-BIOMARCADORES DE ~~INGESTA~~/EFECTO



# APLICACIONES-METABOLOMICS FINGERPRINT



# APLICACIONES-METABOLOMICS FINGERPRINT

## “PLANT-BASED”

- highly processed
- additives & added sugar
- less nutrients

vs.

## PLANT-BASED

- whole food ingredients
- full of vitamins and minerals
- more nutritious



vegan mac & cheese, fries,  
lick of broccoli, vegan cookie

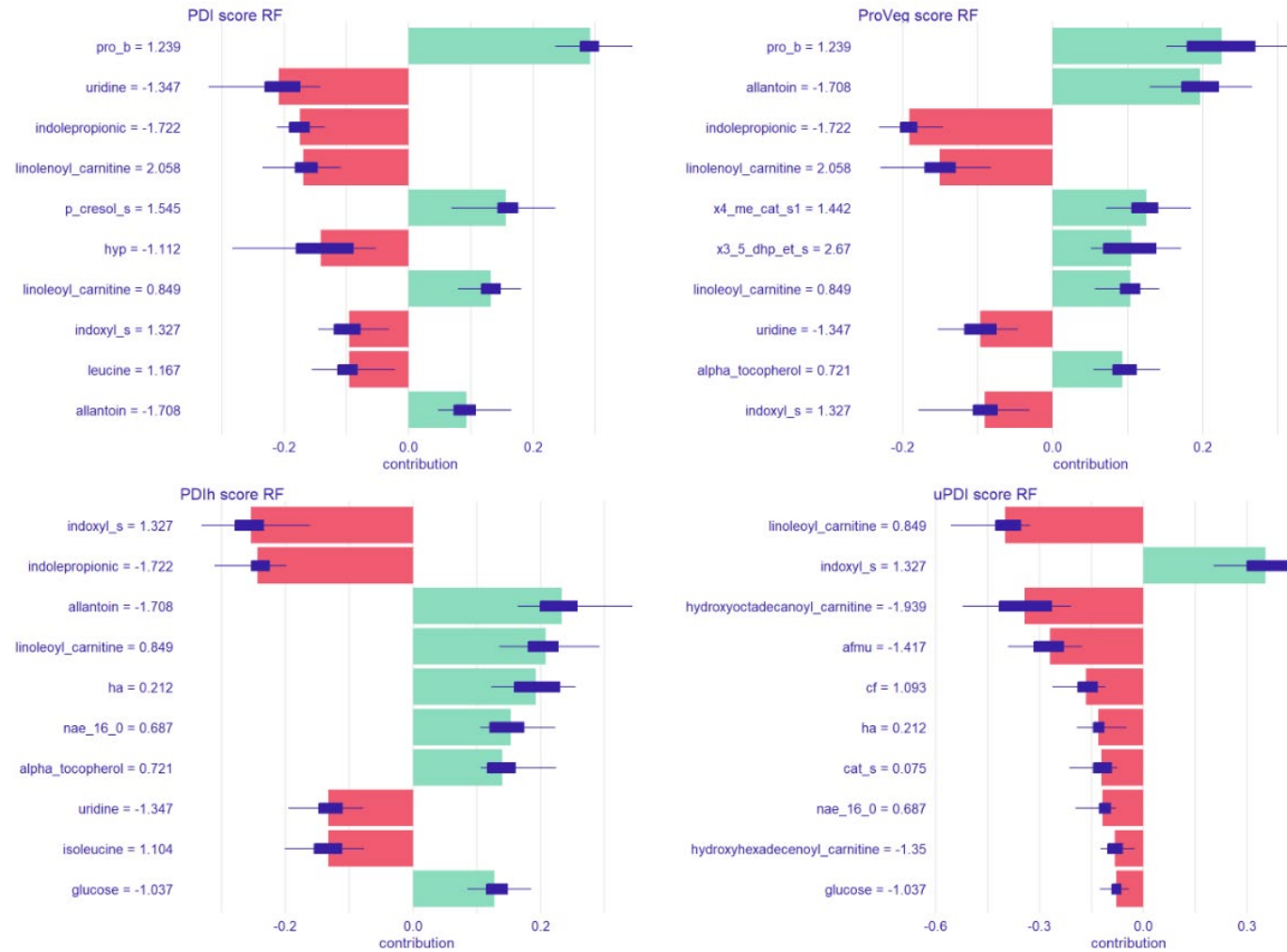


whole food nutritious  
salad

Healthy plant foods	Unhealthy plant foods	Animal foods
Fruits	Fruit juice	Meat
Vegetables	Refined grains	Fish
Whole grains	Potatoes	Eggs
Nuts	Sugar-sweetened beverages	Dairy
Tea & coffee	Sweets & desserts	Animal fat
Vegetable oils		

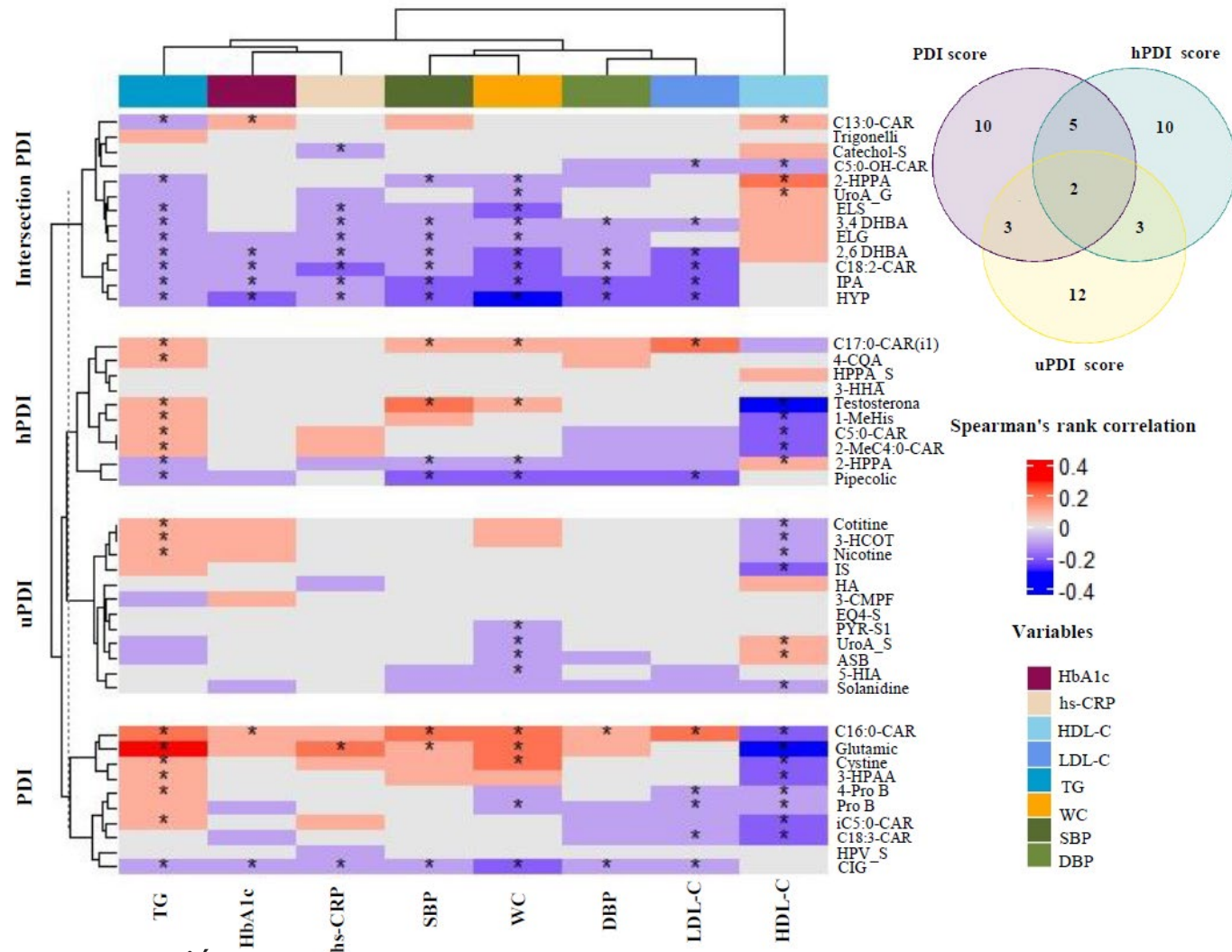
<https://plantbasedhealthprofessionals.com/>

# APLICACIONES-METABOLOMICS FINGERPRINT

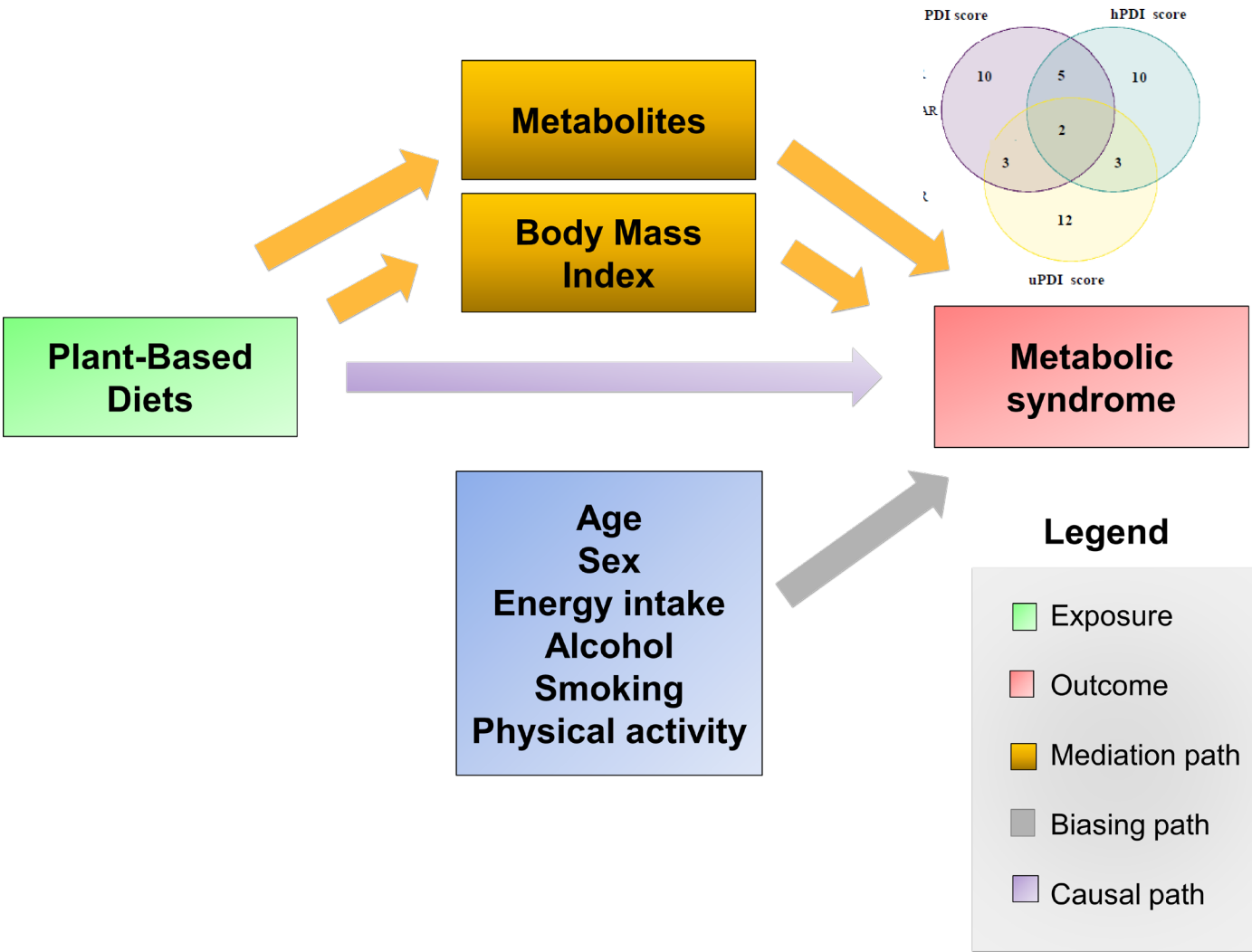




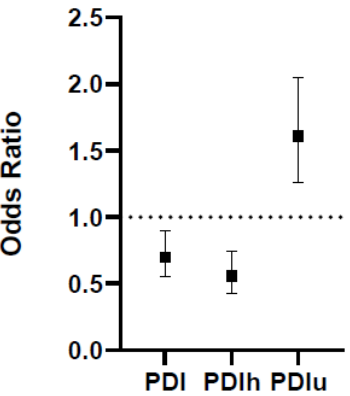
# APLICACIONES-METABOLOMICS FINGERPRINT



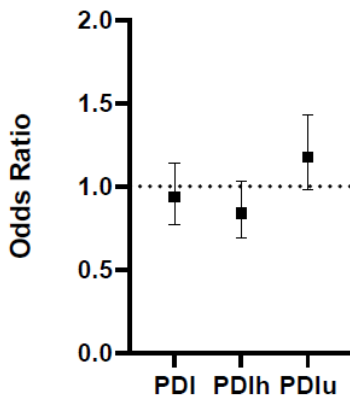
# APLICACIONES-METABOLOMICS FINGERPRINT



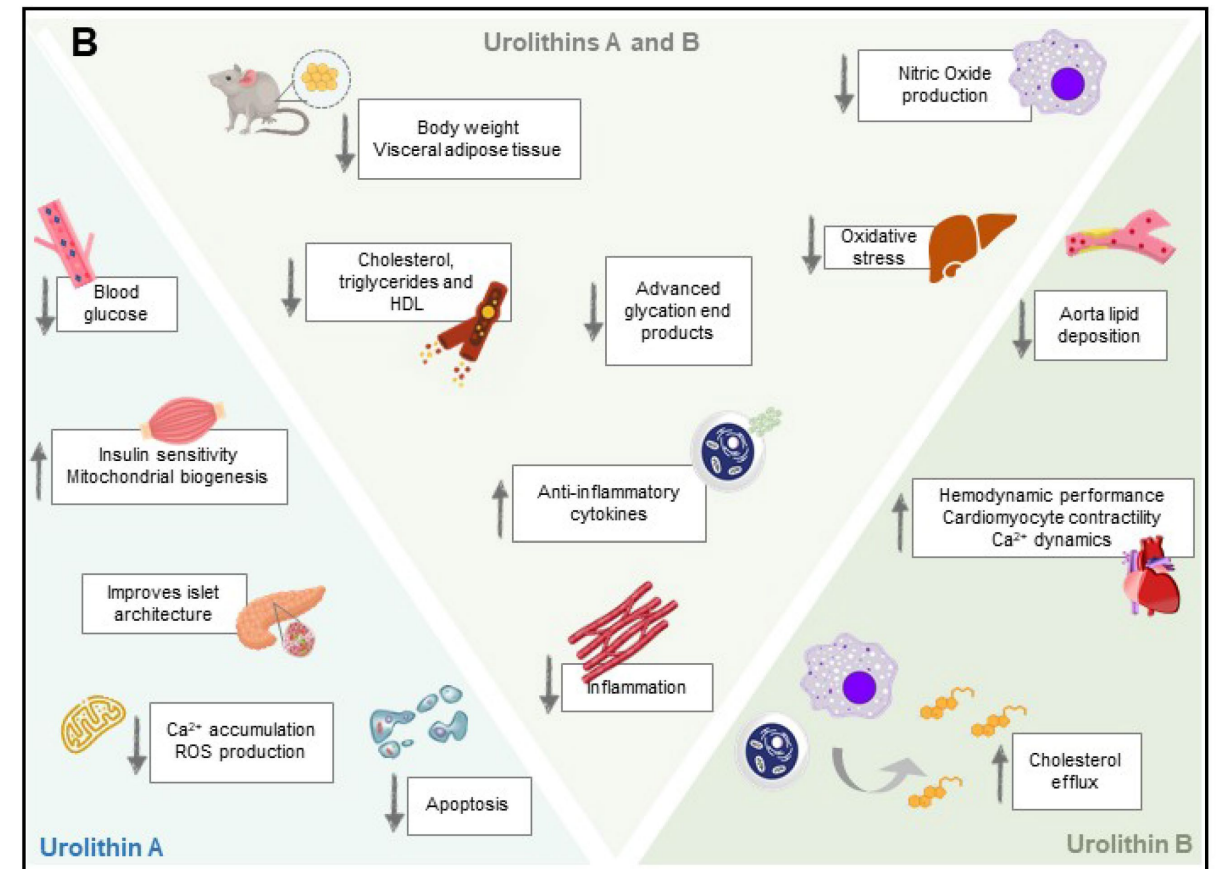
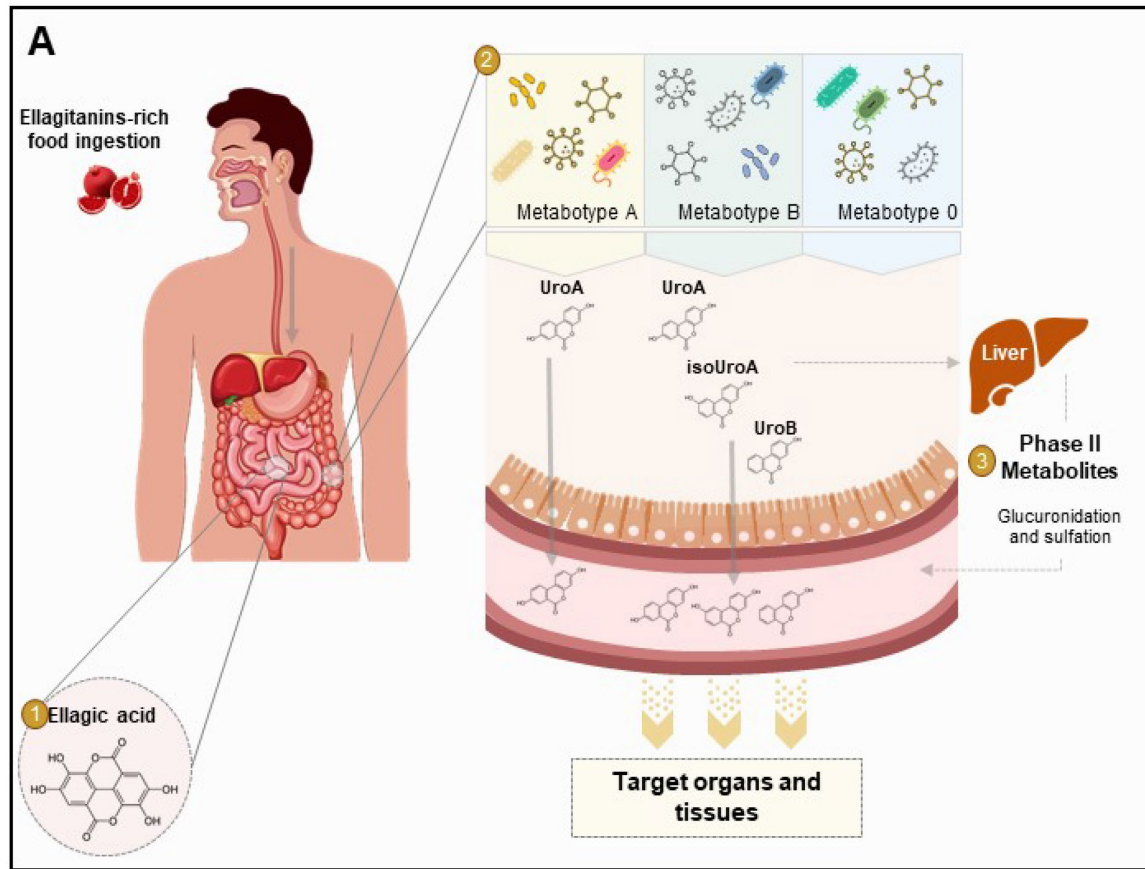
**a Modelo sin BMI**



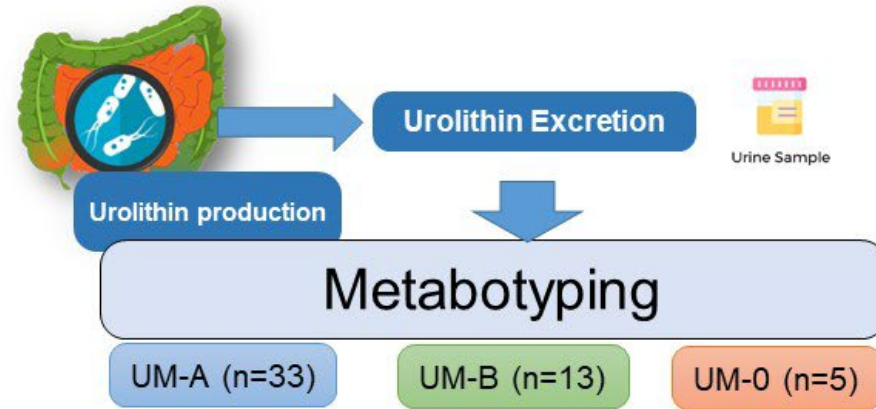
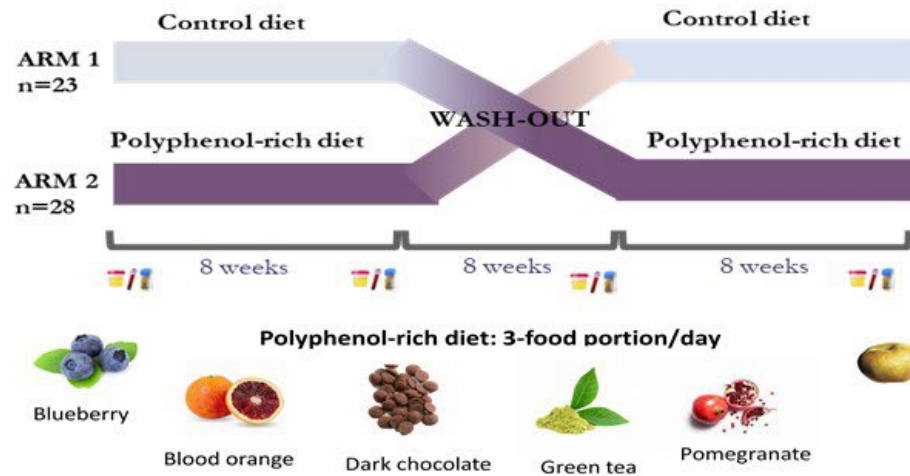
**b Modelo con BMI**



# APLICACIONES-METABOTYPING

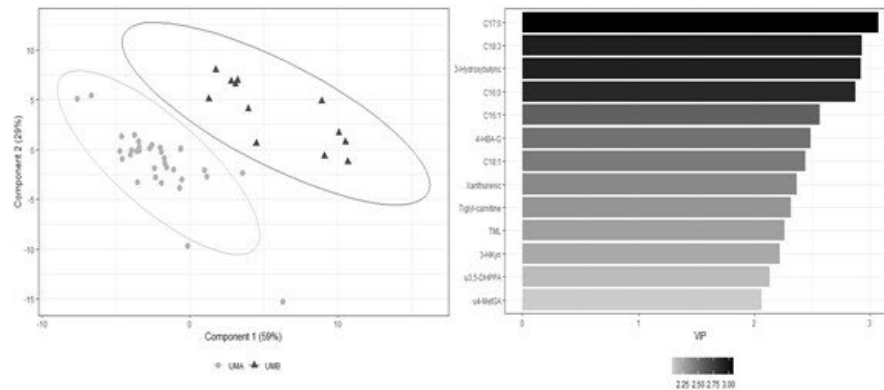


# APLICACIONES-METABOTYPING

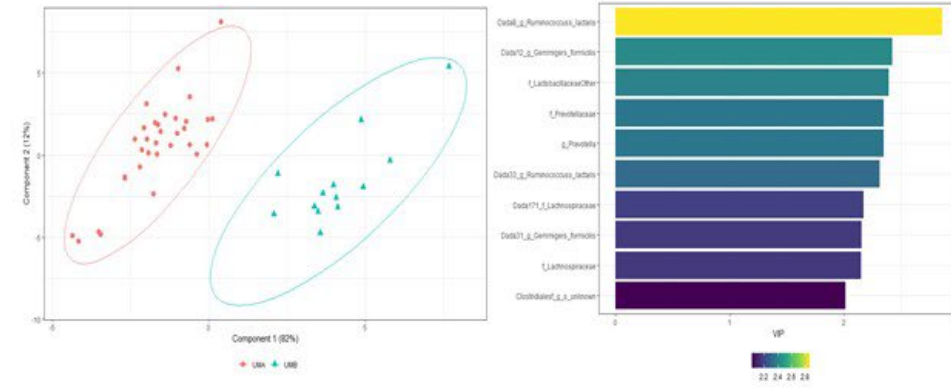


UM-B was associated with a 2-fold higher reduction in zonulin

Different metabolomics response to PR-diet

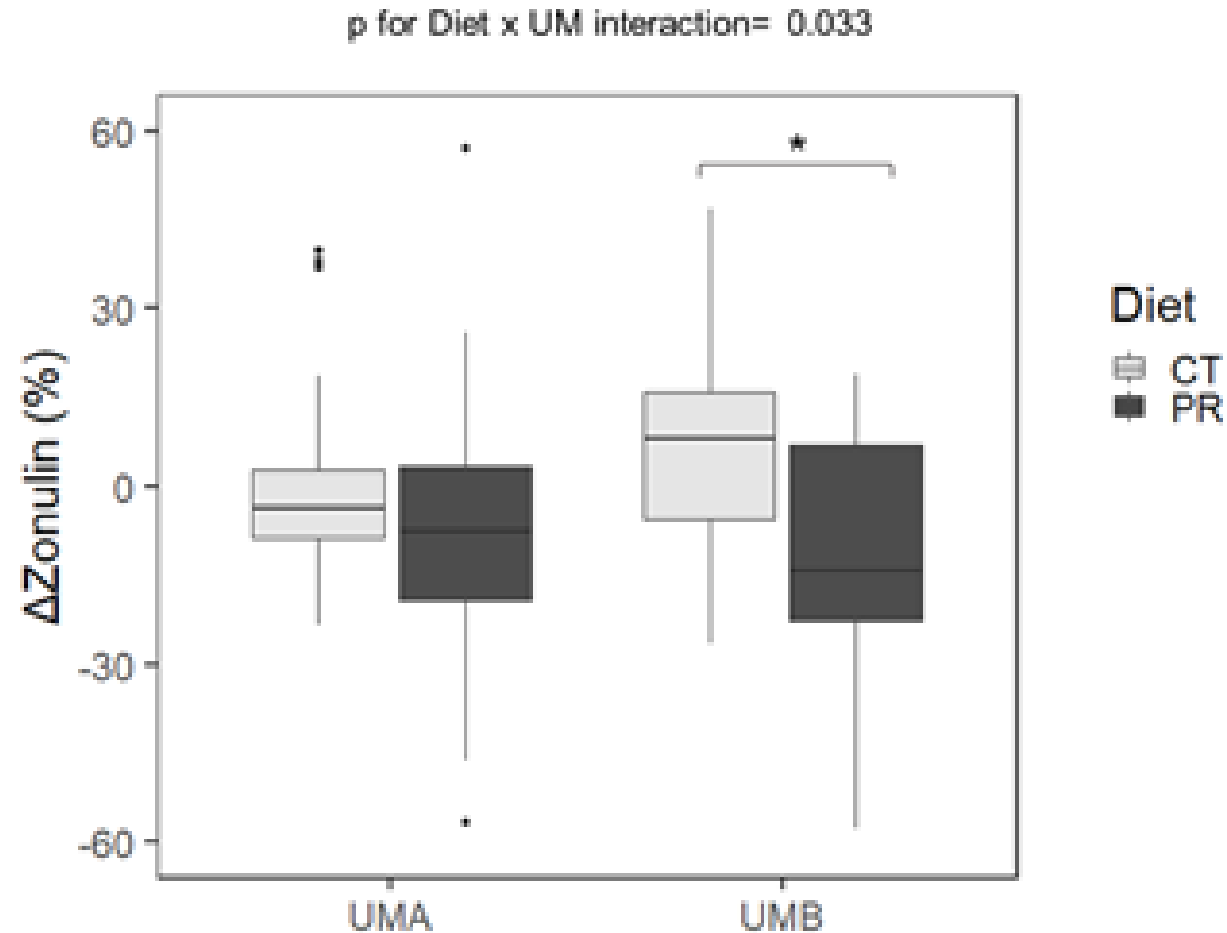
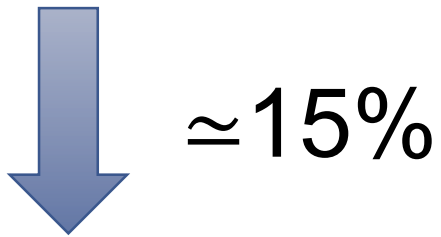
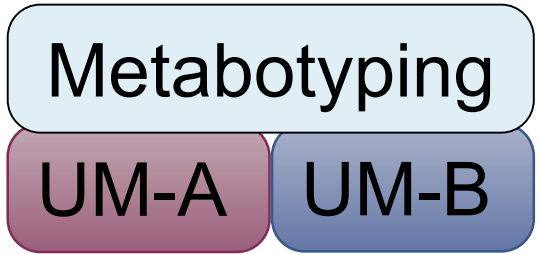
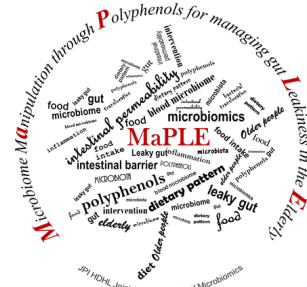


Different gut microbiota response to PR-diet



# APLICACIONES-METABOTYPING

RCT-crossover, MaPLE trial en 51 adultos mayores.





# NUTRIMETABOLÓMICA

Hacia una nutrición personalizada



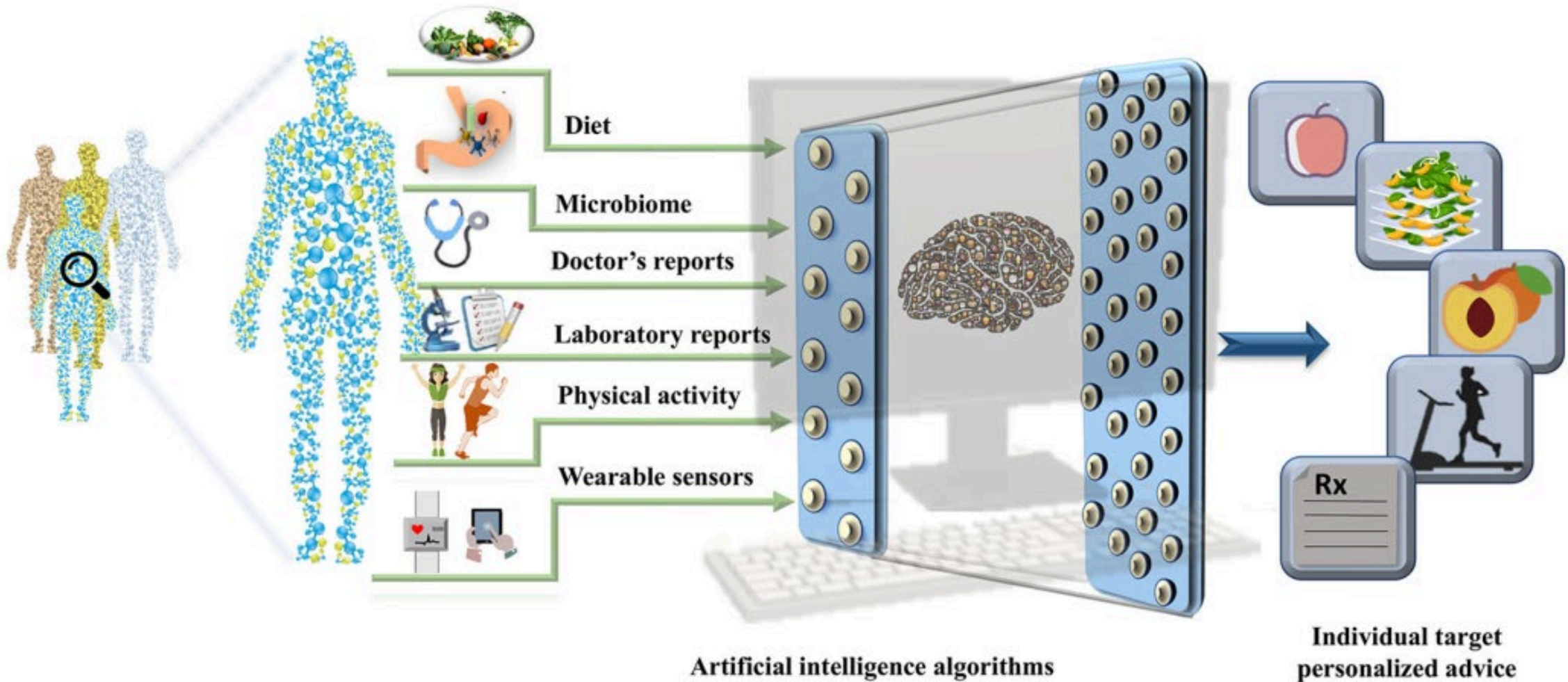
UNIVERSITAT DE  
BARCELONA

*ciberfes*

tomasmerono@ub.edu

Dr. Tomás Meroño

# LO MEJOR ESTÁ POR LLEGAR...





# LO MEJOR ESTÁ POR LLEGAR...

