Ulisses

UNIVERSITY OF LISBON
INTERDISCIPLINARY STUDIES
ON SUSTAINABLE ENVIRONMENT AND SEAS

EPIGENETICS and the Environment

Leonor Morais Cecílio
lmorais@isa.ulisboa.pt

ulisses.ulisboa.pt

unite! University Network for Innovation, Technology and Engineering

U LISBOA | UNIVERSIDADE DE LISBOA

Co-funded by the Erasmus+ Programme of the European Union

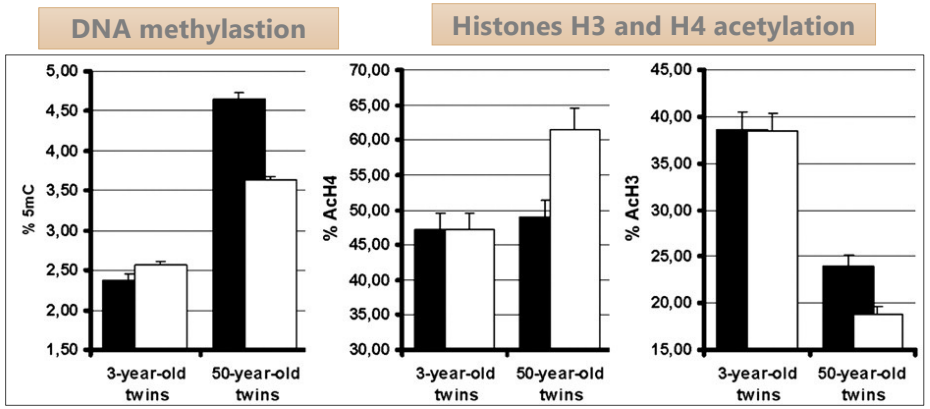
The Environment modifies the Epigenomes

Identical twins are ideal to study the influence of environment into phenotypes since they carry the same genetic information.

Ageing reveals differences in levels of DNA methylation and histone acetylation.

One genome but several epigenomes

The Environment modifies the Epigenomes

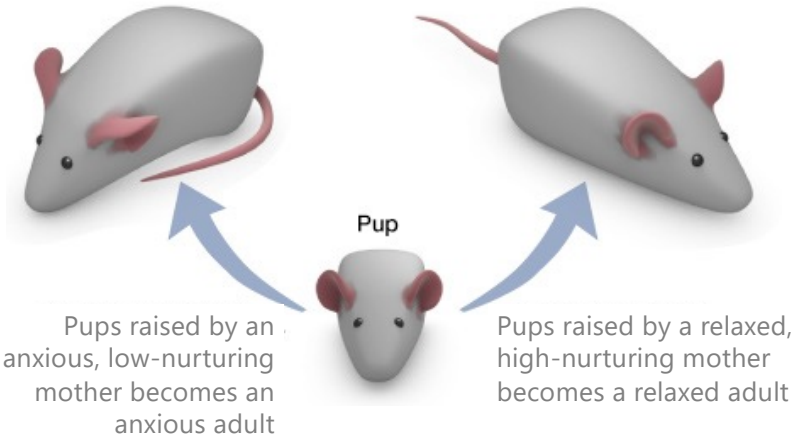


Fraga M F et al. PNAS 2005;102:10604-10609

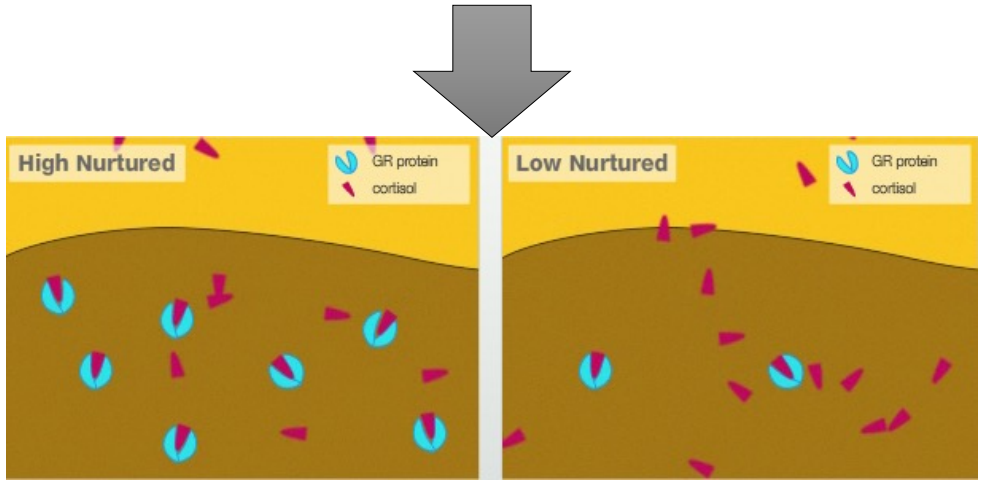
The percentage of DNA methylation and histone acetylation in each 3-year-old twins is very similar.
50-year-old twins show significant differences in the degree of DNA methylation and histone acetylation leading to differences in gene expression

The epigenetics of parenting

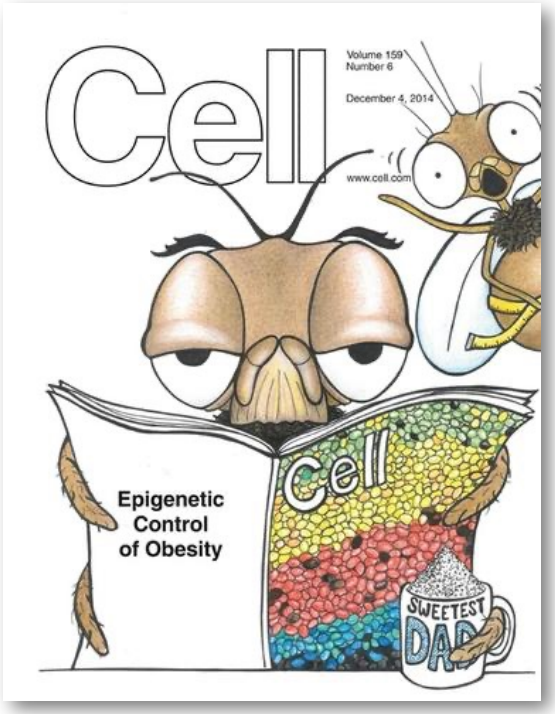
Maternal care affects the response of young rats to stress and affects gene expression. Well cared rats show less stress



Increased pup licking and grooming and arched-back nursing by rat mothers altered the offspring epigenome. A glucocorticoid receptor (GR) gene in the hippocampus becomes hypomethylated and hyperacetylated. Cortisol binds to GR proteins causing calm signals



High-sugar diet in fathers can lead to obese offspring



We are what we eat and we can pass into the offspring

Nutrient	Epigenetic Role	Food Origin
Methionine	SAM synthesis - Methytlation	Seeds, fish, peppers, spinach
Folic Acid	Methionine synthesis - Methylation	Leafy vegetables, liver, baker's yeast
Vitamins B12 and B6	Methionine synthesis - Methylation	Meat, liver, milk, vegetables, nuts
Choline	Methyl donor to SAM - Methylation	Eggs, liver, soy, meat
Resveratrol	Remove acetyl groups from histones	Red wine
Sulforaphane	Increase histone acetylation	Broccoli
Diallyl sulphide	Increase histone acetylation	Garllic

The importance of the diet

All the mice are genetically identical but epigenetically different

Hypomethylated

Hypermethylated

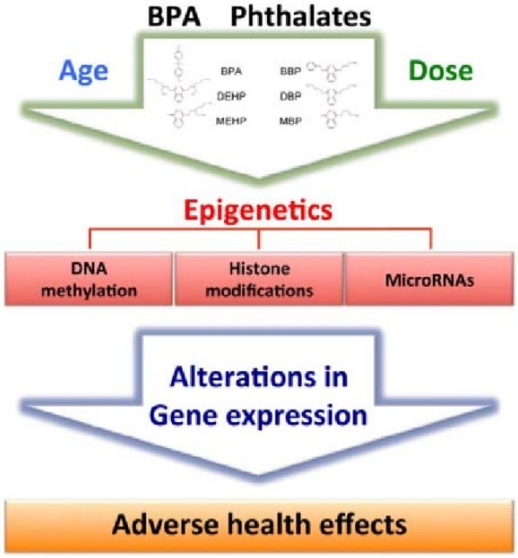
Yellow mice have more health problems like obesity, diabetes and cancer and brown mice are healthier.

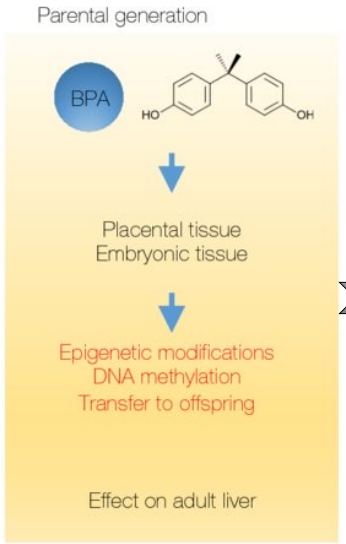
Pregnant brown mice fed with different levels of folic acid modifies the epigenome and can gave birth to browner and healthier mice. Folic acid starts a chain reaction that leads to methlyation of DNA.

Also grandmother's diet affects the epigenetic state of her grandpups.

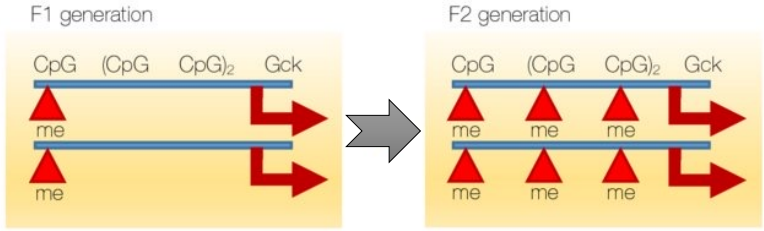
Plastics have strong impact on the epigenome

Bisphenol A (BPA) and Phtalates are substances added to plastics to improve their characteristics that affect the epigenetic mechanisms crucial for normal development





BPA induced epigenetic modifications are actively transmitted to offspring.



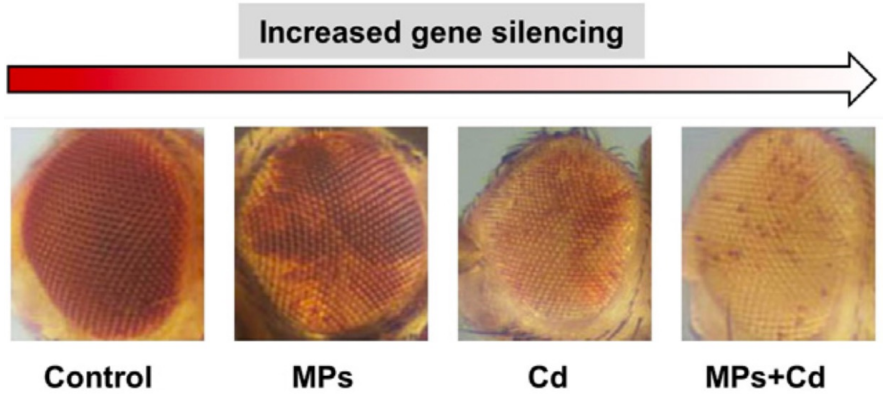
Pjanic, M., 2017. The role of polycarbonate monomer bisphenol-A in insulin resistance. *PeerJ, 5*, p.e3809.

Phthalates have been linked with altered DNA methylation patterns

https://www.genengnews.com/topics/omics/sperm-epigenetics-may-be-skewed-by-dads-exposure-to-plastics/

Wu, H., Estill, M.S., Shershebnev, A., Suvorov, A., Krawetz, S.A., Whitcomb, B.W., Dinnie, H., Rahil, T., Sites, C.K. and Pilsner, J.R., 2017. Preconception urinary phthalate concentrations and sperm DNA methylation profiles among men undergoing IVF treatment: a cross-sectional study. Human Reproduction, 32(11), pp.2159-2169.

Microplastics enhance Cadmium-induced epigenetic gene silencing in Drosophila

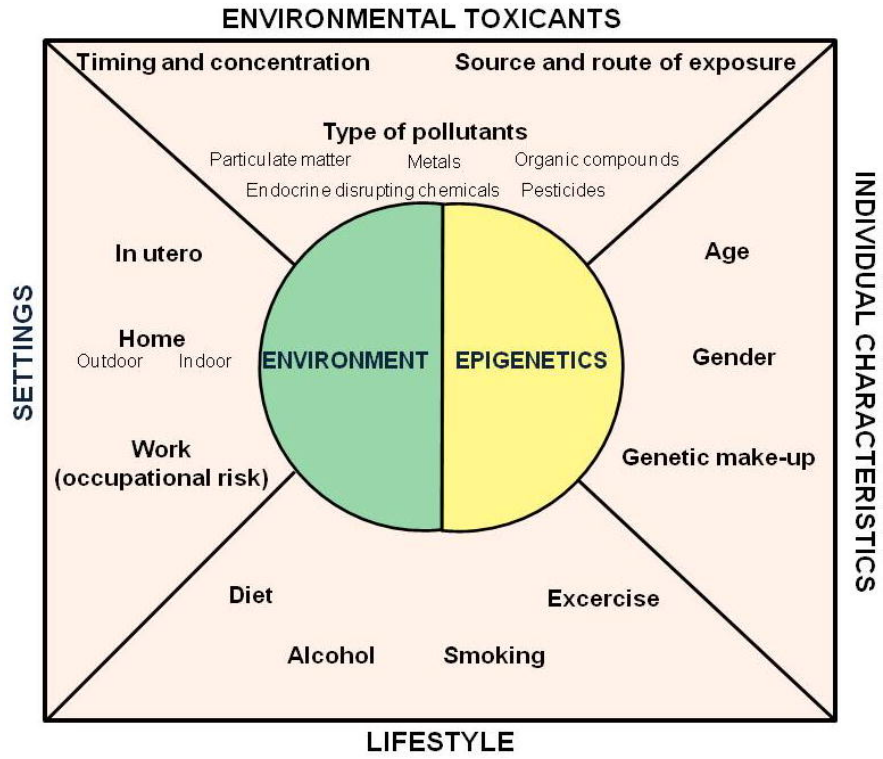


MPs - microplastics

Zhang, Y., Wolosker, M.B., Zhao, Y., Ren, H. and Lemos, B., 2020. Exposure to microplastics cause gut damage, locomotor dysfunction, epigenetic silencing, and aggravate cadmium (Cd) toxicity in Drosophila. *Science of The Total Environment*, *744*, p.140979.

unite! University Network for Innovation, Technology and Engineering
U LISBOA | UNIVERSIDADE DE LISBOA
INSTITUTO SUPERIOR DE AGRONOMIA Universidade de Lisboa
Co-funded by the Erasmus+ Programme of the European Union

Environment-Epigenetics interactions



Alegria-Torres, J.A., Baccarelli, A. and Bollati, V., 2011. Epigenetics and lifestyle. *Epigenomics*, 3(3), pp.267-277.

Importance of lifestyle:

- nutrition,
- behavior,
- stress,
- physical activity,
- working habits,
- smoking
- alcohol consumption
- .....


Ulisses
UNITE!
University Network for Innovation, Technology and Engineering
U LISBOA
UNIVERSIDADE DE LISBOA