

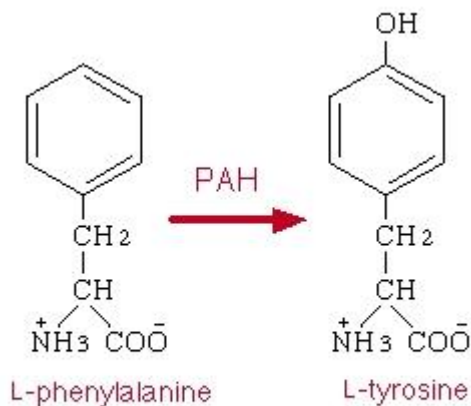
# Dining out with your DNA.... Tailoring nutrition to fit your genes

Nathan O'Callaghan  
Nutritional Genomics  
Food and Nutritional Sciences, CSIRO



# Personalised Nutrition

- Historically based on
  - Adverse outcomes
  - allergies
  - intolerances
- Genetic basis
  - Example Phenylketonuria (PKU)
  - Result in excluding from diet

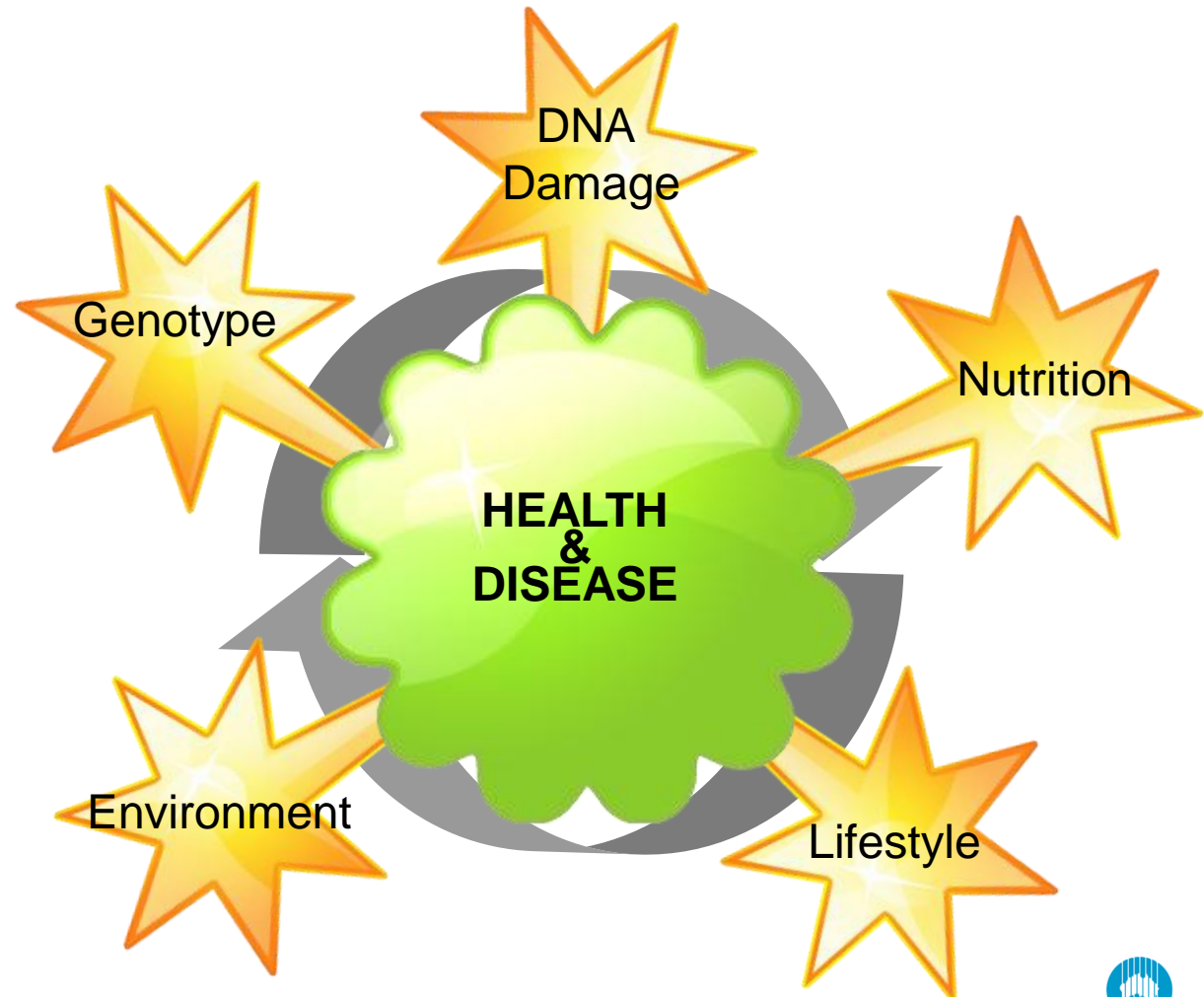


The enzyme phenylalanine hydroxylase converts the amino acid phenylalanine to tyrosine.

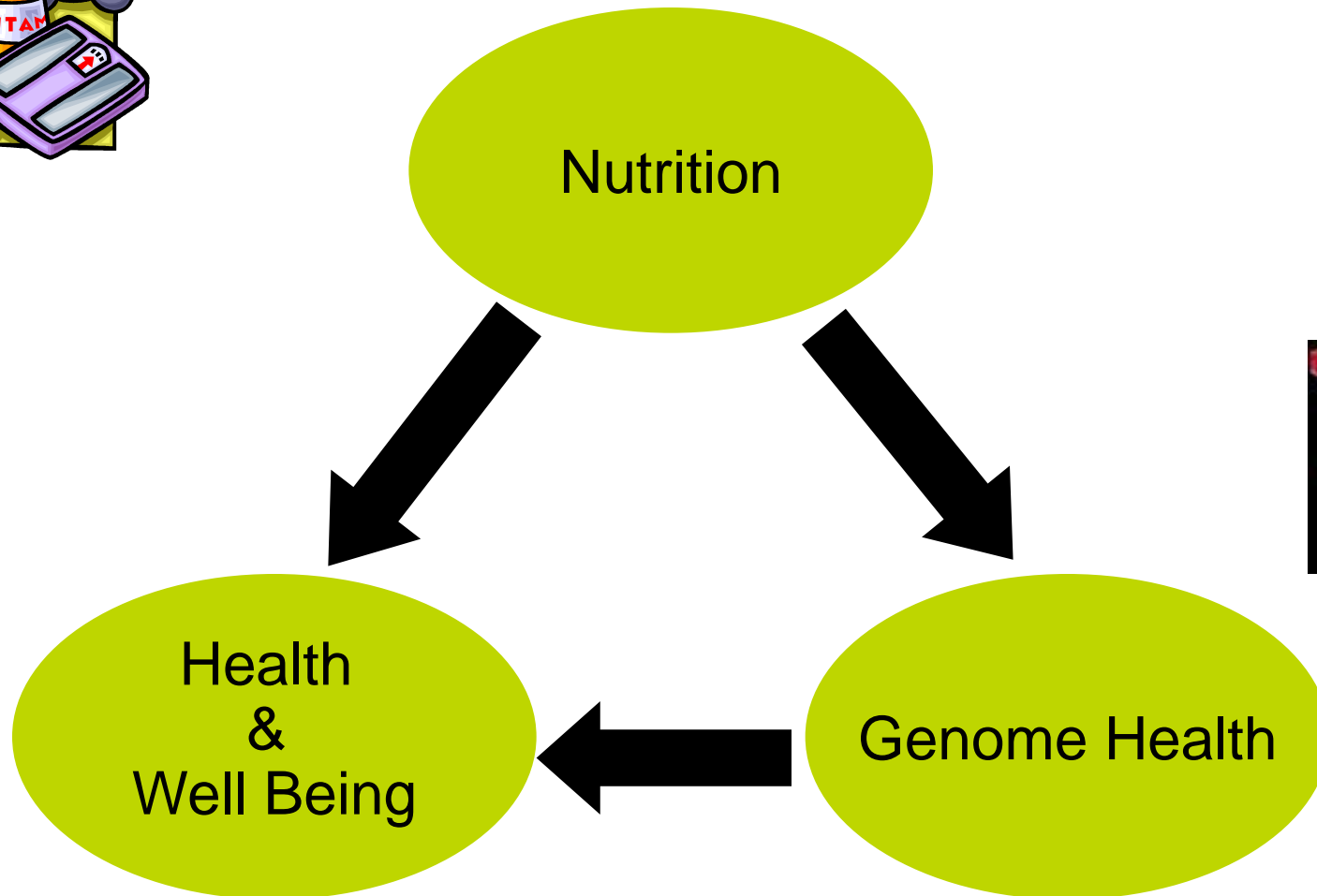
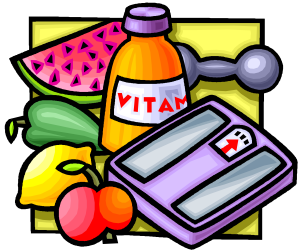
If Allergic to:	Risk of Reaction to at Least One:	Risk:
<b>A legume*</b> peanut	<b>Other legumes</b> peas  lentils  beans	5%
<b>A tree nut</b> walnut	<b>Other tree nuts</b> brazil  cashew  hazelnut	37%
<b>A fish*</b> salmon	<b>Other fish</b> swordfish  sole	50%
<b>A shellfish</b> shrimp	<b>Other shellfish</b> crab  lobster	75%
<b>A grain*</b> wheat	<b>Other grains</b> barley  rye	20%
<b>Cow's milk*</b> 	<b>Beef</b> hamburger	10%
<b>Cow's milk*</b> 	<b>Goat's milk</b> goat	92%
<b>Cow's milk*</b> 	<b>Mare's milk</b> horse	4%
<b>Pollen</b> birch  ragweed	<b>Fruits/vegetables</b> apple  peach  honeydew	55%
<b>Peach*</b> 	<b>Other Rosaceae</b> apple  plum  pear  cherry	55%
<b>Melon*</b> cantaloupe	<b>Other fruits</b> watermelon  banana  avocado	92%
<b>Latex*</b> latex glove	<b>Fruits</b> kiwi  banana  avocado	35%
<b>Fruits</b> kiwi  avocado  banana	<b>Latex</b> latex glove	11%

# Overview

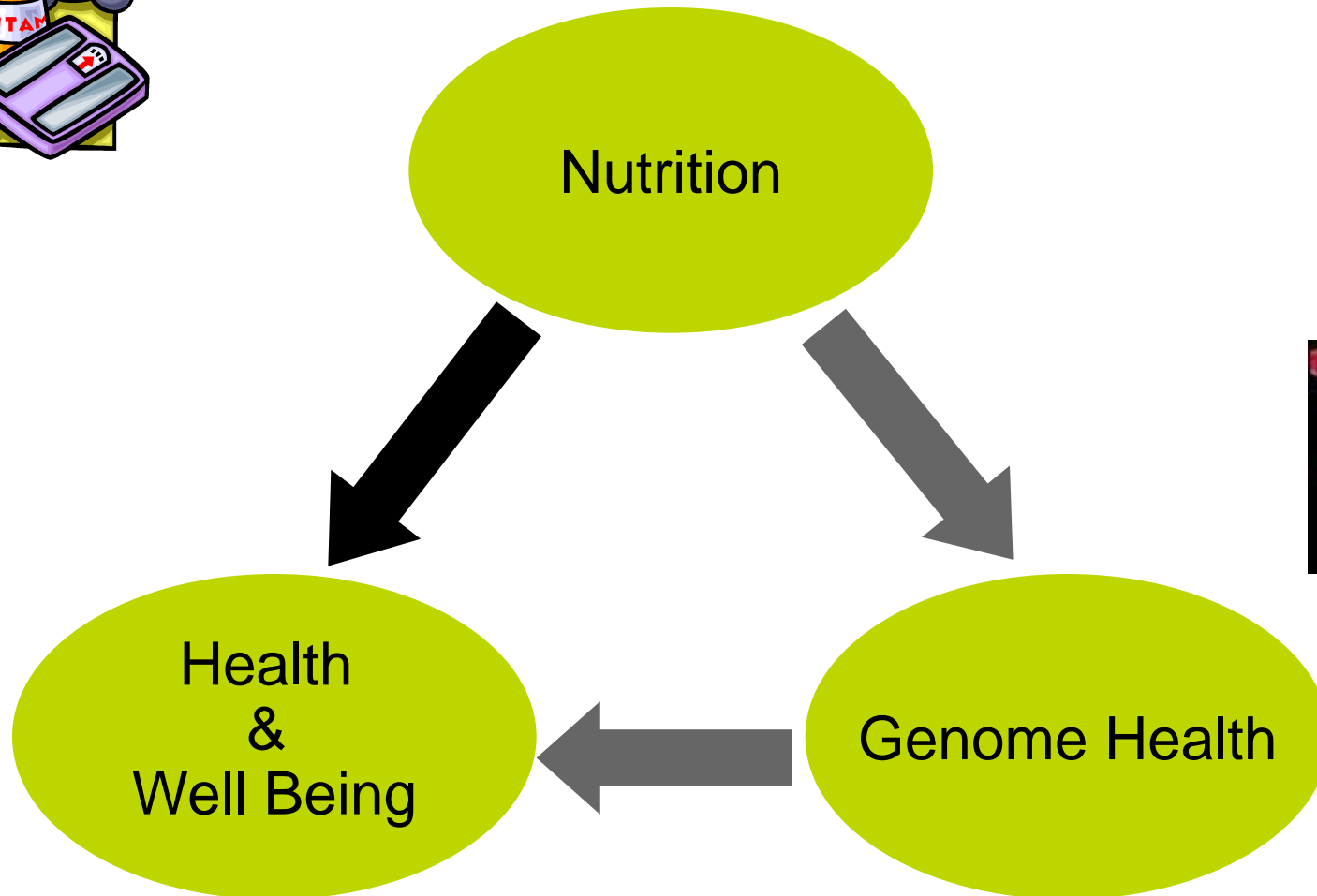
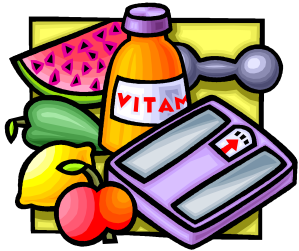
- Nutrigenomics
  - Chromosome health
  - Evidence for nutrition affecting DNA
  - Functional genomics approach
- Tailoring nutrition to improve health



# Nutrition, health and DNA



# Nutrition, health and DNA



# Nutrition and Health

## Food for health

### Dietary Guidelines for Children and Adolescents

Encourage and support breastfeeding

#### Children and adolescents need sufficient nutritious foods to grow and develop normally

- Growth should be checked regularly for young children
- Physical activity is important for all children and adolescents

#### Enjoy a wide variety of nutritious foods

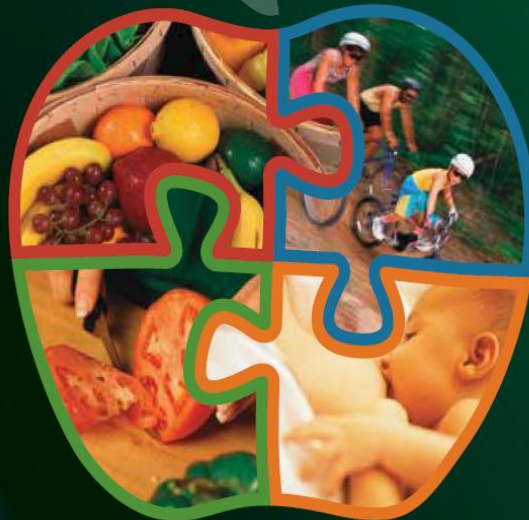
Children and adolescents should be encouraged to:

- Eat plenty of vegetables, legumes and fruits
- Eat plenty of cereals (including breads, rice, pasta and noodles), preferably wholegrain
- Include lean meat, fish, poultry and/or alternatives
- Include milks, yoghurts, cheeses and/or alternatives. Reduced-fat milks are not suitable for young children under 2 years, because of their high energy needs, but reduced-fat varieties should be encouraged for older children and adolescents
- Choose water as a drink

and care should be taken to:

- Limit saturated fat and moderate total fat intake
- Low-fat diets are not suitable for infants
- Choose foods low in salt
- Consume only moderate amounts of sugars and foods containing added sugars

Care for your child's food: prepare and store it safely



Australian Government  
Department of Health and Ageing  
National Health and Medical Research Council

Materials including a booklet and brochure for the general public and nutrition educators are available by contacting the Population Health Publications Officer, Australian Government Department of Health and Ageing, on toll free 1800 020 103 extension 8654 or email [phd.publications@health.gov.au](mailto:phd.publications@health.gov.au)

### Dietary Guidelines for Australian Adults

#### Enjoy a wide variety of nutritious foods

- Eat plenty of vegetables, legumes and fruits
- Eat plenty of cereals (including breads, rice, pasta and noodles), preferably wholegrain
- Include lean meat, fish, poultry and/or alternatives
- Include milks, yoghurts, cheeses and/or alternatives. Reduced-fat varieties should be chosen, where possible
- Drink plenty of water

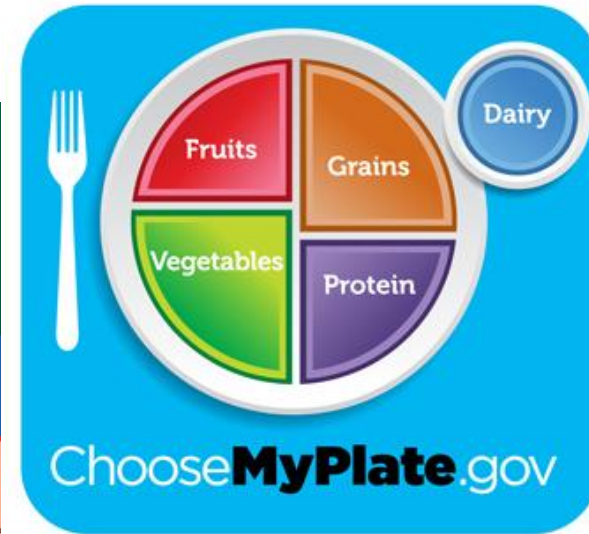
and take care to:

- Limit saturated fat and moderate total fat intake
- Choose foods low in salt
- Limit your alcohol intake if you choose to drink
- Consume only moderate amounts of sugars and foods containing added sugars

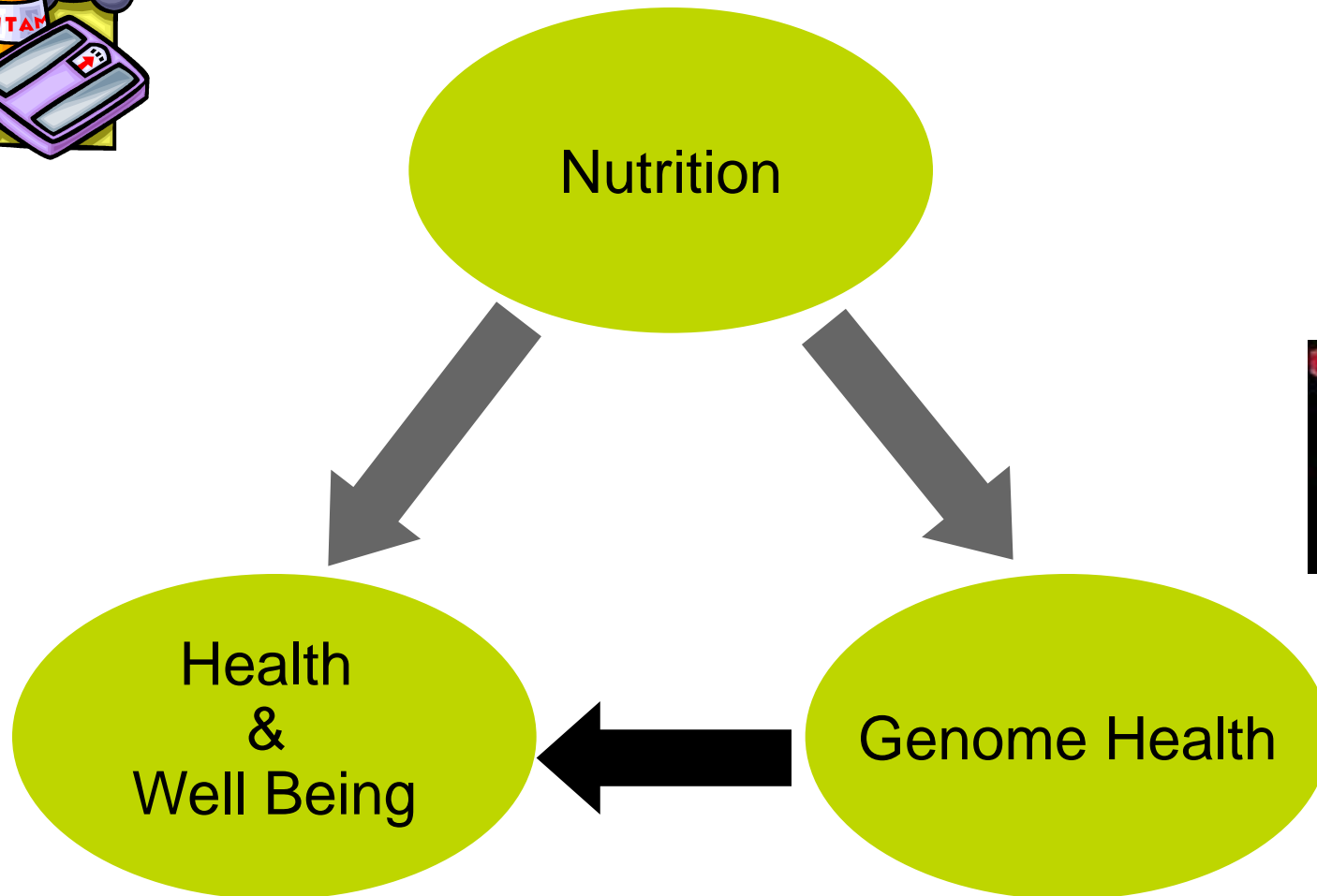
Prevent weight gain: be physically active and eat according to your energy needs

Care for your food: prepare and store it safely

Encourage and support breastfeeding



# Nutrition, health and DNA



# Nutrigenomics



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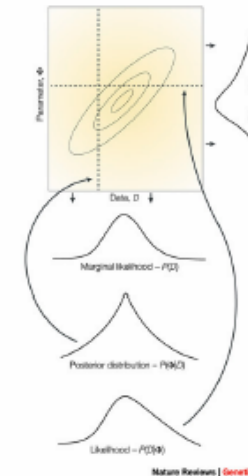
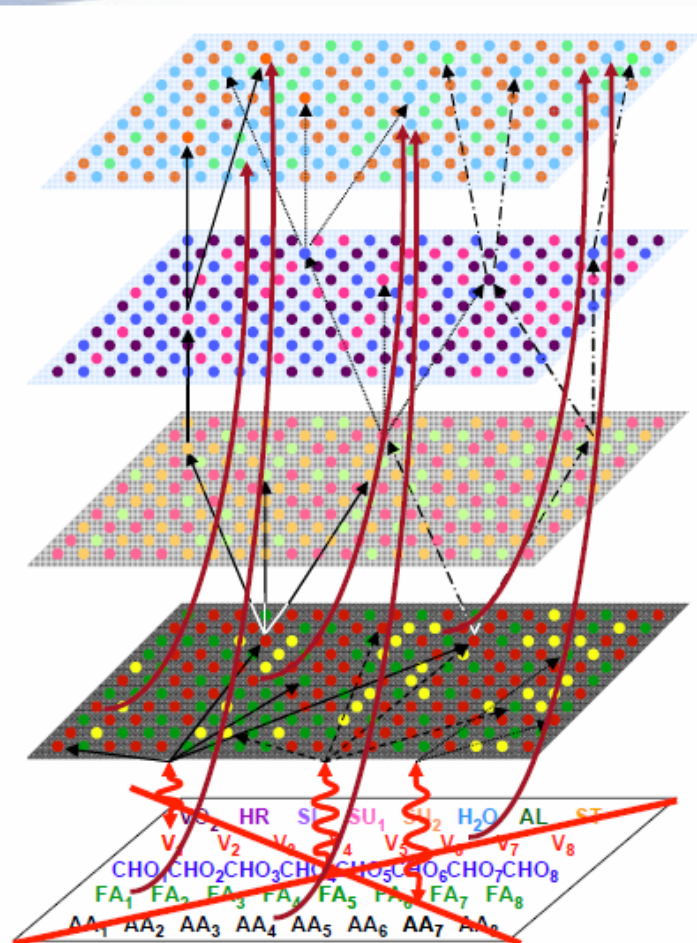
Clinical  
& Metabolomics

Proteomics

Transcriptomics

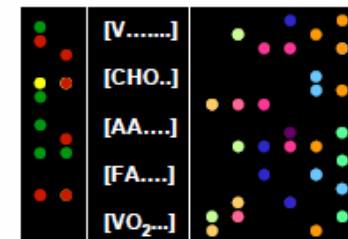
Genomics  
& Epigenomics

Diet & Lifestyle

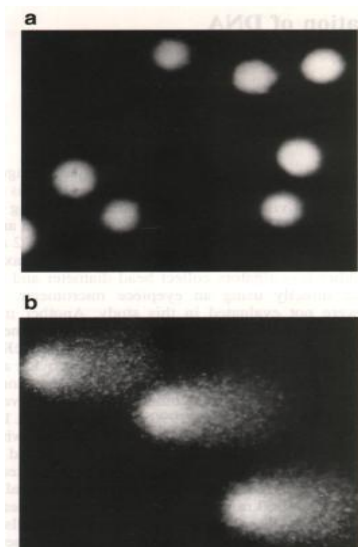
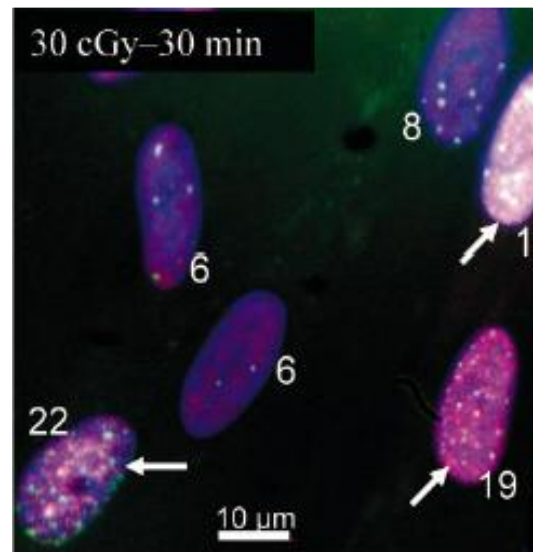
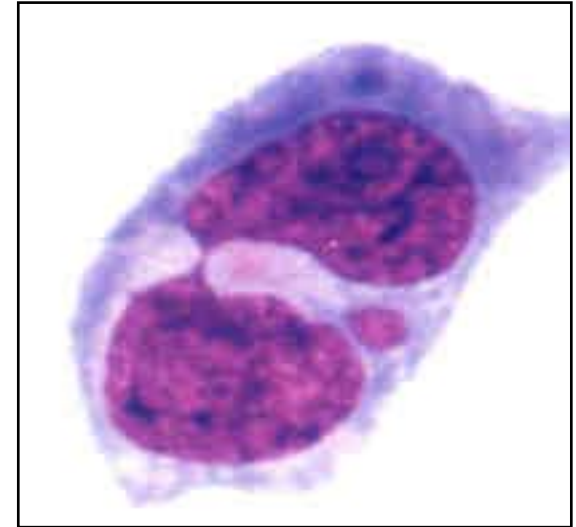
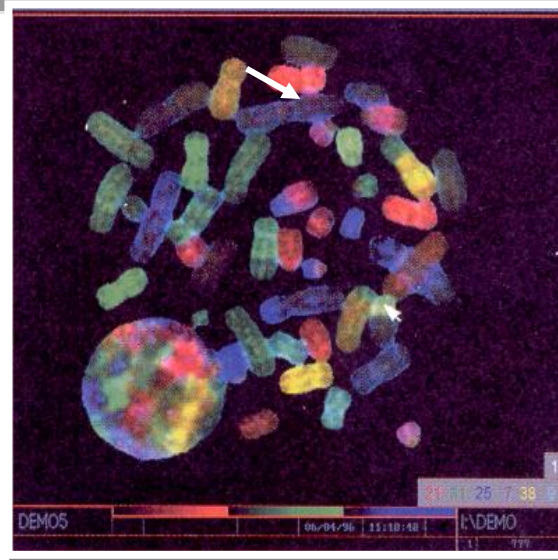
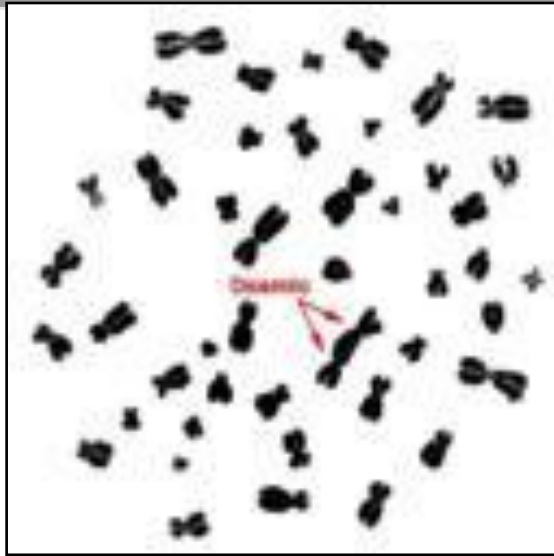


NRG 5:251 (2004)

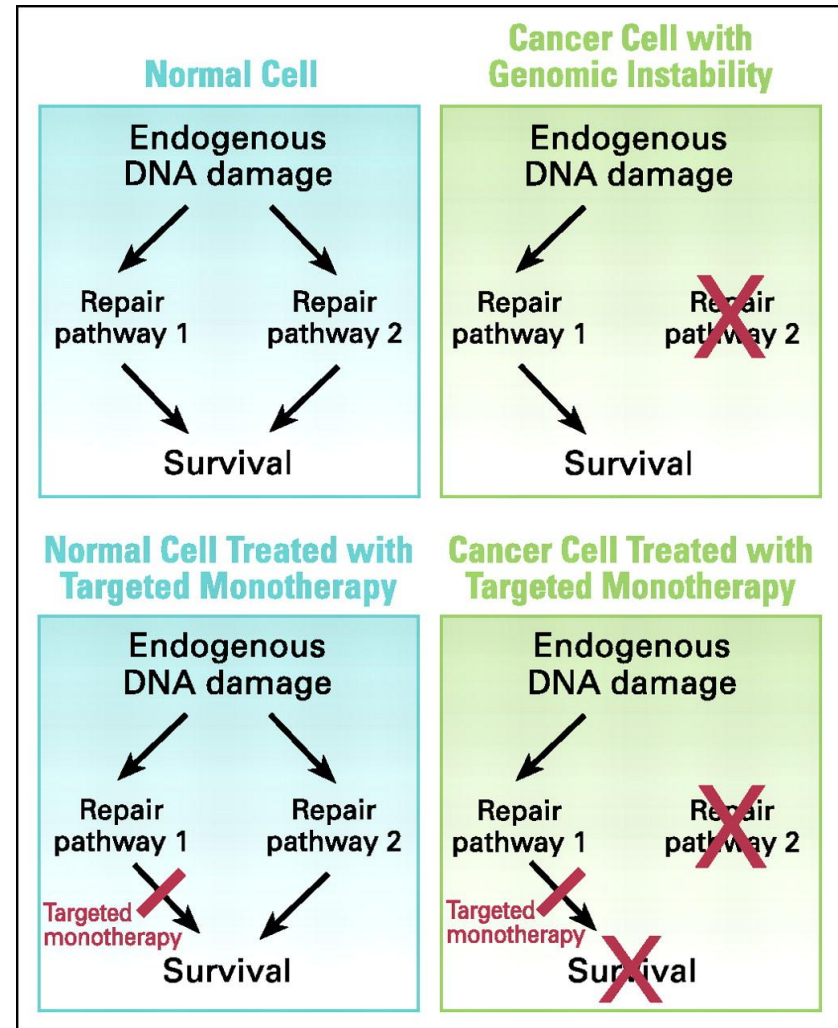
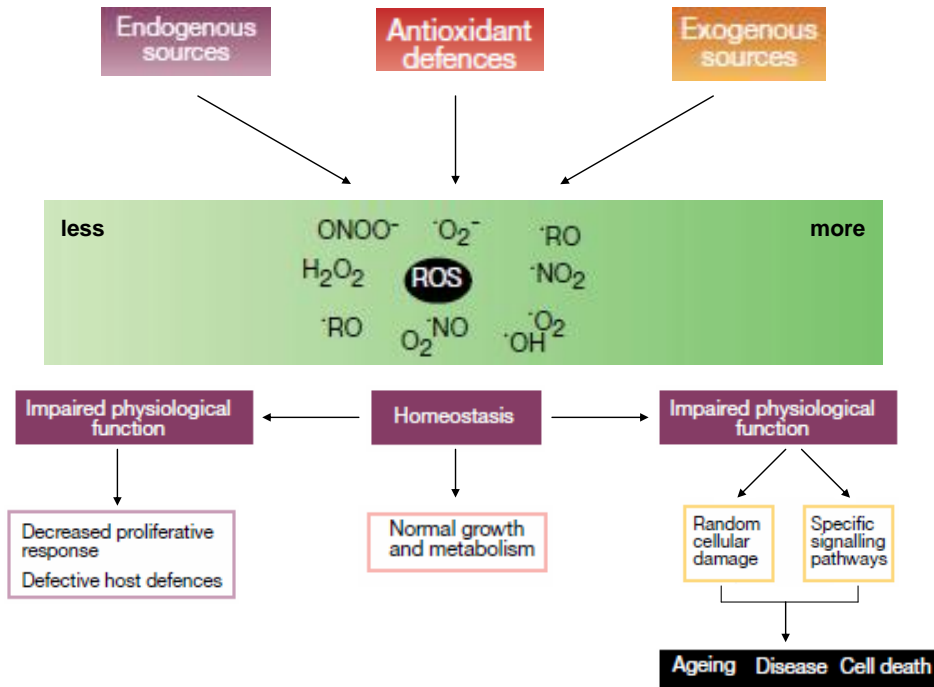
$$\int \Sigma(G \times E) \mid \text{Group}$$



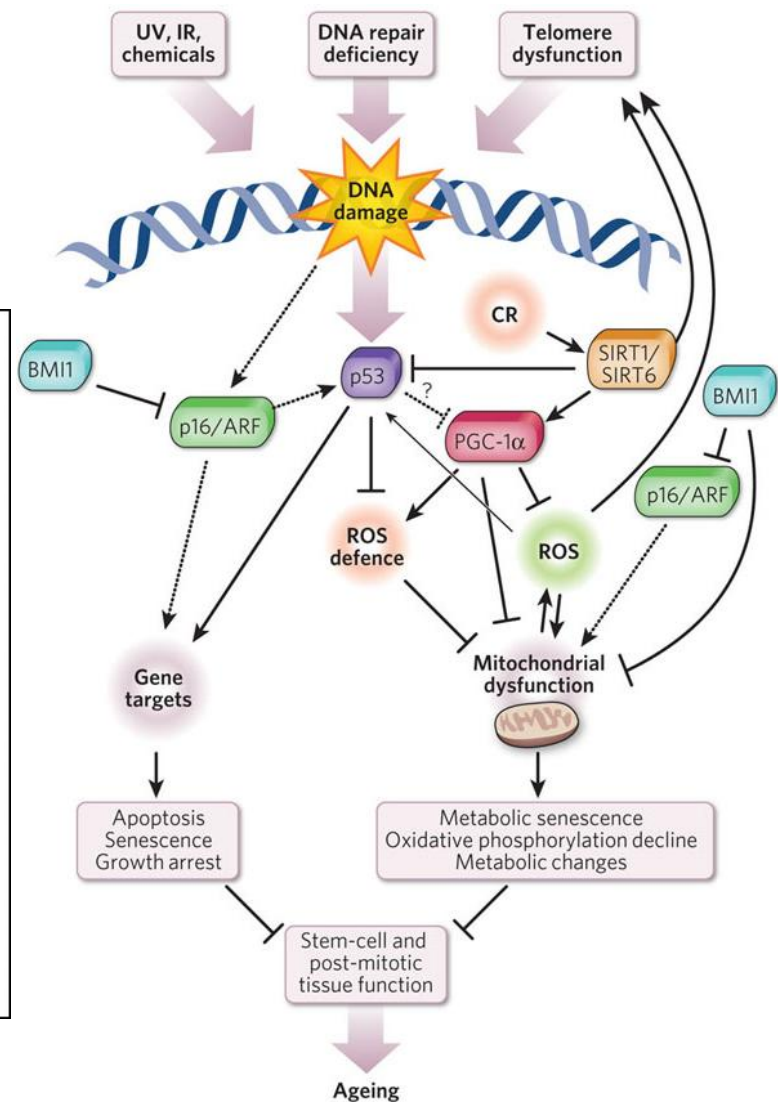
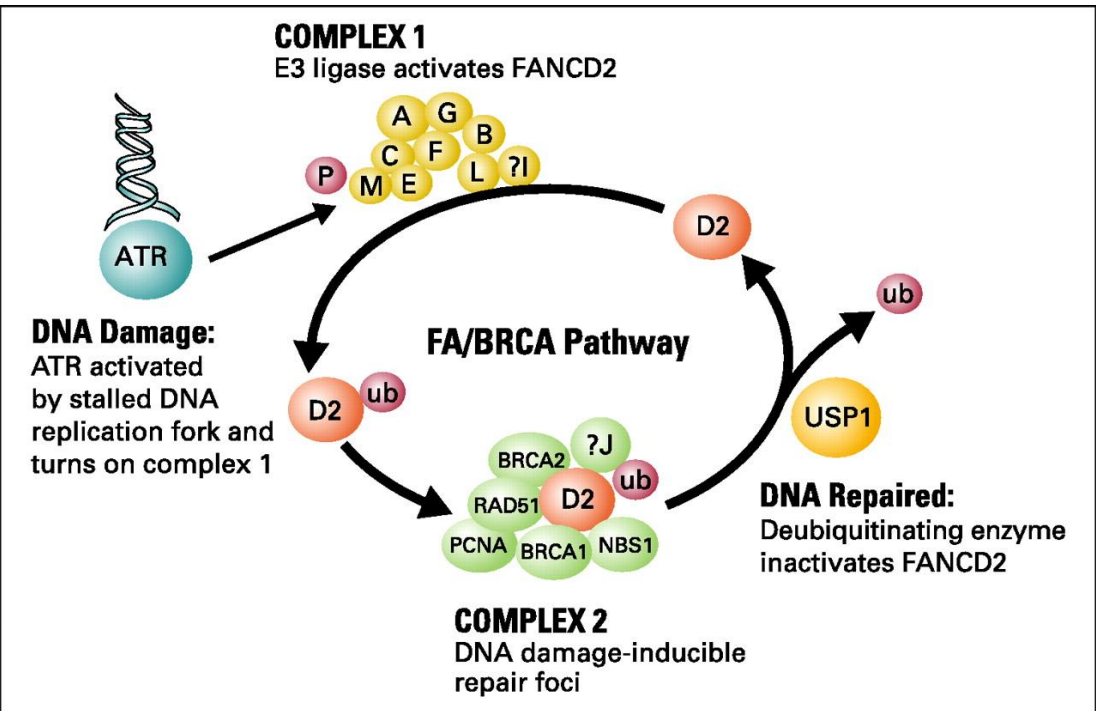
# How to measure DNA damage



# Sources of DNA damage

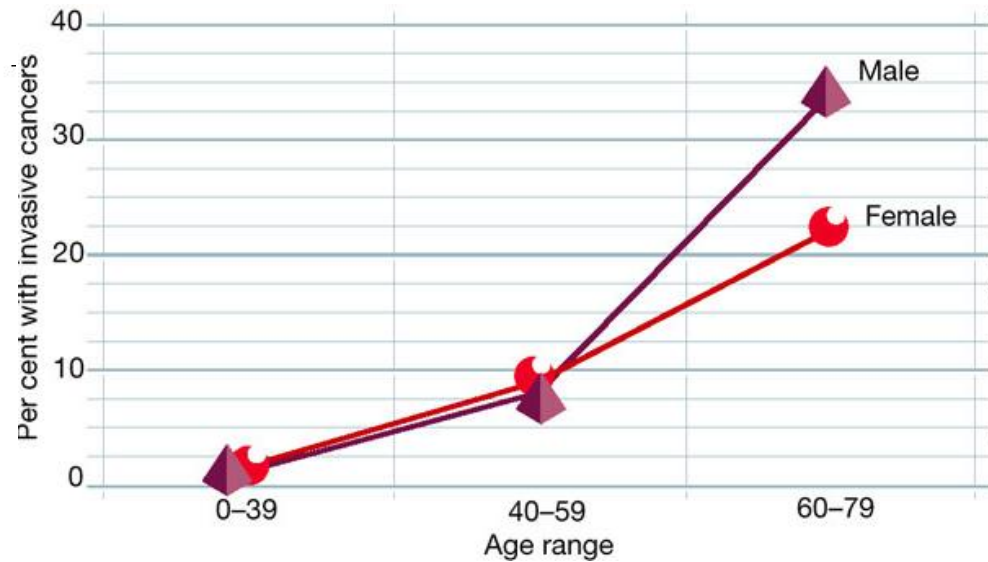
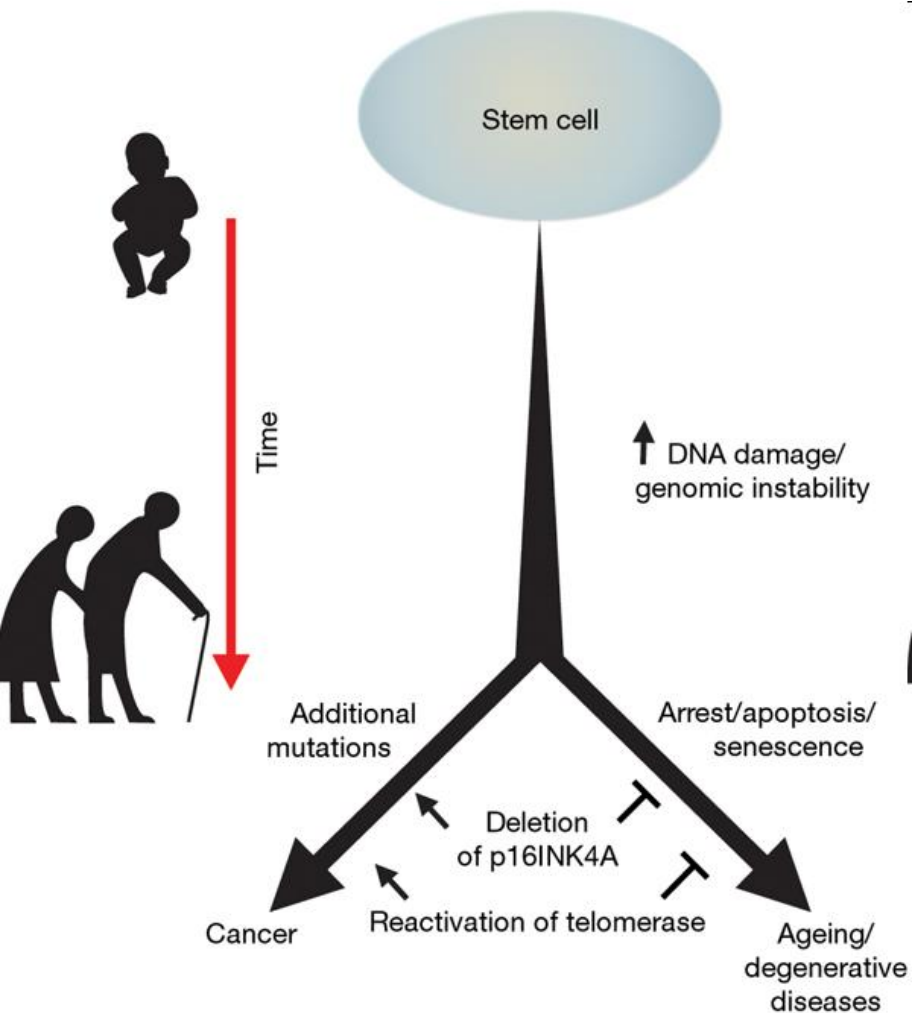


# DNA damage *should* be transient

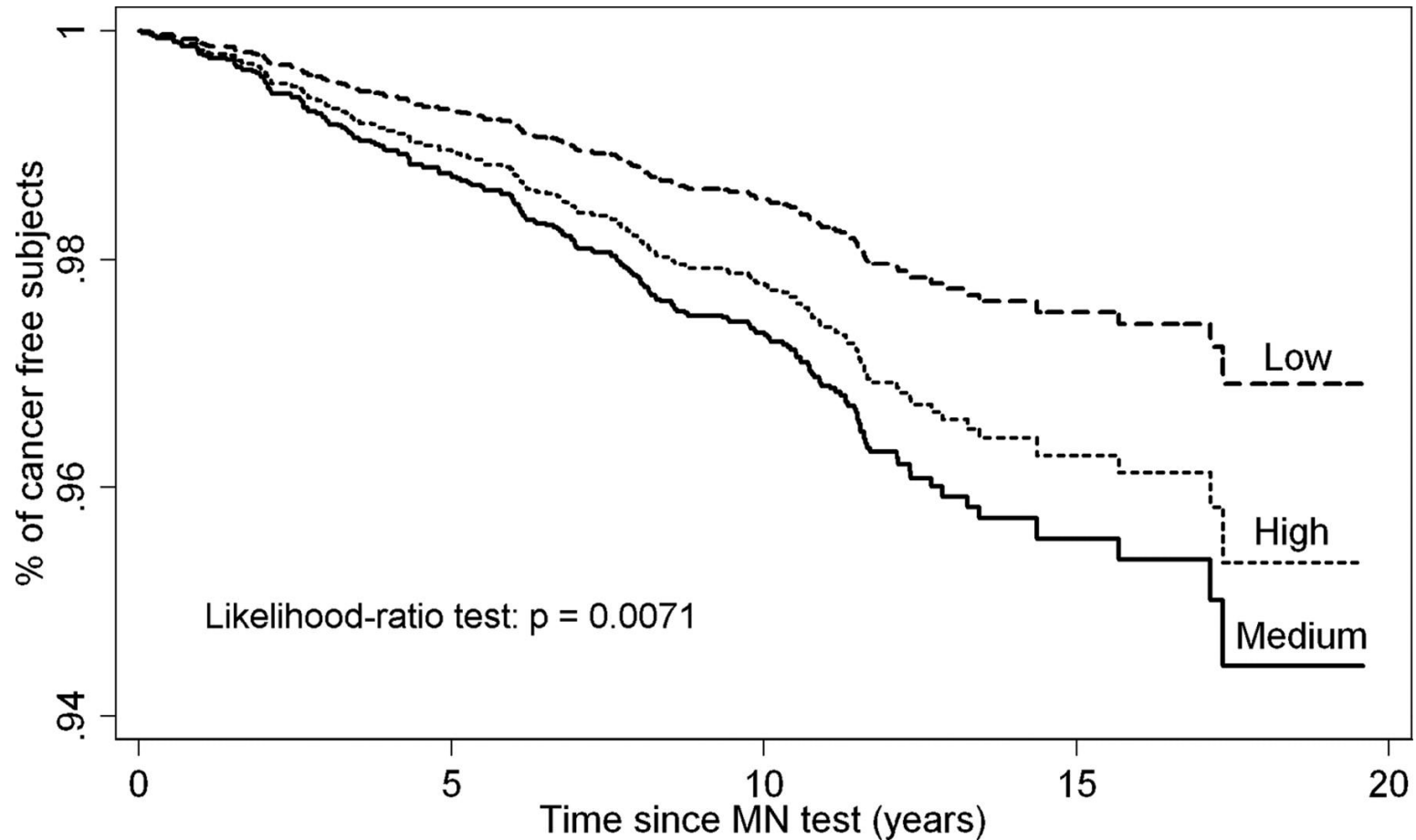


Kennedy R D , D'Andrea A D JCO 2006;24:3799-3808

# DNA, ageing and disease



# DNA damage index predicts cancer risk



Bonassi, S. et al. *Carcinogenesis* 2007 28:625-631; doi:10.1093/carcin/bgl177

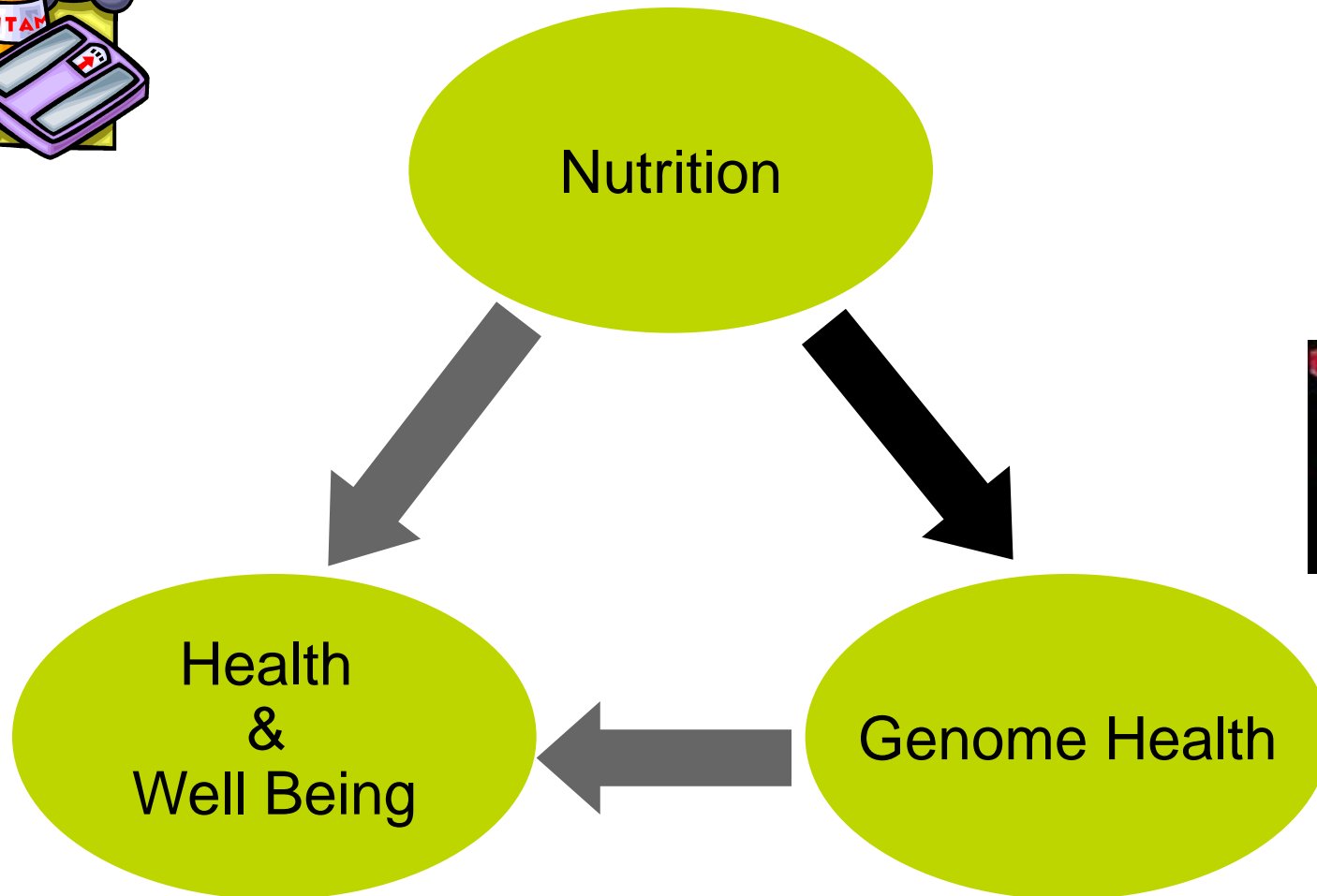
# Genome health is modified by life-style factors

## DNA damage accelerated by:

- Smoking
- Obesity and low physical activity
- Psychological stress
- Diet (inc. malnutrition)
- Environmental exposures
- Hours of sleep



# Nutrition, health and DNA



# Dietary impacts on DNA

**Increase DNA damage are associated with:**

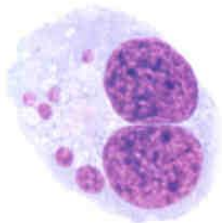
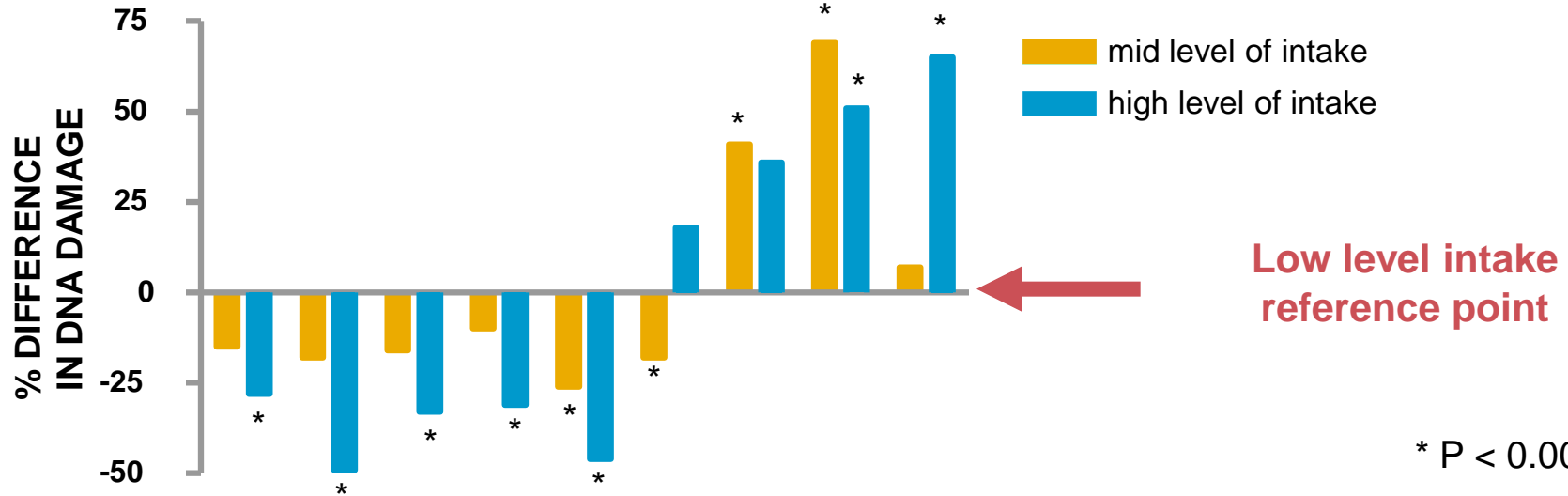
- Increased homocysteine
- low fruit & veg intake
- Increased alcohol intake
- Increased processed meat intake

**Genome health is positively associated with:**

- plasma folate
- Multi-vitamin use
- Vitamins E, D
- Fish intake
- Dietary fibre (cereals)
- Selenium



# Micronutrient intake is a determinant of DNA Damage

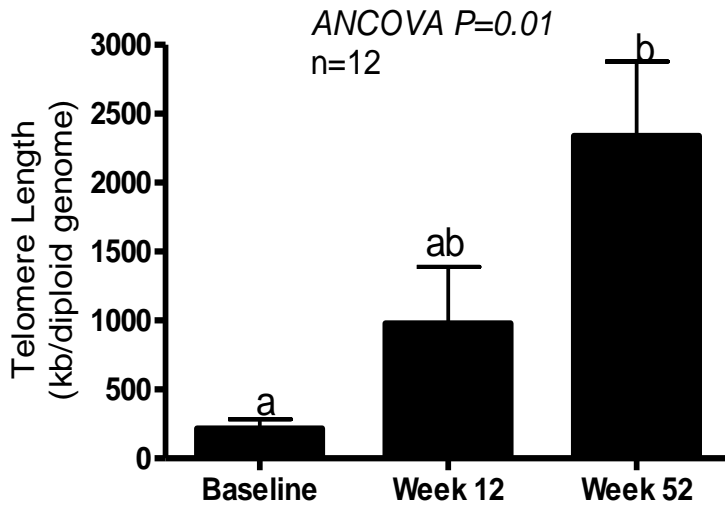


Vitamin E	Calcium	Folate	Retinol	Nicotinic acid	$\beta$ -Carotene	Riboflavin	Pantothenic acid	Biotin
More is better					More is worse			

# Nutrition and DNA damage

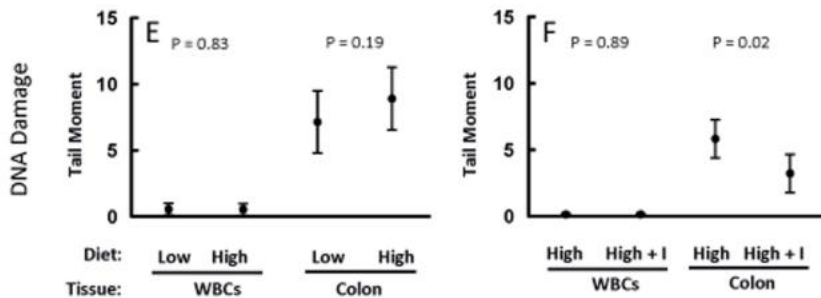
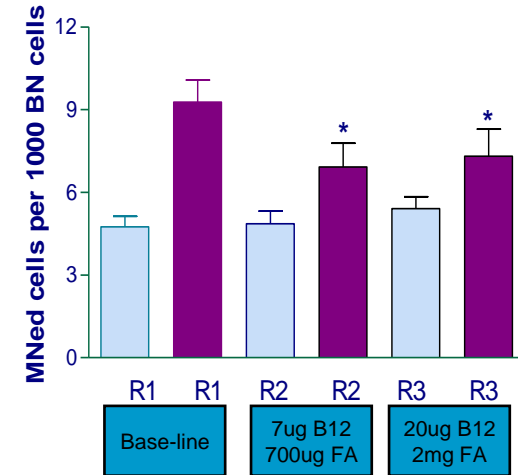
DNA oxidation prevention	Vit C, Cu, Zn, Vit E, polyphenols
DNA synthesis	folate, B12, Zn, Mg
DNA repair	niacin, Zn, folate
Gene expression	folate, Vit D, Vit A
Chromosome segregation	folate, Vit A, Mg
Telomere length	niacin? via PARP, folate
Necrosis/Apoptosis	niacin, Zn, Vit E, Vit D, Vit C Vit A, Vit K2.

# DNA Damage can be modified by diet



Low MNed cell freq. at R1. [N = 17] ANOVA P = 0.65

High MNed cell freq. at R1. [N = 16] ANOVA P < 0.0005



How long does this change last?

Does altering DNA damage profile modify disease risk?

# Nutrigenomics



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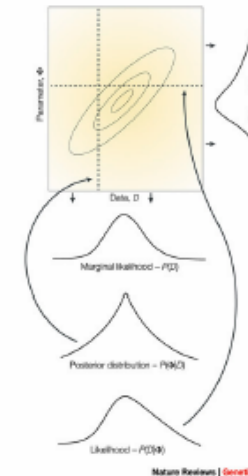
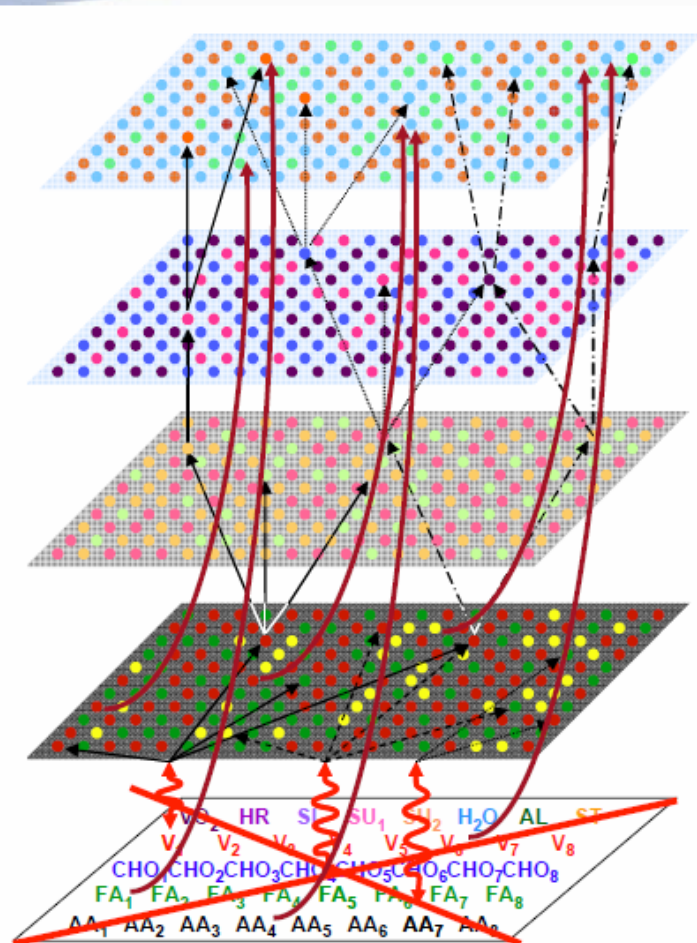
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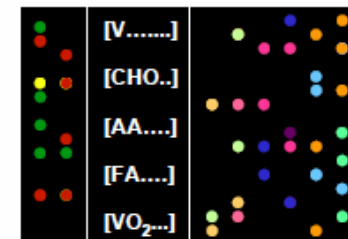
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$$\int \Sigma(G \times E) \mid \text{Group}$$



# Functional genomics approach

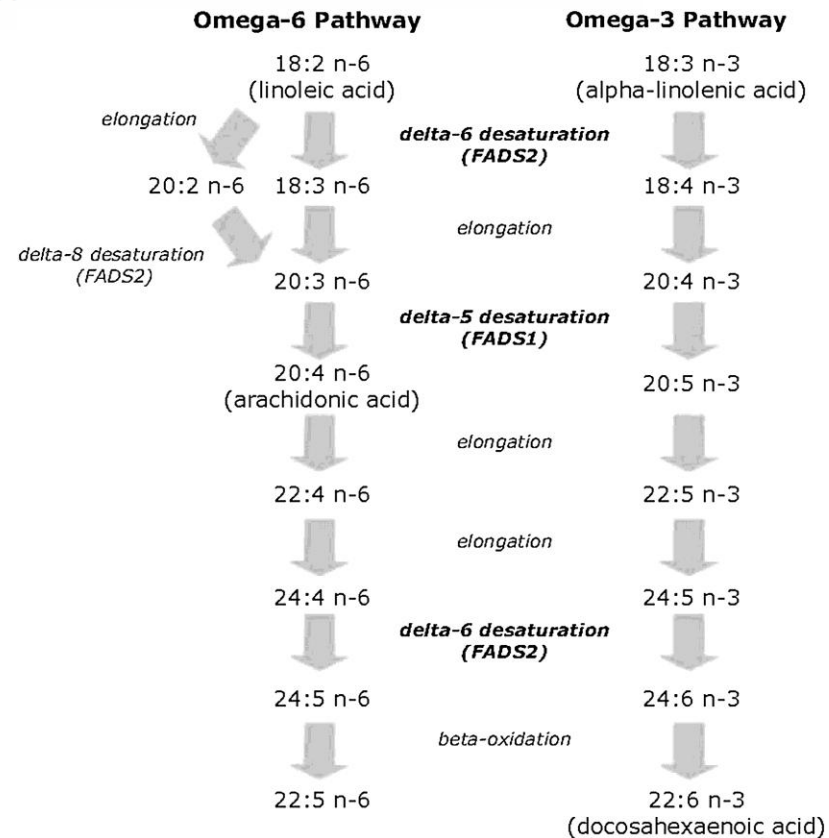
Genetic variants of the fatty acid desaturase gene cluster predict amounts of red blood cell docosahexaenoic and other polyunsaturated fatty acids in pregnant women: findings from the Avon Longitudinal Study of Parents and Children<sup>1-3</sup>

Berthold Koletzko, Eva Lattka, Sonja Zeilinger, Thomas Illig, and Colin Steer

PUFA content in blood and tissues known health benefit

Prevalence of these variants is 11-40%

Implications for DHA recommended during pregnancy and lactation





# Tailoring nutrition to fit your genes

- Utilise targeted –omic markers as tools to better understand an individual's response to food
  - systems biology approach and –omic technologies (alongside current best-practice clinical diagnostics) in a strategic, targeted way to define and measure health-related biomarkers in nutritional science.
- How are we doing this at CSIRO:
  - development and validation of scientific 'tool-kit' to measure health
  - identifying how nutrients, supplements or dietary patterns impact on these biomarkers of health in individuals
  - applying this science and technology into demonstrable improvements in health.
- We are striving to provide informed and robust dietary recommendations for optimal health of individuals in a resource limited environment.

Dr Nathan O'Callaghan  
Research Team Leader – Novel Biomarkers  
Pre-clinical and clinical substantiation  
Food and Nutritional Sciences, Adelaide

www.csiro.au

# Thank you

**Contact Us**

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Email: [enquiries@csiro.au](mailto:enquiries@csiro.au) Web: [www.csiro.au](http://www.csiro.au)



# Reference list

- Images are sited on slide they appear
- Others images:
  - Life be in it
  - Gearfuse.com
  - Futurama.com