



Tracing Health to It's Roots: Linking Early Child Development to Healthy Adulthood

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The Global Challenge

Nothing is more important to the success of Society than the future health and wellbeing of our children



Health



Society



Learning

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The environment during the 1st 2000 days of life establishes life long trajectories towards health or disease (e.g., obesity, metabolic disease cardiovascular disorders, anxiety/depression), learning capability and social functioning





What is the future burden of disease and loss of human potential resulting from a failure to investing in mothers, infants and children?



Health



Society



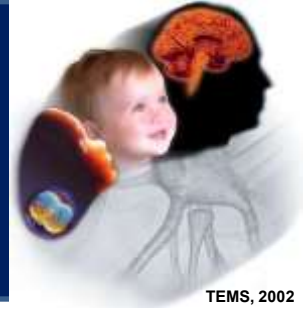
Learning



Challenges in the 21st Century

- Non-communicable disease burden increasing dramatically - United Nations summit (September 2011). Metabolic syndrome (coronary artery disease, stroke, hypertension, insulin resistance, diabetes, dyslipidemia), obesity, lung disease, cancer and mental health problems.
- By 2030, chronic diseases will cost the world \$47 trillion - [World Economic Forum](#). Question the sustainability of healthcare systems.
- A failure to maximize the learning capability of our children dooms societies to limit their potential economic development and an individual's personal economic growth.
- Optimal child development enhances societal functioning and contributes to the development of a pluralistic society.

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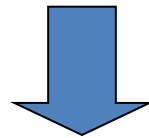
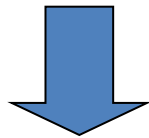
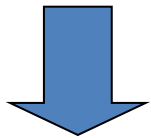


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Woman's Pre-pregnancy health

Pregnancy Environment

Environment In infancy / childhood



Health



Learning



Society

Developmental Trajectories and Human Development



Lennart Nilsson, M.D. 1990

The miracle of Human Development



**Environment
+ / -**

Development

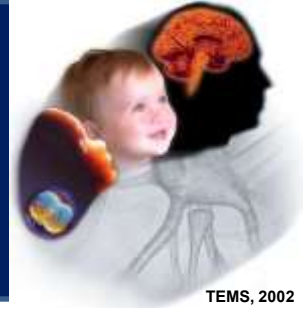
**Variations in
Genetic
Sequence**

**Adverse
Environment**

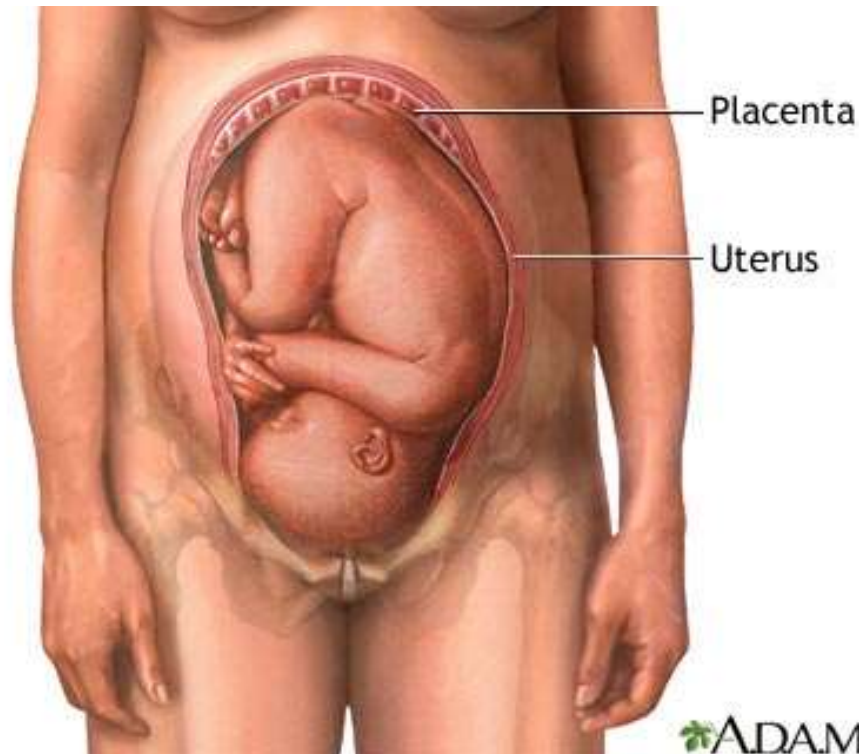
**Epigenetic
Modification**

Adult Disease

**CHD
Hypertension
Stroke
Insulin resistance
Diabetes
Dyslipidemia
Obesity
Neurologic
disorders
Mental illness
Cancer**



Maternal-Placental-Fetal Unit: The most intimate of relationships



Fetus develops according to a genetic blue print (DNA) but the read-out of the blue print (gene expression) is influenced by the environment.

Fetus totally relies on the maternal environment

The infants environment includes mother, parents and society



Maternal / Fetal Adversity



Maternal Stress
Socio economic status
Pre-Pregnancy / Maternal Health
Nutrition

Placental Insufficiency
Hormones/Drugs
Environmental toxins



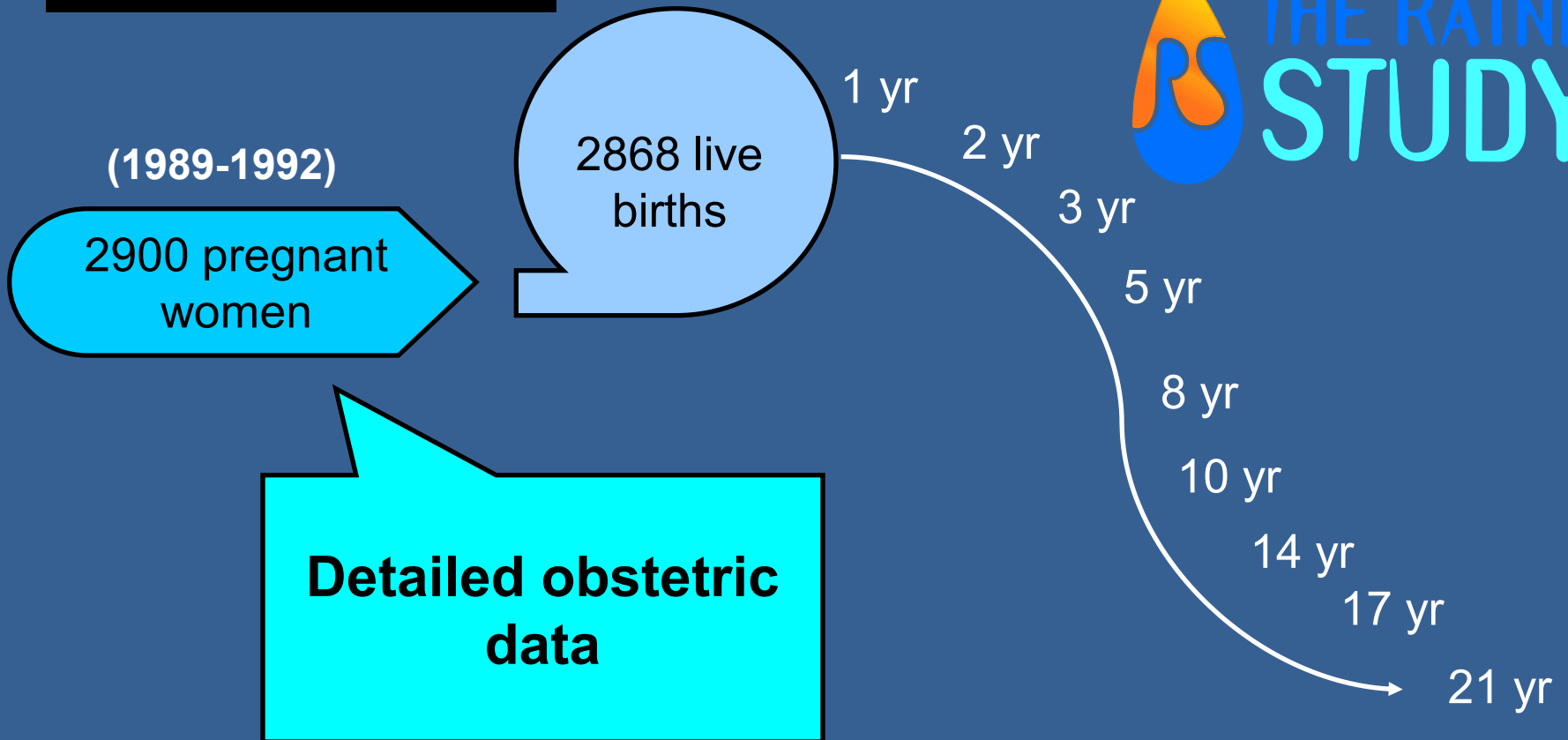
Stressors and Health

- Obesity
- Sarcopenia
- Fatty liver
- Hypertension
- Endothelial dysfunction
- Insulin resistance
- Leptin resistance
- Impaired thermogenesis
- Increased anxiety
- Hyperphagia
- Fat preference in diet
- Altered HPA
- Premature puberty
- Altered gene expression
- Altered epigenetic state



THE RAINE STUDY

The Western Australian Pregnancy Cohort 1989-2011



THE RAINE
STUDY

The Western Australian
Pregnancy Cohort
1989-2011

Stressful Life Events Study

To determine the impact of maternal stressful life events during pregnancy on offspring behavioural outcomes with differentiation between:

- The number of stressful events

- The type of stressful events

- The timing of stressful events

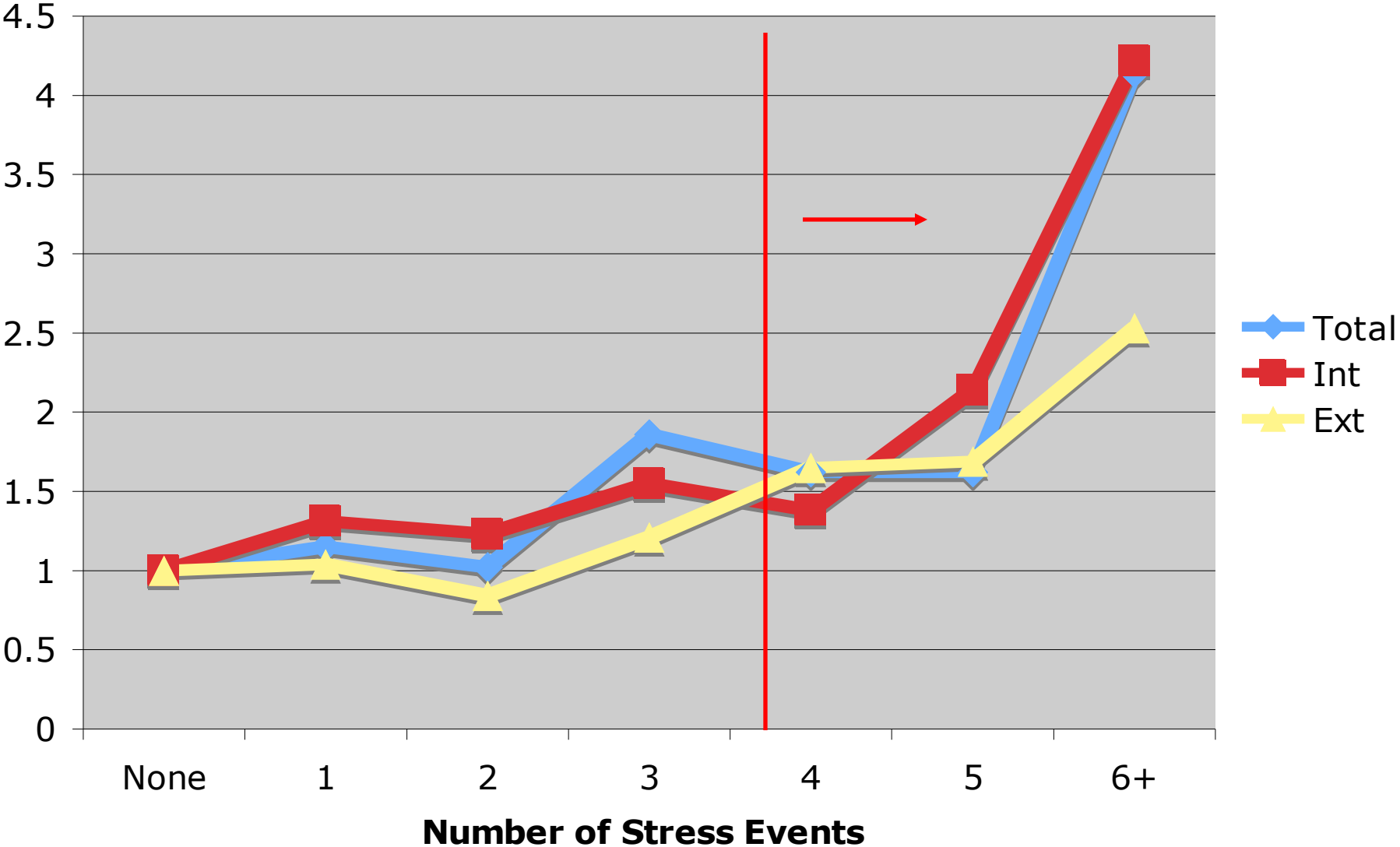
Monique Robinson PhD MPsych (Clinical)

THE RAINE STUDY

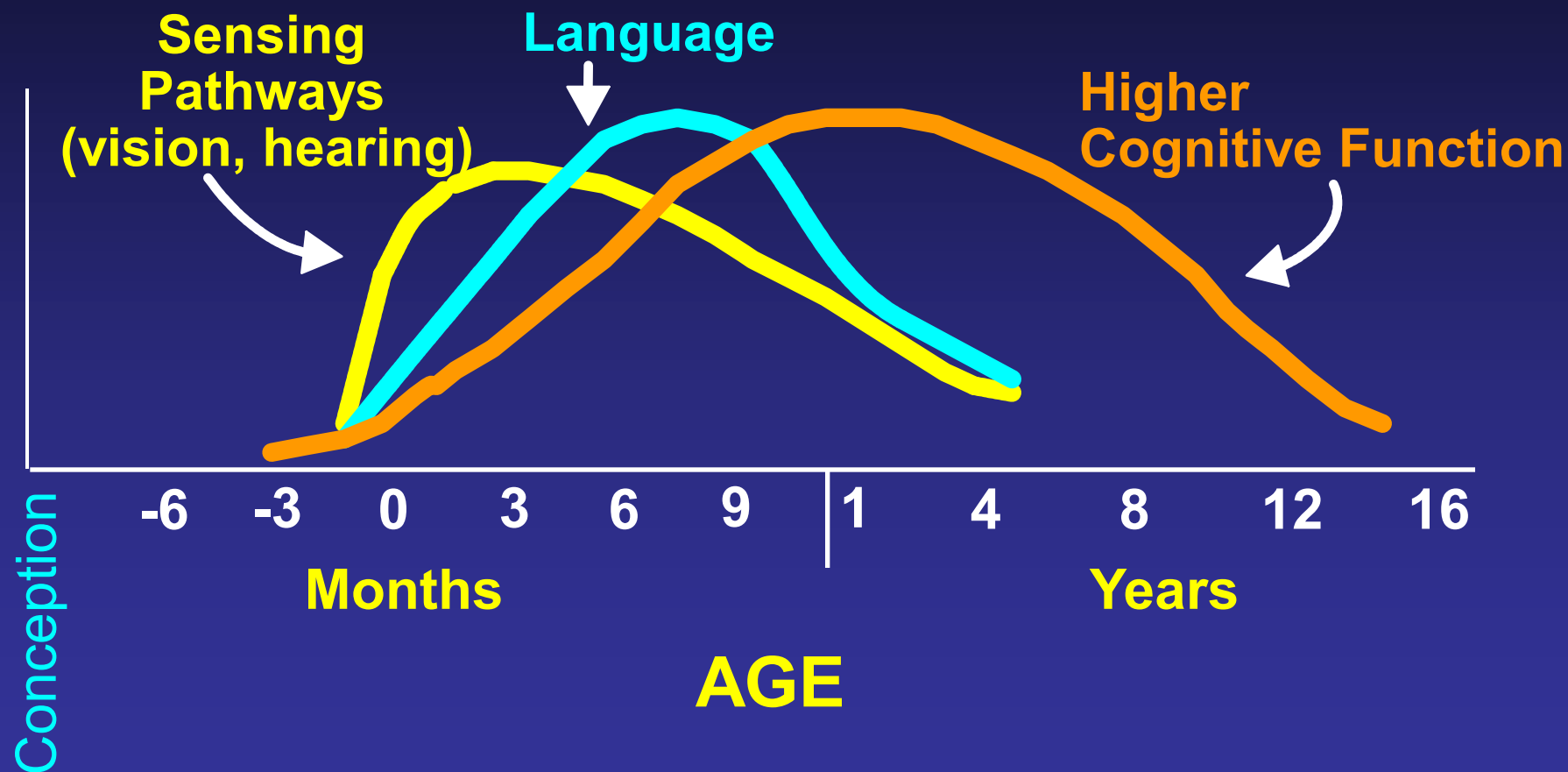


Maternal
stressful
events
during
pregnancy

Number of Stressful Events



Critical Periods of Development as Windows of Opportunity



Chuck Nelson

C. Nelson, in *From Neurons to Neighborhoods*, 2000.

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Early life is a period of high brain plasticity, where differences in cognitive, social and emotional development start to consolidate.

Experiences can affect many aspects of brain development, including the type (glia or neurons) and number of brain cells made, and the extent of branching and pruning.

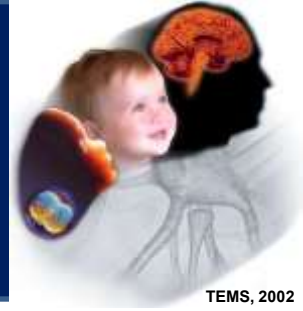
During critical periods, the neural circuits involved are sculpted and can be changed by experience.

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Nurturing Environments In Infancy





Mechanisms

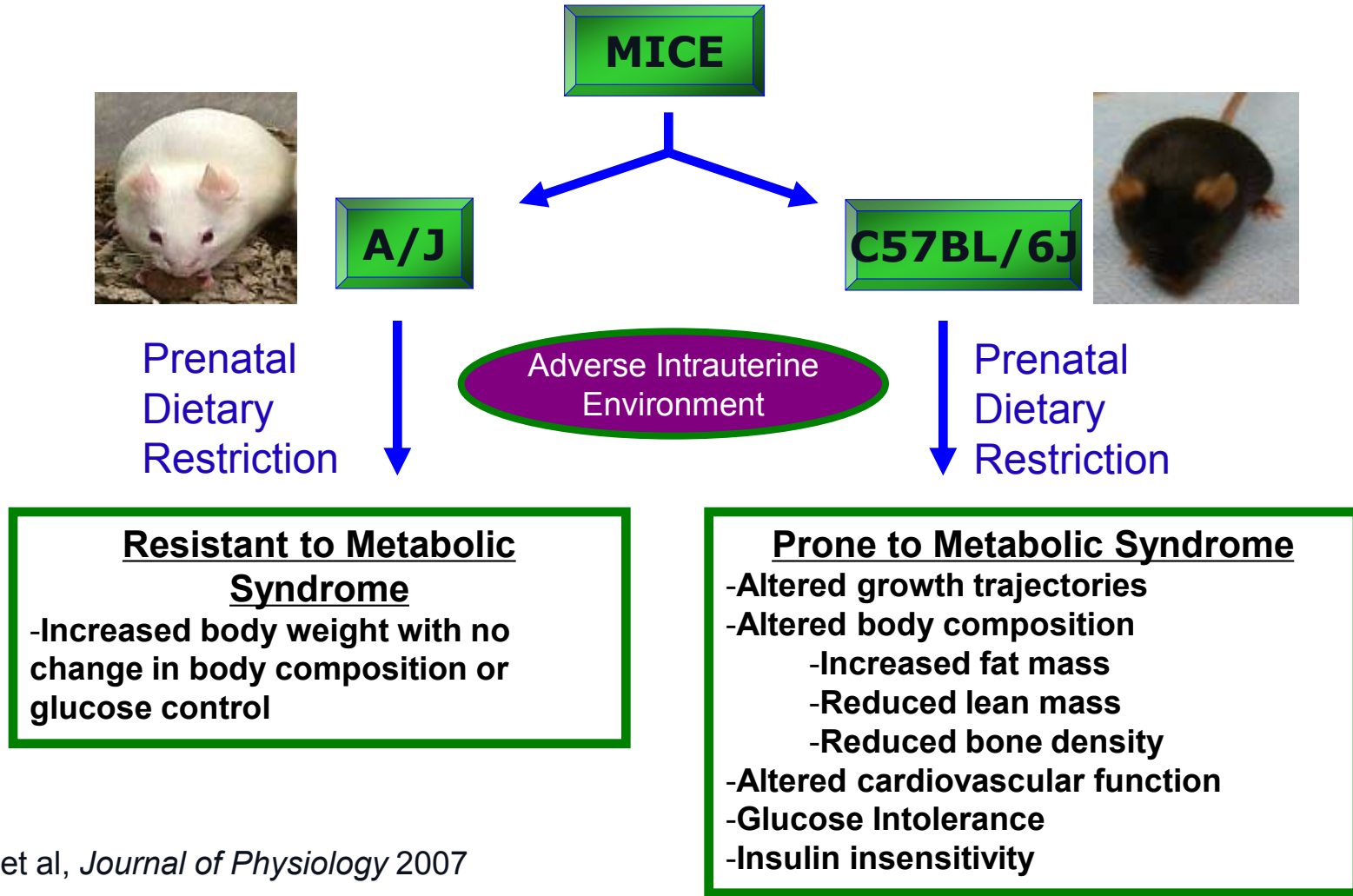
Early adversity sets developmental trajectories for health and behaviour across the life-time.

How?

a) Gene-Environment Interactions

b) Epigenetics

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Knight et al, *Journal of Physiology* 2007

Knight et al, *Journal of Physiology* 2008



Mechanisms

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How?

a) Gene-Environment Interactions

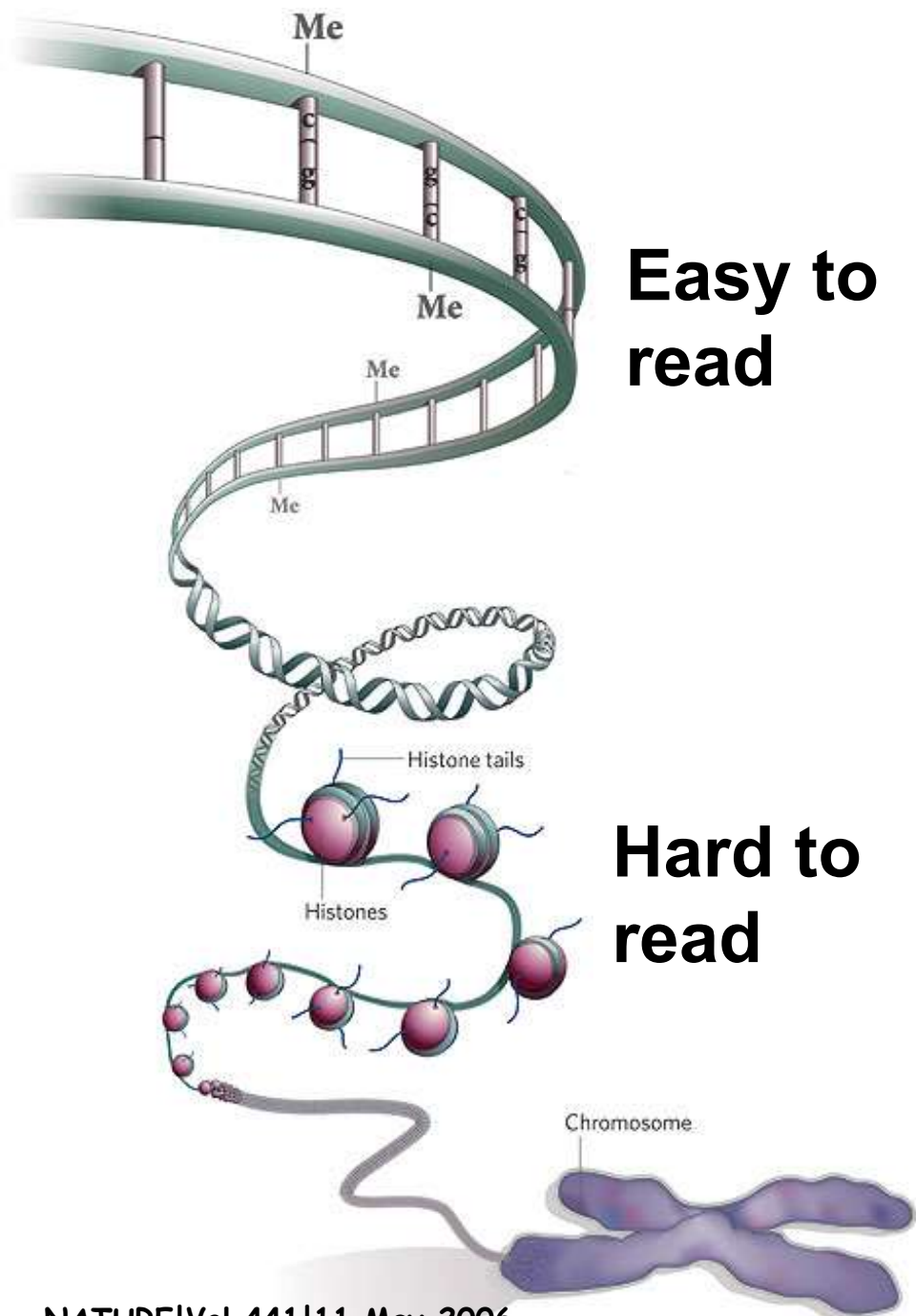
b) Epigenetics



Epigenetics



the study of those environmental factors that alter whether genes are “expressed” without altering the DNA sequence



Easy to read

Hard to read

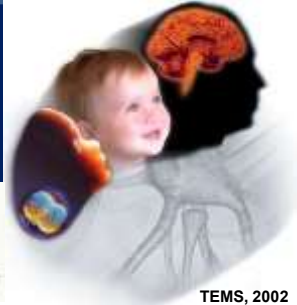
Epigenetic changes:

DNA methylation

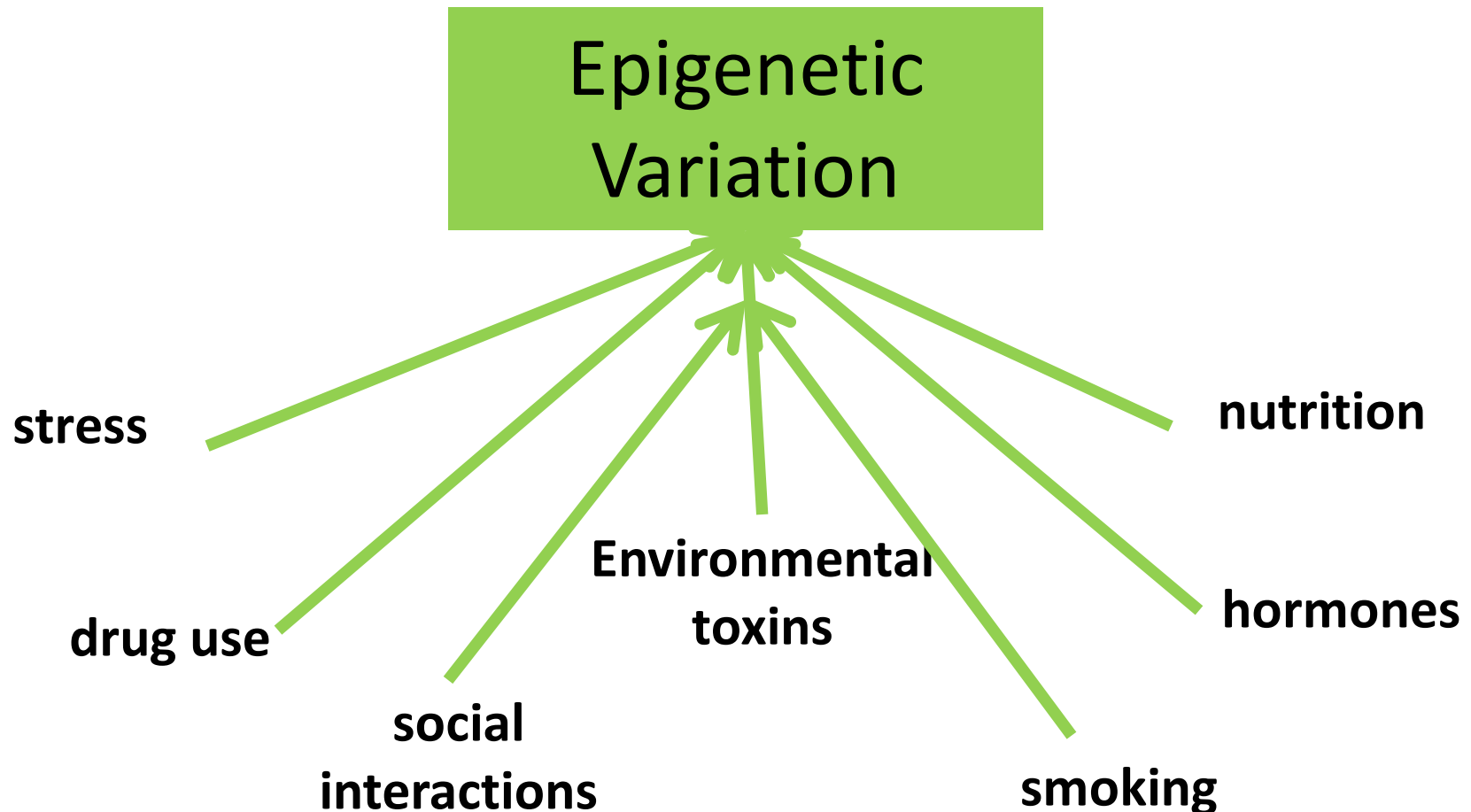
Histone modification

Early adversity makes some genes difficult to read (**switched off**) and some genes easier to read (**switched on**)

Many of the genes affected are those linked to chronic disease



What factors induce epigenetic changes?



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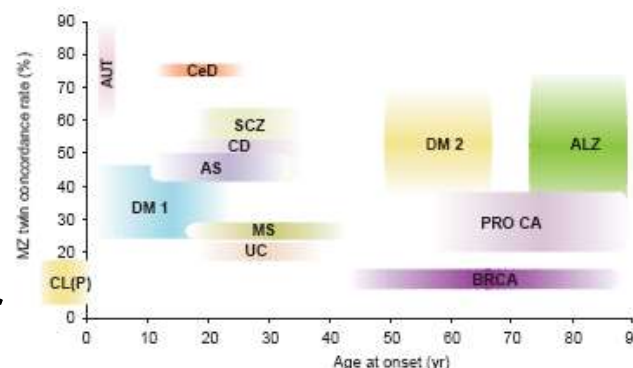
Impact of Epigenetics on Health and Disease

Nutrition and lifestyle of mother affects epigenome of child



Maternal care affects epigenome of offspring

Identical twins acquire discordant epigenomes during life-course



Dr. Michael Kobor



Social Interactions: Natural Variations in Maternal Care in the Rat: High and Low Lickers and Groomers. Differential Methylation (Epigenetic mark) of the Glucocorticoid Receptor in rats (and humans) impacting neuroendocrine stress pathway





Consequences?

- Early experiences (social context) affects the lifelong health of the infants via later stress reactivity
- The mom's behaviour is transferred to the pups in an epigenetic manner
- Changes in the epigenome are a cellular memory of an environmental event



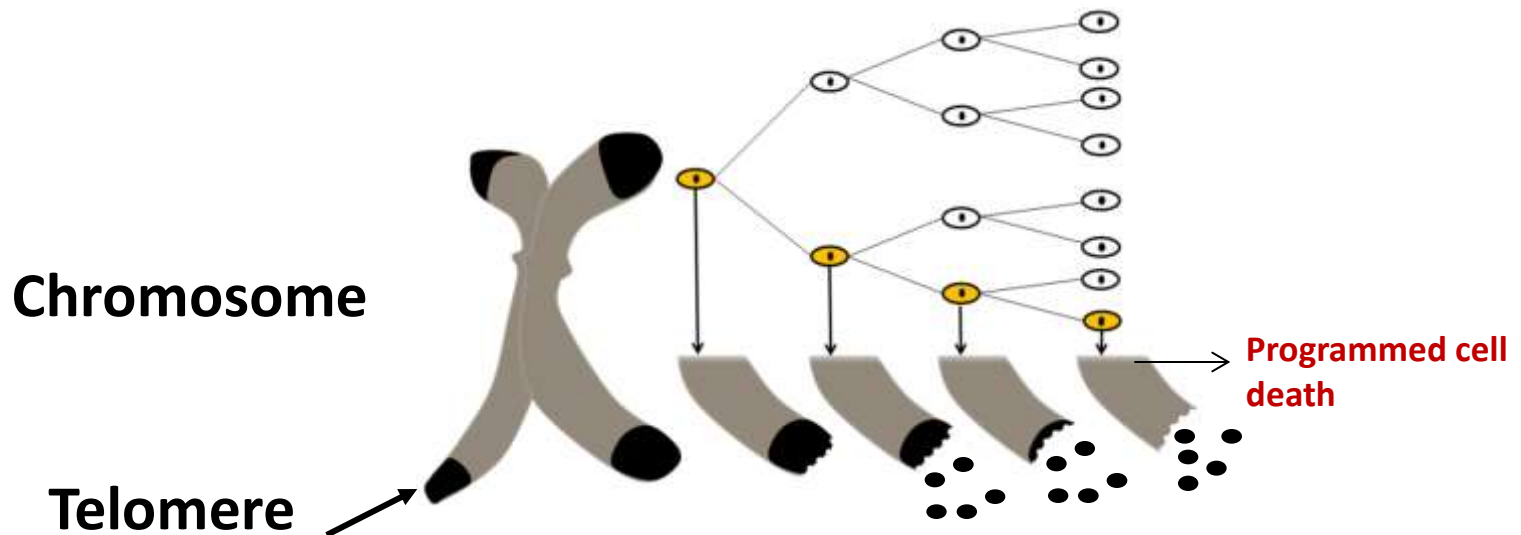
Opportunities for Interventions

1st 2000 days = time of plasticity



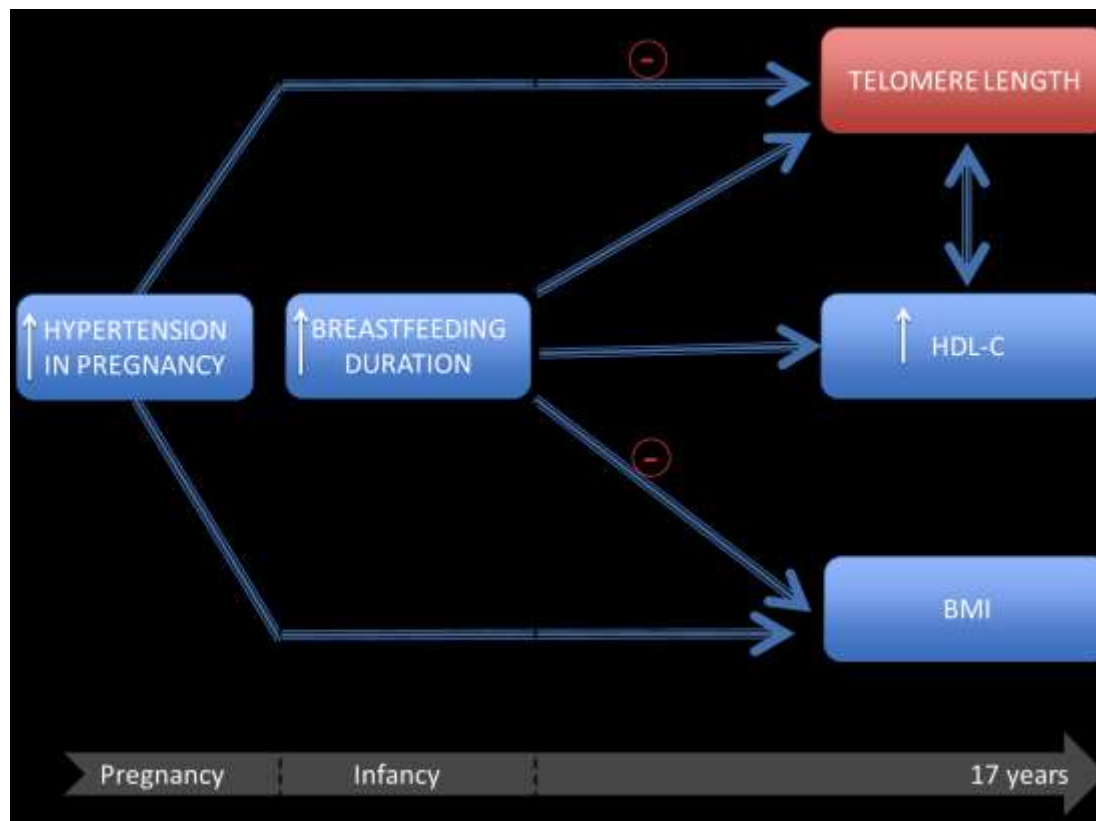
Early-Life Exposures and Telomere Length

- DNA-protein complexes that cap the ends of chromosomes, promote stability and prevent the degradation of chromosomes during cell division
- Stressors cause accelerated telomere shortening and cellular senescence in cells. Leukocyte telomere length (LTL) has emerged as a novel indicator of human aging





Early-Life Exposures and Telomere Length





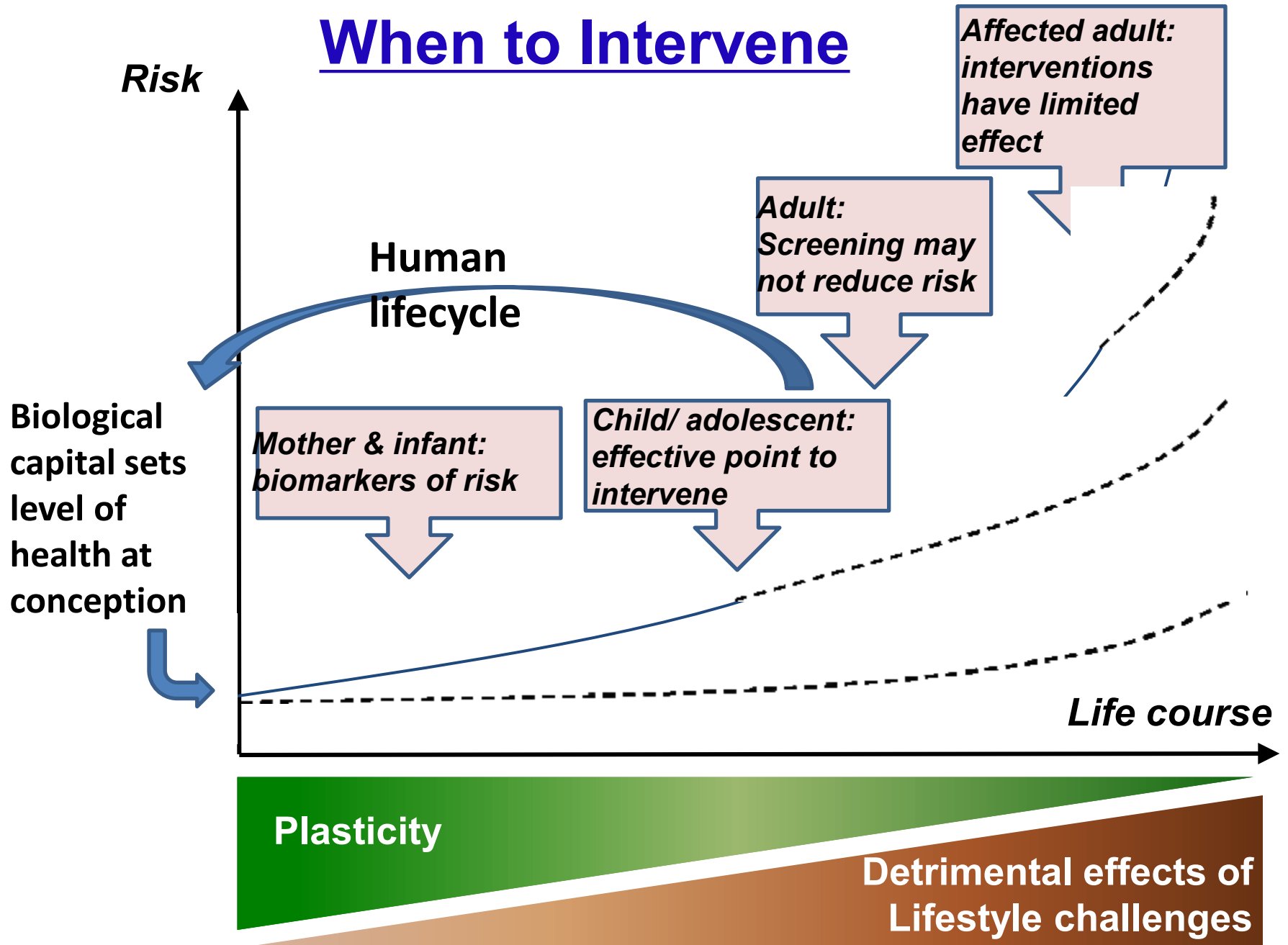
Interventions in Early Child Development

Intervene early

Intervene often

Intervene effectively

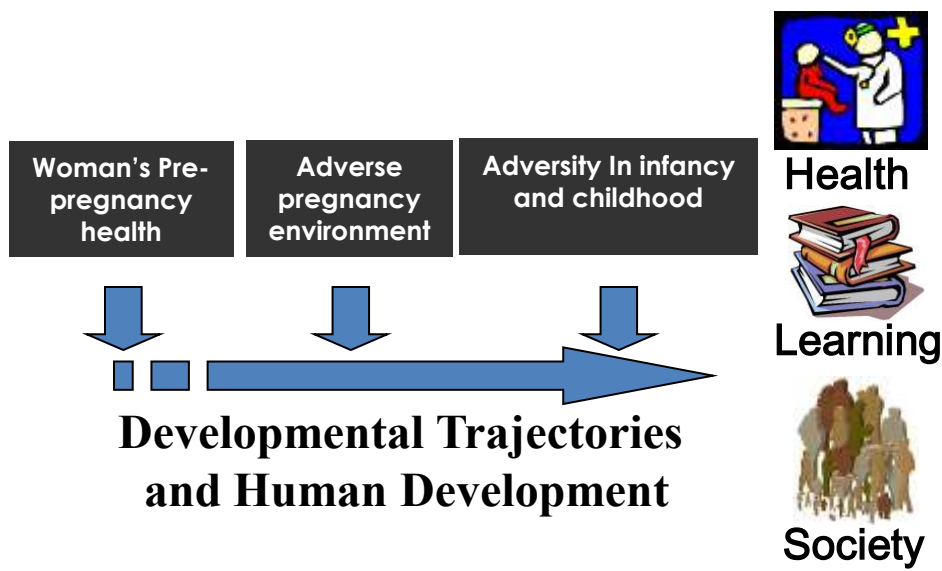
When to Intervene



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The entire environment of the fetus and infant can modify its development and establish trajectories that will impact its lifelong health, learning and social functioning

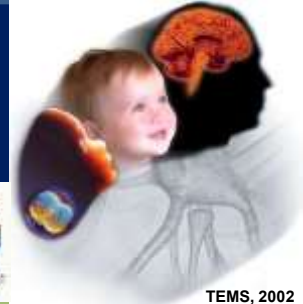
The environment interacts with and modulates the genetic blueprint that specifies development

Early interventions can optimize development and mitigate the detrimental effects of adversity (environmental and genetic)



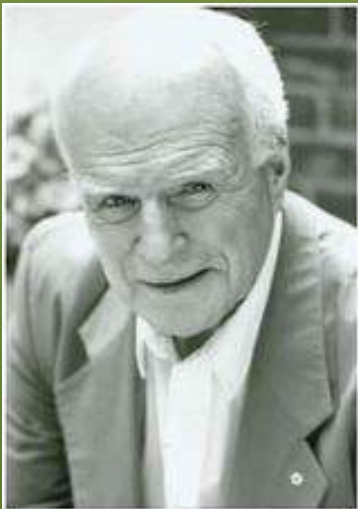
IHD: Optimal Development for Lifelong Health, Learning and Humanity

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Investing in the 1st 2000 days
- supporting all children,
everywhere
to reach their full potential



J. Fraser Mustard 1927-2011

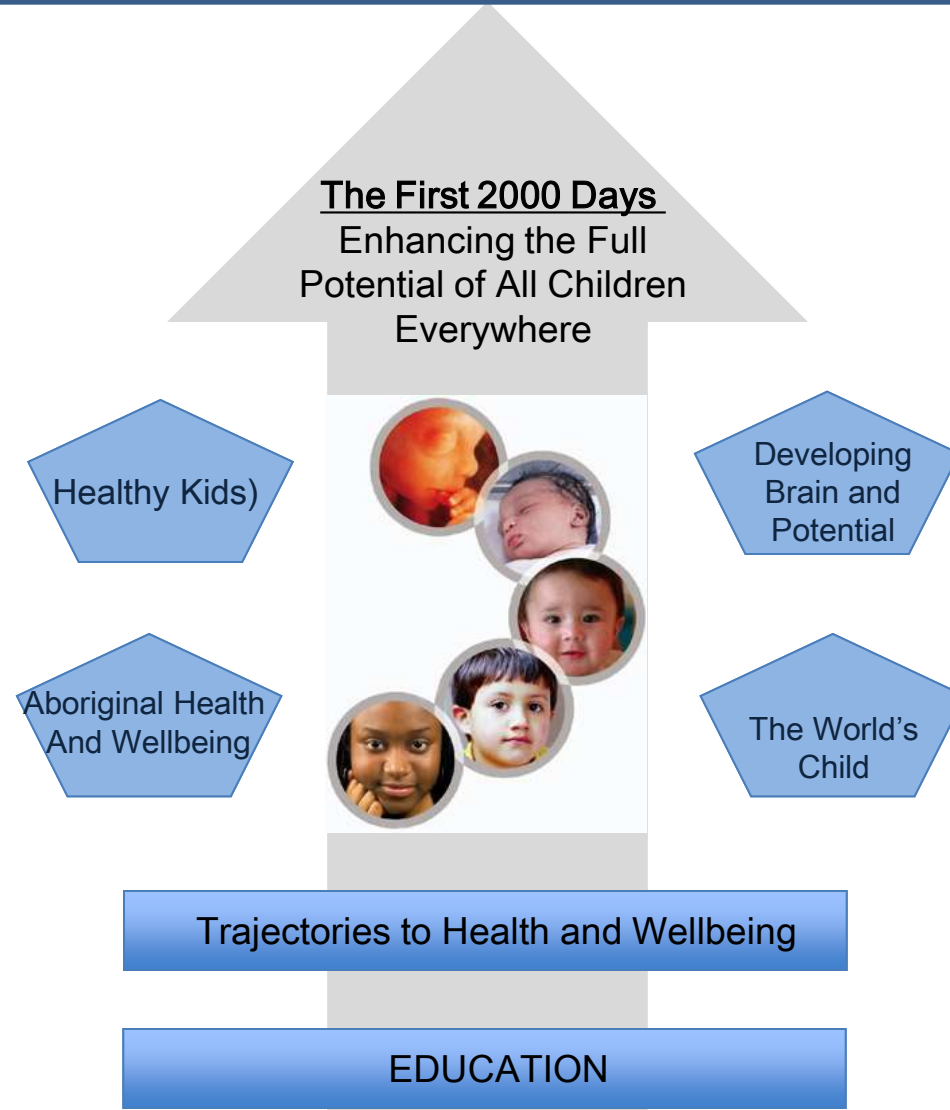
Thank you!



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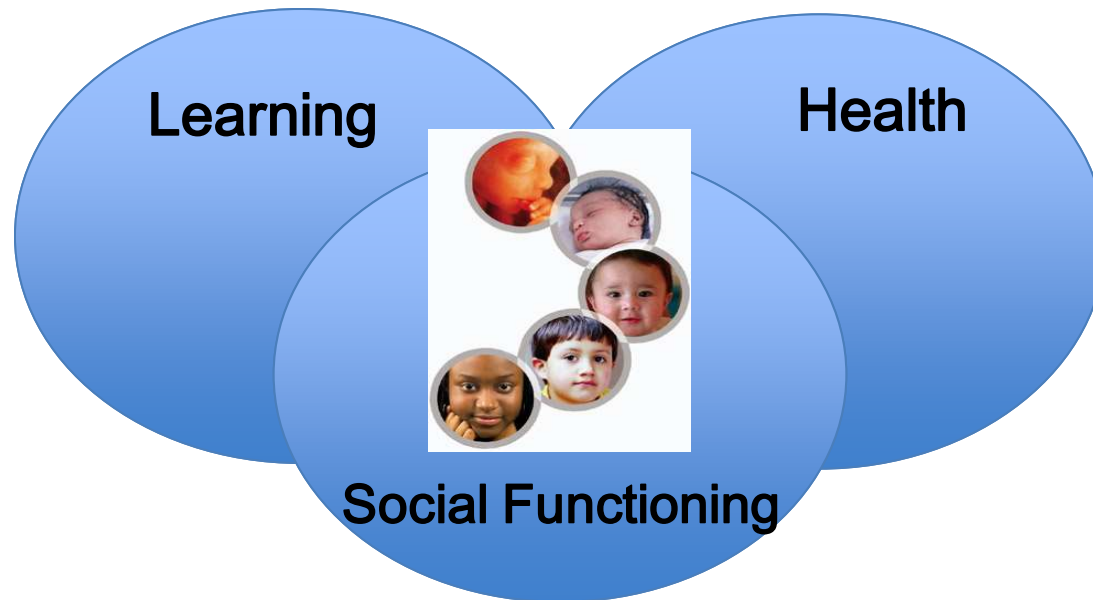


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Impact through Partnership

**Academic / Public / Private Sector
/ NGOs**