Personal view

Our Children are the guardians of our genome.
Health and wealth of future generations relies on the priorities we give them today

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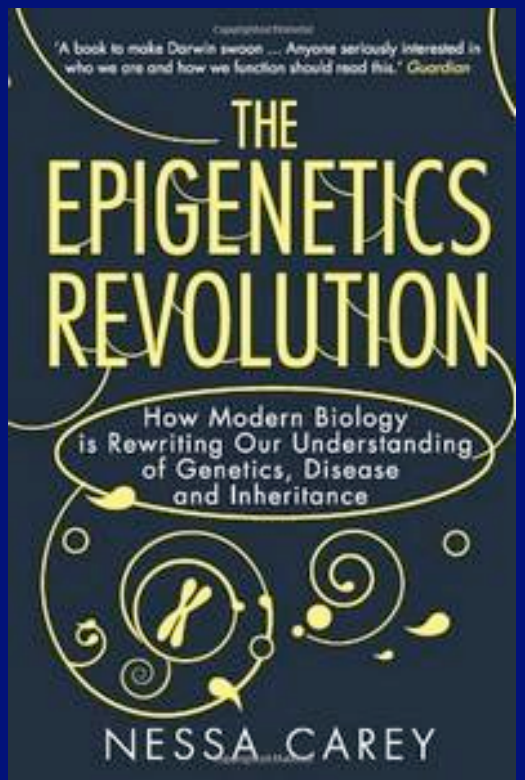
Consultant in Public Health Genomics

Research evidence to the published BMJ paper

BMJ 2015;351:h6265

Mapping of the Human Genome in 2000

The Unfolding Science of Epigenetics & its Implications to health and Diseases



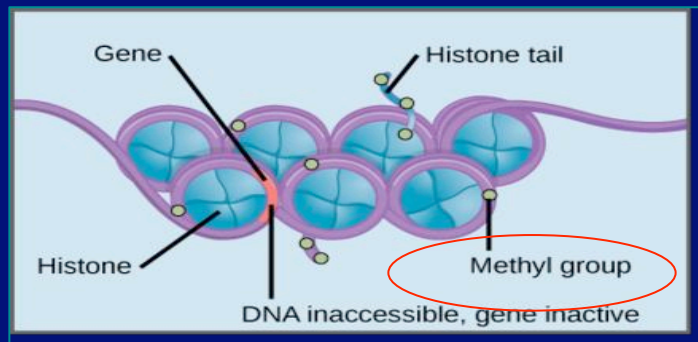
Epigenetics: Inheritance, but not as we know it!

- It is the study of heritable changes in gene expression without altering the underlying DNA sequence through:
  - DNA methylation
  - Histone modifications
  - MicroRNA
- Epigenetic modifications are reversible
- It may last for multiple generations

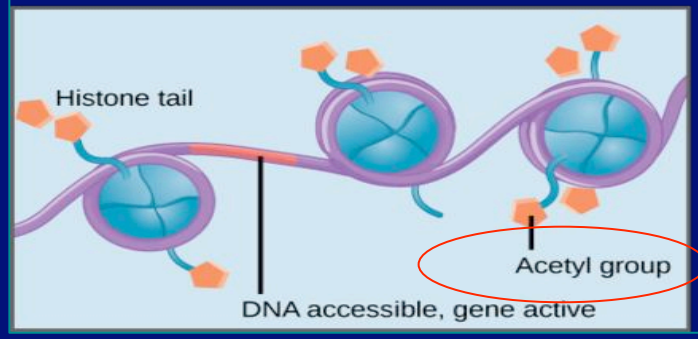
Exercise

Cruciferous vegetables

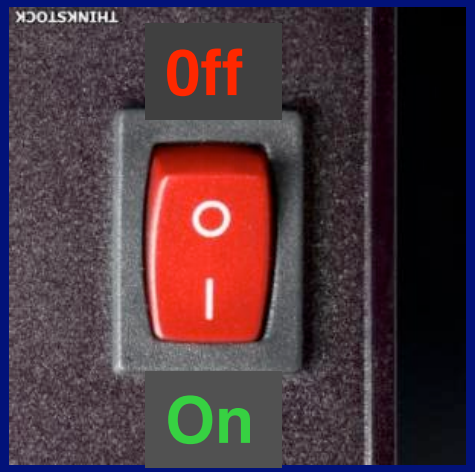
Toxins



Switching the gene off



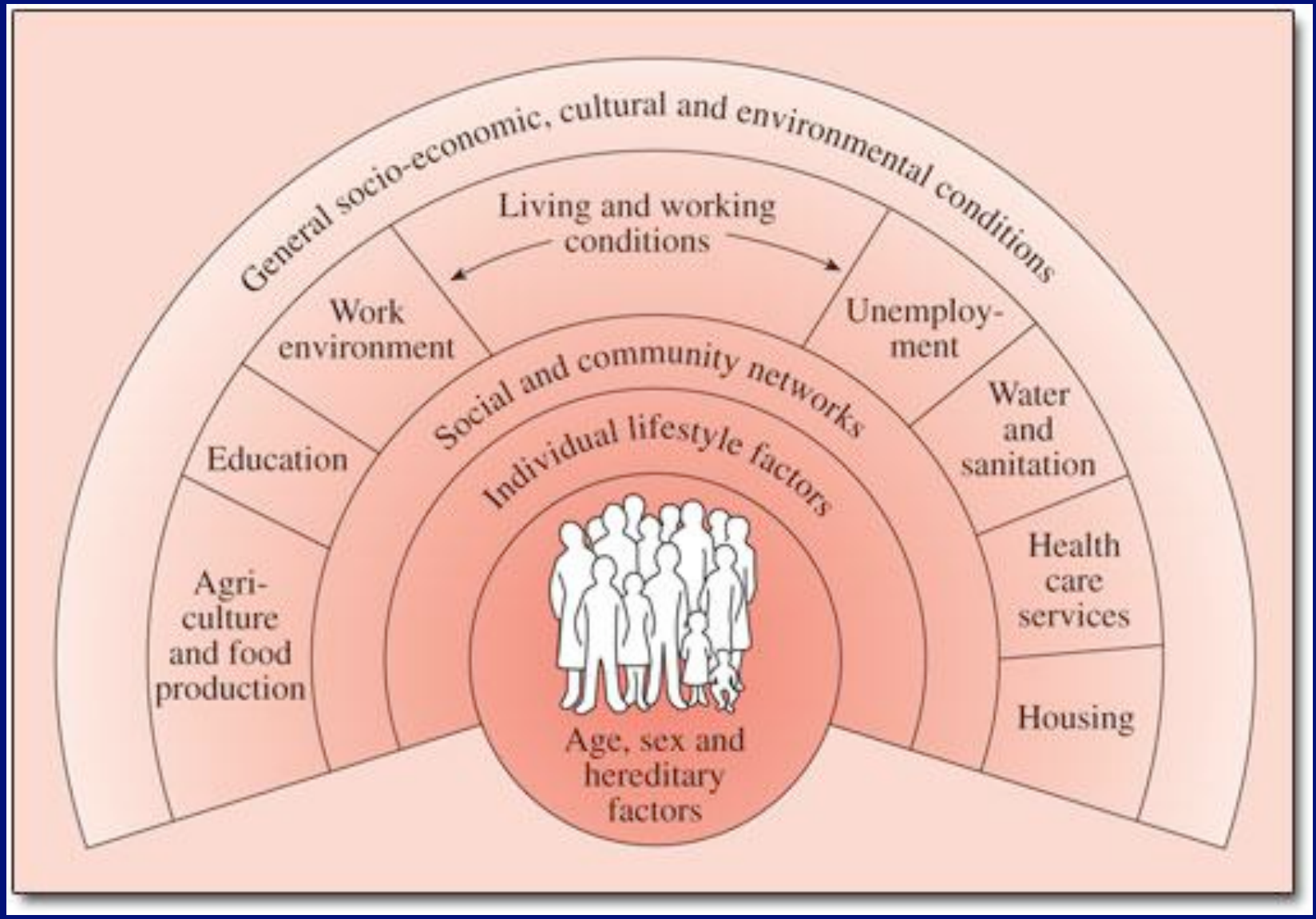
Switching the gene on



Smoking

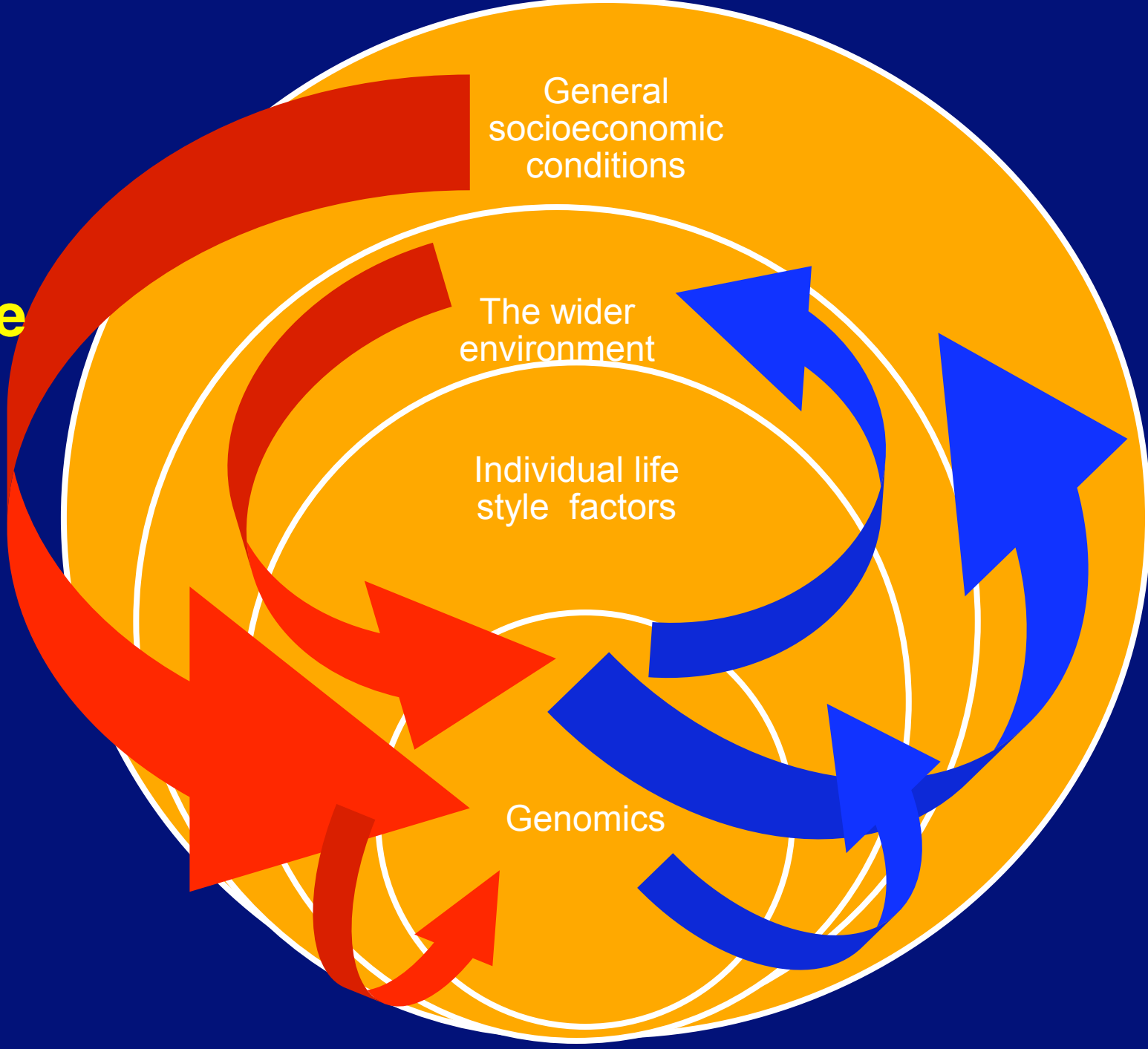
Pollution

Hormones



The main determinants of health (Dahlgren and Whitehead, 1991)

We & our genes are more flexible than we ever thought before

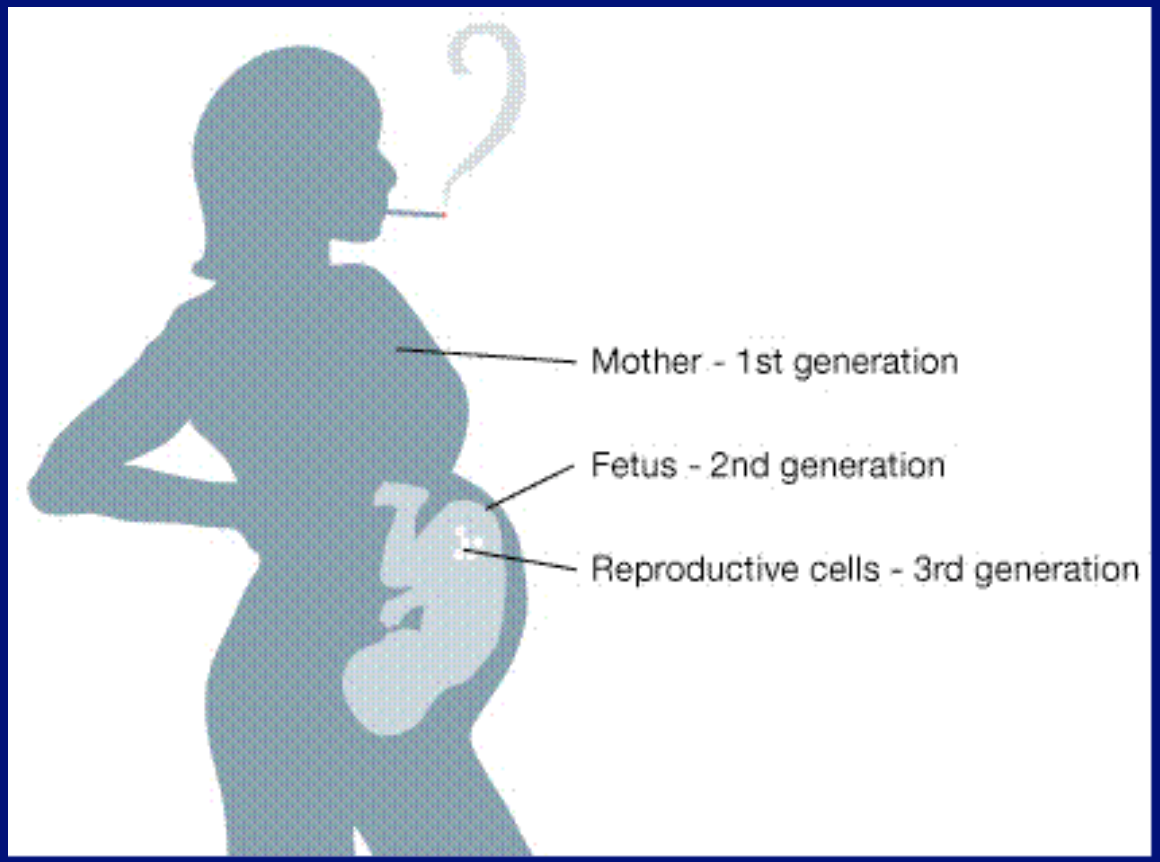


1. We now have evidence at the DNA level confirming that positive life style & environmental changes can lead to epigenetic modifications of genes that are associated with improved health outcomes.

We cannot change our genome,
but we can change our epigenome

- Exercise has been shown to ↑methylation of genes associated with obesity, diabetes & waist-hip ratio. Even those who have inherited 'fattening' genes their risk is ↓by 30%.
- Diet, consuming **cruciferous vegetables, garlic**, & **onions,** which are histones inhibitors, will allow tumour suppressor genes to activate & fight cancer.

2. Health interventions in pregnancy impact 3 generations at the same time



3 generations at once are exposed to the same environmental conditions (diet, toxins, hormones, etc.).

Mothers are the INCUBATORS of future generations

University of Utah Genetics Science Learning Centre Website

Diethylstilbestrol hormone exposure *in the uterus*

- Given to pregnant women to reduce risk of miscarriage 1930s-1970s
- Women exposed prenatally developed structural anomalies of reproductive tract, menstrual irregularity, infertility, miscarriages & increased risk of Gynae cancers especially vaginal cancer.
- *The granddaughters showed* menstrual irregularities & infertility (3 generations)
- Similar studies in mice have shown the same outcomes in female descendants.

The Swedish Överkalix study

- Observational study utilising historical records of harvests at the beginning of last century in an isolated municipality in Sweden, Överkalix.

- Females experienced a twofold higher mortality if their paternal grandmother had abundant food availability during their Slow Growth Period (8-10 years old)

- Paternal grandfather's food supply was only linked to mortality rates of grandsons, while paternal grandmother's food supply was only linked to mortality of granddaughters.

- A single winter of overeating as a youngster could initiate a biological chain of events that would lead one's grandchildren to die decades earlier than their peers did.
- Grandsons of Overkalix boys who had overeaten died an average of 6 years earlier due to cardiovascular diseases than the grandsons of those who had endured a poor harvest. Controlling confounding factors it ↑ 32 years!
- If food was plentiful, then diabetes mortality in the grandchildren increased
- Women lived shorter lives on average if their paternal grandmothers experienced famine during pregnancy

Dutch Famine in 1944

- Children of pregnant women exposed to famine were more susceptible to diabetes, obesity, cardiovascular disease & kidney problems.
- Exposure to famine in second trimester ↑ incidence of schizophrenia & other neurological defects in their children.
- Exposed children were born smaller & they themselves also had smaller babies (3 generations).

A multigenerational perspectives to public health research, practice & policy is essential

Mother's diet during pregnancy

•Researchers looked for "epigenetic markers of increased methylation" in umbilical cord blood

•Mothers with early pregnancy diets low in carbohydrates had children with these markers which were strongly linked with child's obesity at ages 6 & 9

•*It explains 25% of the difference in the fatness*

•**The effect was "considerably greater" than birth weight & did not depend on how thin or fat the mother was**.

3. The health of children especially at pre-puberty is of paramount importance for the child & as he/she become an adult & for their future children & grandchildren.

Not just the first 1000 days of life or up to 7 years of age!

British Birth Cohort of 1958
(Marcus Pembrey)

The cohort were chosen from extreme socioeconomic position
Their DNA as 45 year old men carried distinct DNA methylation patterns associated with

- child socio-economic position,
- prenatal tobacco exposure
- child abuse

•Studies of hippocampus from suicide victims who had known histories of childhood abuse showed higher methylation when compared with those who were not abused.

4. Father's health & well being is as important as that of the mother

Paternal smoking & obesity

- Researchers tested blood cells, spermatozoa & cord blood from 39 family trios & identified transgenerational DNA damage & instability in offspring of smoking fathers, increasing their risk of developing cancers (Wilms, colorectal & ovarian & other chronic diseases)
- Newborn epigenetics study showed hypomethylation at Insulin like growth factor 2 gene in umbilical cord blood have been found to be associated with paternal obesity.

The Avon Longitudinal Study of Parents and Children (ALSPAC) (Children's of the 90s)

- Fathers who smoked as pre-adolescents have increased their sons BMI at 9 years of age, but not their daughters.

- Slow growth period is pre-puberty (9-12 years in boys, 8-10 years for girls). The time when environmental factors have larger impact on gametes.

- Boys who smoke at pre-puberty may contribute to obesity in adolescent boys of the next generation

- Women who suffer higher levels of stress while pregnant are more likely to have children with lower IQs & greater emotional difficulties.

New Scientist

Daily news 4 June 2015

First evidence of how parents' lives could change children's DNA

For the first time, scientists have discovered a mechanism in humans that could explain how your lifestyle choices may impact your children & grandchildren's genes.

Mounting evidence suggests that environmental factors such as smoking, diet & stress, can leave their marks on the genes of your children and grandchildren

New Scientist

Daily news 4 June 2015

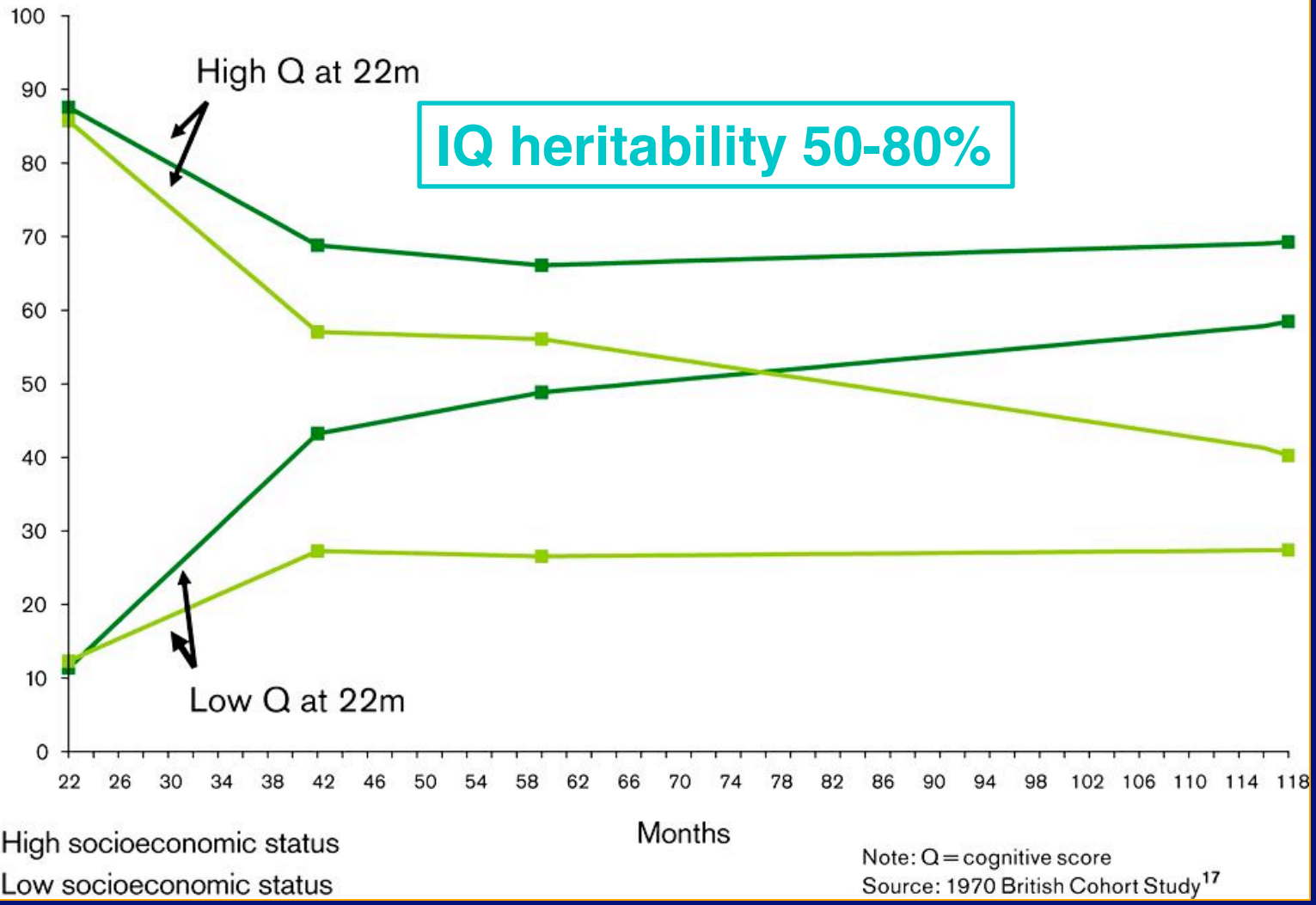
First evidence of how parents' lives could change children's DNA

The Escasping Genes

About 2 to 5% of methylation across the genome escaped reprogramming either at embryo stage or at gamete maturation at puberty

Mounting evidence suggests that environmental factors such as smoking, diet & stress, can leave their marks on the genes of your children & grandchildren

1970 British Cohort Study
Inequality in cognitive development of children (22 months to 10 years)

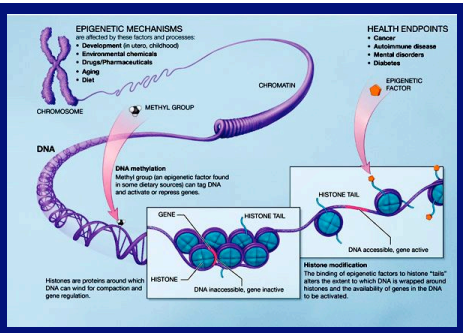


Wider environmental factors

Psycho-social & behavioral factors

Economic factors

Embryo → Early childhood → Pre-puberty



Can alter the function of genes

leading to an increase in chronic diseases

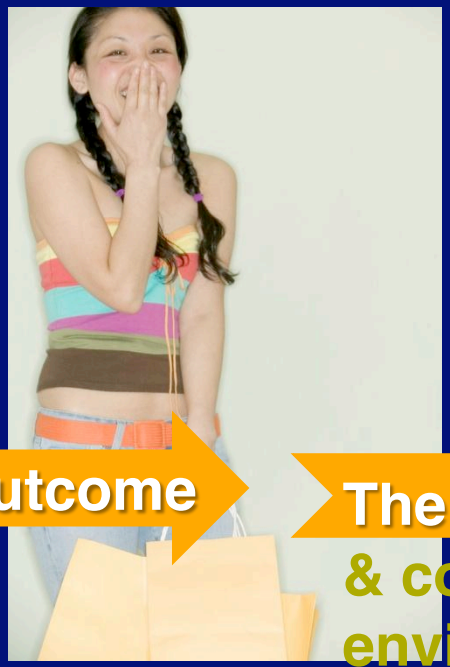
These gene alterations can be inherited perpetuating the ill health cycle in future generations

The Health economic argument is strong

First favourable intervention

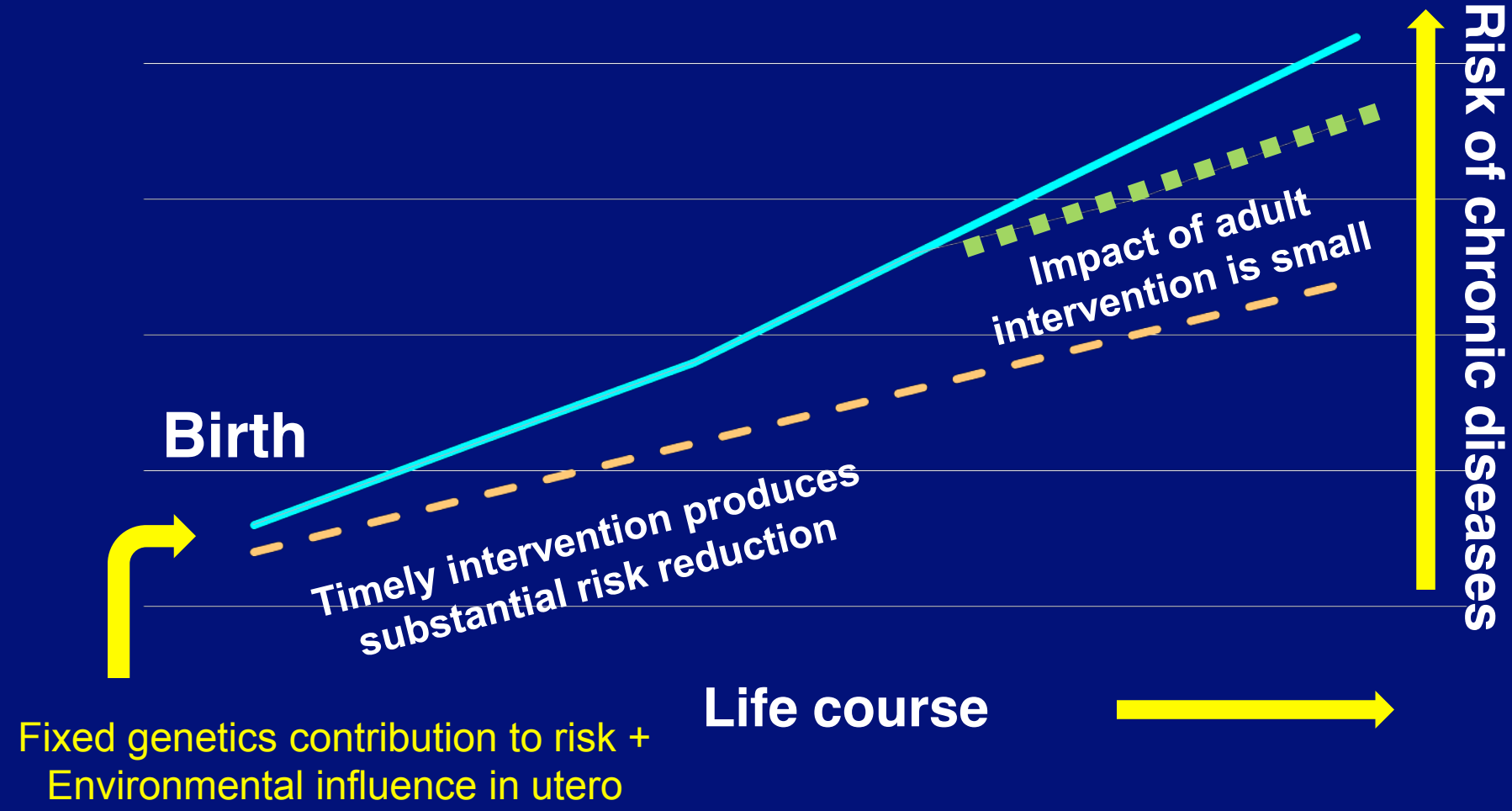
Continuous Favourable Environment in childhood

Health outcome



The effect of same 1st intervention & continuous favourable common environment in childhood

Childhood development period is THE most important & cost effective time to intervene & prevent diseases



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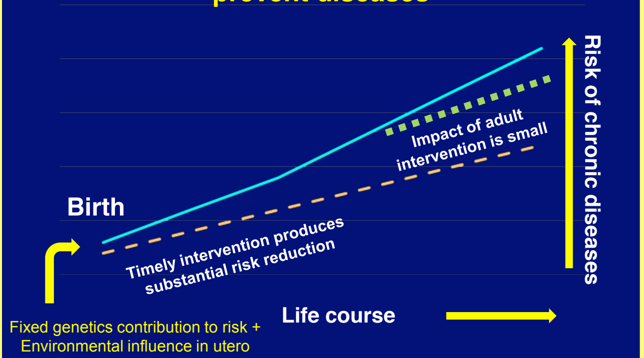

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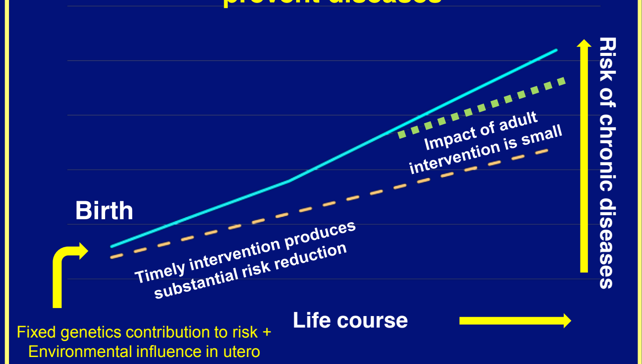
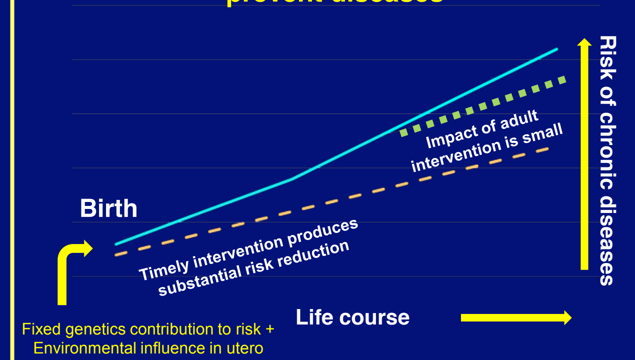
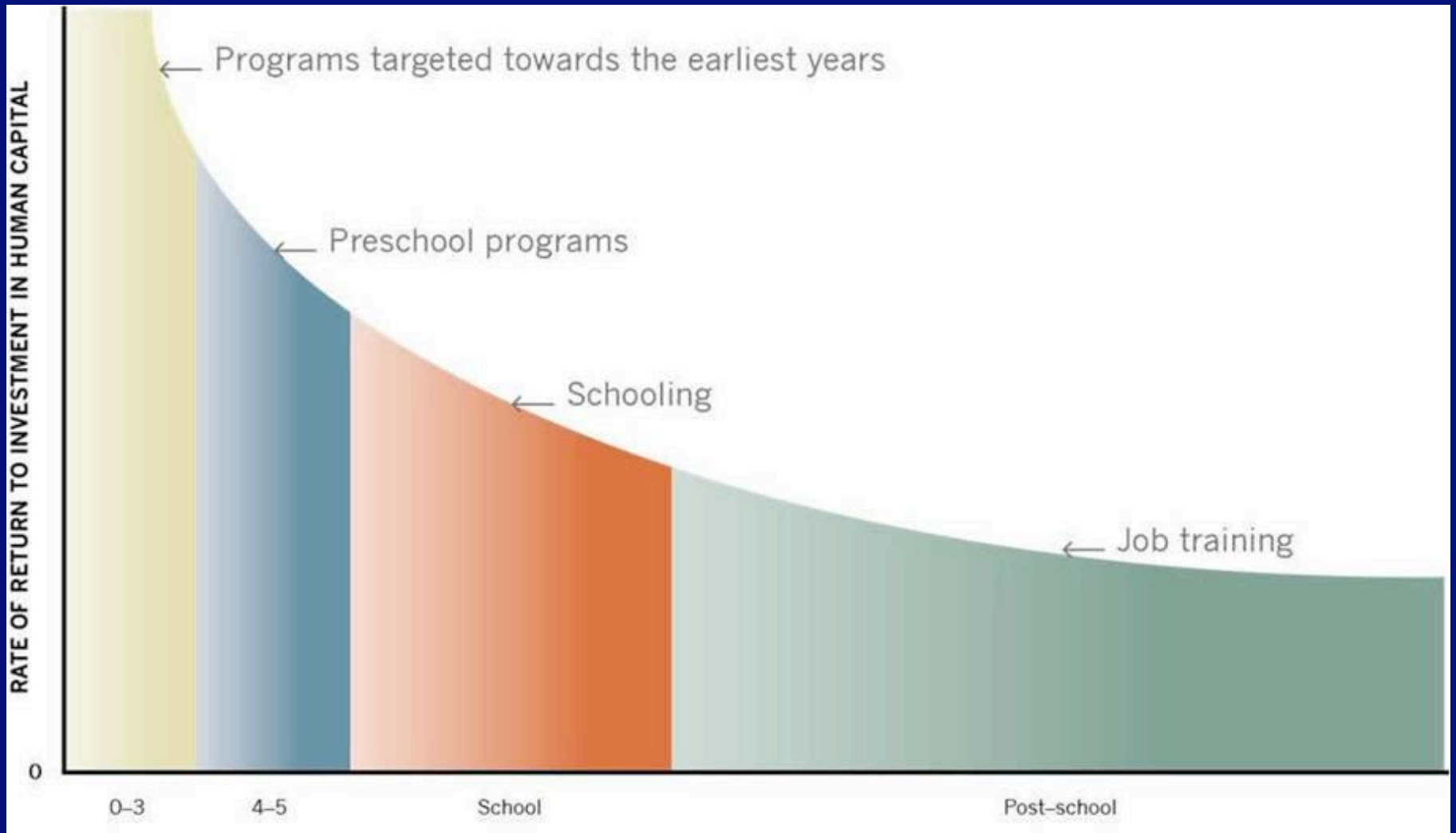


Childhood development period is THE most important & cost effective time to intervene & prevent diseases



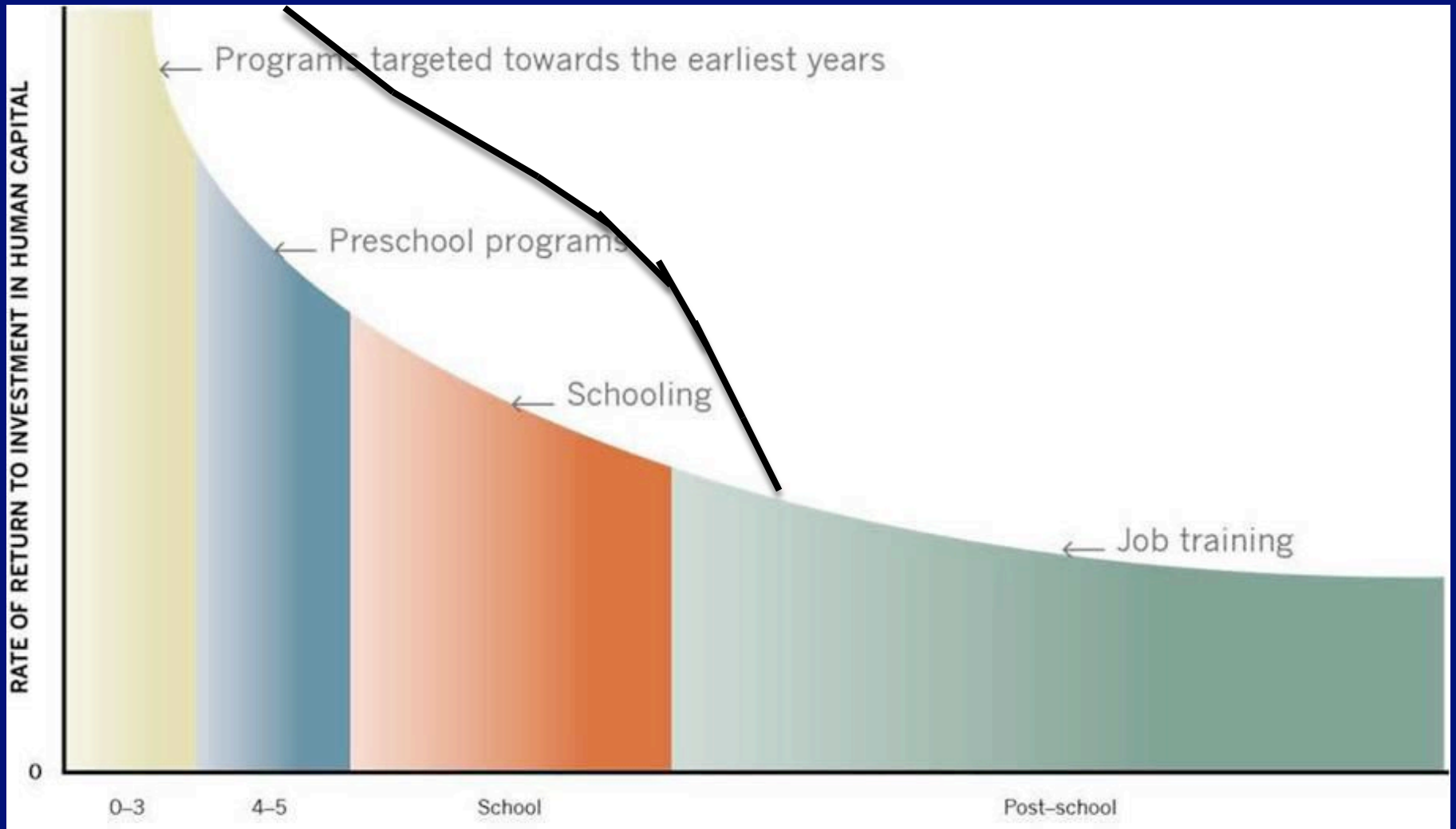
Mother	child	grandchild
Generation 1	Generation 2	Generation 3

From James Joseph Heckman 2008 on the rate of return on investment in human capital



Source: Heckman (2008)

From James Joseph Heckman 2008 on the rate of return on investment in human capital



Source: Heckman (2008)

Evidence on Education

OECD Report
Centre for Educational Research & Innovation, 2006 report

- Considerable international evidence that education is strongly linked to health & to determinants of health such as health behaviours, risky contexts & preventative service use.
- A substantial element of this effect is causal.
- Education does not act on health in isolation. Income is another very important factor
- Empirical investigations often find that the effect of education on health is as great as that of income.

Report: The wellness impact: enhancing academic success through healthy school environment

- It reinforces the crucial link between quality nutrition, physical activity & academic performance.
- Brain imaging shows improved cognitive function in children & higher academic achievement after just 20 minutes of physical activity
- Breakfast eaters have better attention & memory span than breakfast skippers

Greater levels of education can lead to:

- Improved chances of finding secure, well paid employment, with subsequent health benefits
- More opportunities for social development & enhanced social skills, with
- Positive impacts on individuals & wider community & subsequently for general health
- Developing knowledge, attitudes & behaviours conducive to good health

Public Health Nutr. 2015 Sep 28:1-8.

Association between breakfast consumption and educational outcomes in 9-11-year-old children. (DECIPHer)

CONCLUSIONS:

•Significant positive associations between self-reported breakfast consumption & educational outcomes were observed.

UNICEF 2007 -A League Table of Child Well Being in 21 rich countries

		Dimension 1	Dimension 2	Dimension 3	Dimension 4	Dimension 5	Dimension 6
Dimensions of child well-being	Average ranking position (for all 6 dimensions)	Material well-being	Health and safety	Educational well-being	Family and peer relationships	Behaviours and risks	Subjective well-being
Netherlands	4.2	10	2	6	3	3	1
Sweden	5.0	1	1	5	15	1	7
Denmark	7.2	4	4	8	9	6	12
Finland	7.5	3	3	4	17	7	11
Spain	8.0	12	6	15	8	5	2
Switzerland	8.3	5	9	14	4	12	6
Norway	8.7	2	8	11	10	13	8
Italy	10.0	14	5	20	1	10	10
Ireland	10.2	19	19	7	7	4	5
Belgium	10.7	7	16	1	5	19	16
Germany	11.2	13	11	10	13	11	9
Canada	11.8	6	13	2	18	17	15
Greece	11.8	15	18	16	11	8	3
Poland	12.3	21	15	3	14	2	19
Czech Republic	12.5	11	10	9	19	9	17
France	13.0	9	7	18	12	14	18
Portugal	13.7	16	14	21	2	15	14
Austria	13.8	8	20	19	16	16	4
Hungary	14.5	20	17	13	6	18	13
United States	18.0	17	21	12	20	20	–
United Kingdom	18.2	18	12	17	21	21	20

UNICEF 2013 -A League Table of Child Well Being in 29 rich countries

		Overall well-being	Dimension 1	Dimension 2	Dimension 3	Dimension 4	Dimension 5
		Average rank (all 5 dimensions)	Material well-being (rank)	Health and safety (rank)	Education (rank)	Behaviours and risks (rank)	Housing and environment (rank)
1	Netherlands	2.4	1	5	1	1	4
2	Norway	4.6	3	7	6	4	3
3	Iceland	5	4	1	10	3	7
4	Finland	5.4	2	3	4	12	6
5	Sweden	6.2	5	2	11	5	8
6	Germany	9	11	12	3	6	13
7	Luxembourg	9.2	6	4	22	9	5
8	Switzerland	9.6	9	11	16	11	1
9	Belgium	11.2	13	13	2	14	14
10	Ireland	11.6	17	15	17	7	2
11	Denmark	11.8	12	23	7	2	15
12	Slovenia	12	8	6	5	21	20
13	France	12.8	10	10	15	13	16
14	Czech Republic	15.2	16	8	12	22	18
15	Portugal	15.6	21	14	18	8	17
16	United Kingdom	15.8	14	16	24	15	10
17	Canada	16.6	15	27	14	16	11
18	Austria	17	7	26	23	17	12
19	Spain	17.6	24	9	26	20	9
20	Hungary	18.4	18	20	8	24	22
21	Poland	18.8	22	18	9	19	26
22	Italy	19.2	23	17	25	10	21
23	Estonia	20.8	19	22	13	26	24
23	Slovakia	20.8	25	21	21	18	19
25	Greece	23.4	20	19	28	25	25
26	United States	24.8	26	25	27	23	23
27	Lithuania	25.2	27	24	19	29	27
28	Latvia	26.4	28	28	20	28	28
29	Romania	28.6	29	29	29	27	29

- A key common feature in the Nordic area is the respect accorded to & training required for those working with children in schools & early years

- Case study from England showed clearly that staff qualifications had a direct impact on children's outcomes.

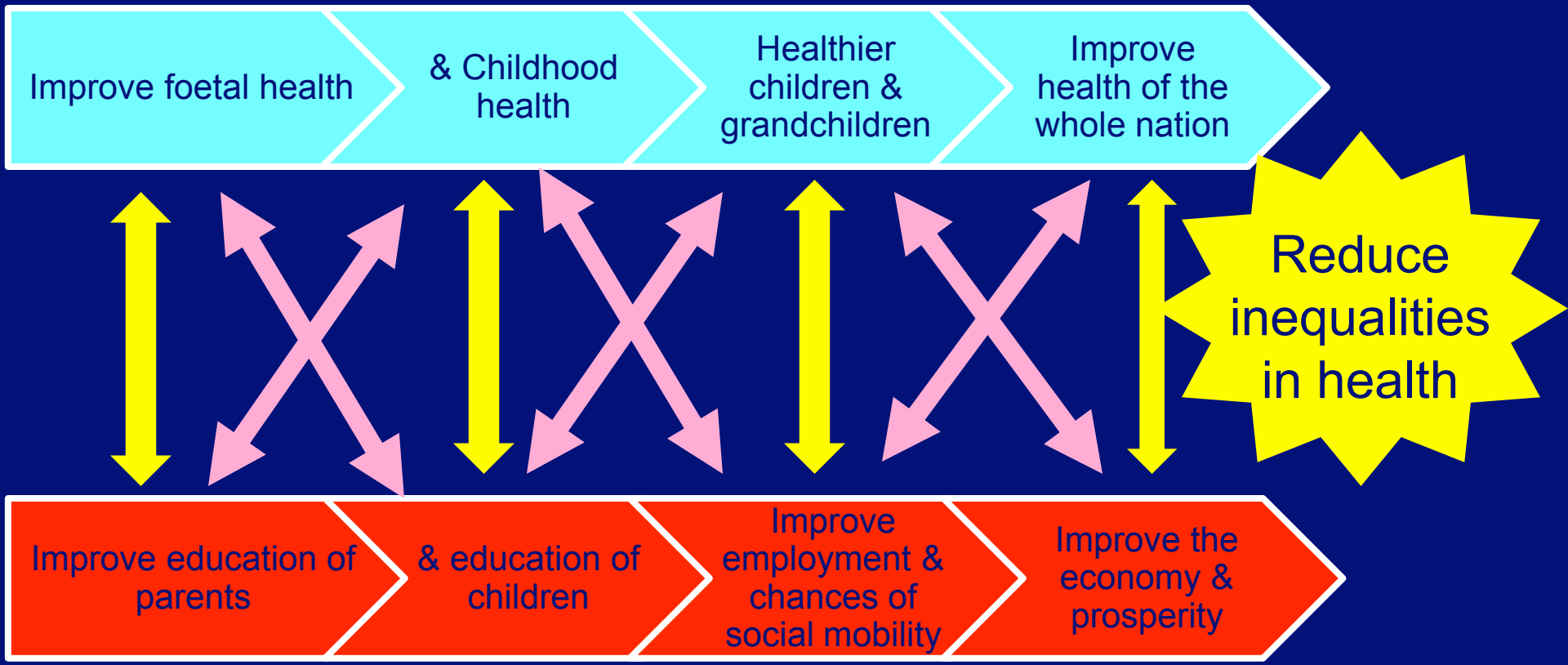
Key messages from Marmot 2010 review

1. Social gradient on health inequalities is reflected in the social gradient on educational attainment

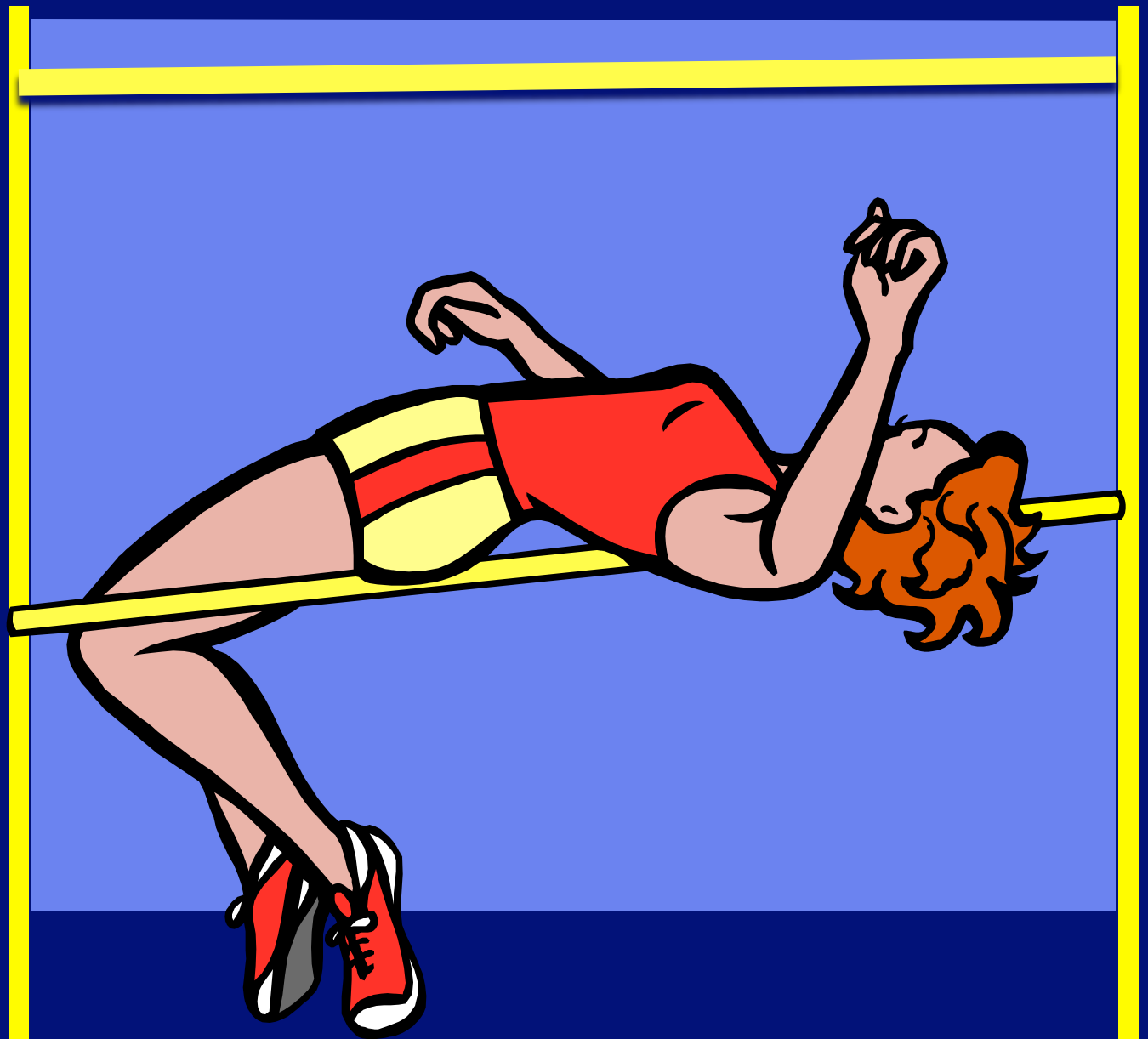
2. **Focusing solely on the most disadvantaged will not reduce health inequalities sufficiently.**

3. To reduce the steepness of the curve, actions must be **universal,** but with 'proportionate universalism'.

4. Actions by central & local government, NHS, third & private sectors & community groups is required


Improve foetal health
& Childhood health
Healthier children & grandchildren
Improve health of the whole nation
Reduce inequalities in health
Improve education of parents
& education of children
Improve employment & chances of social mobility
Improve the economy & prosperity

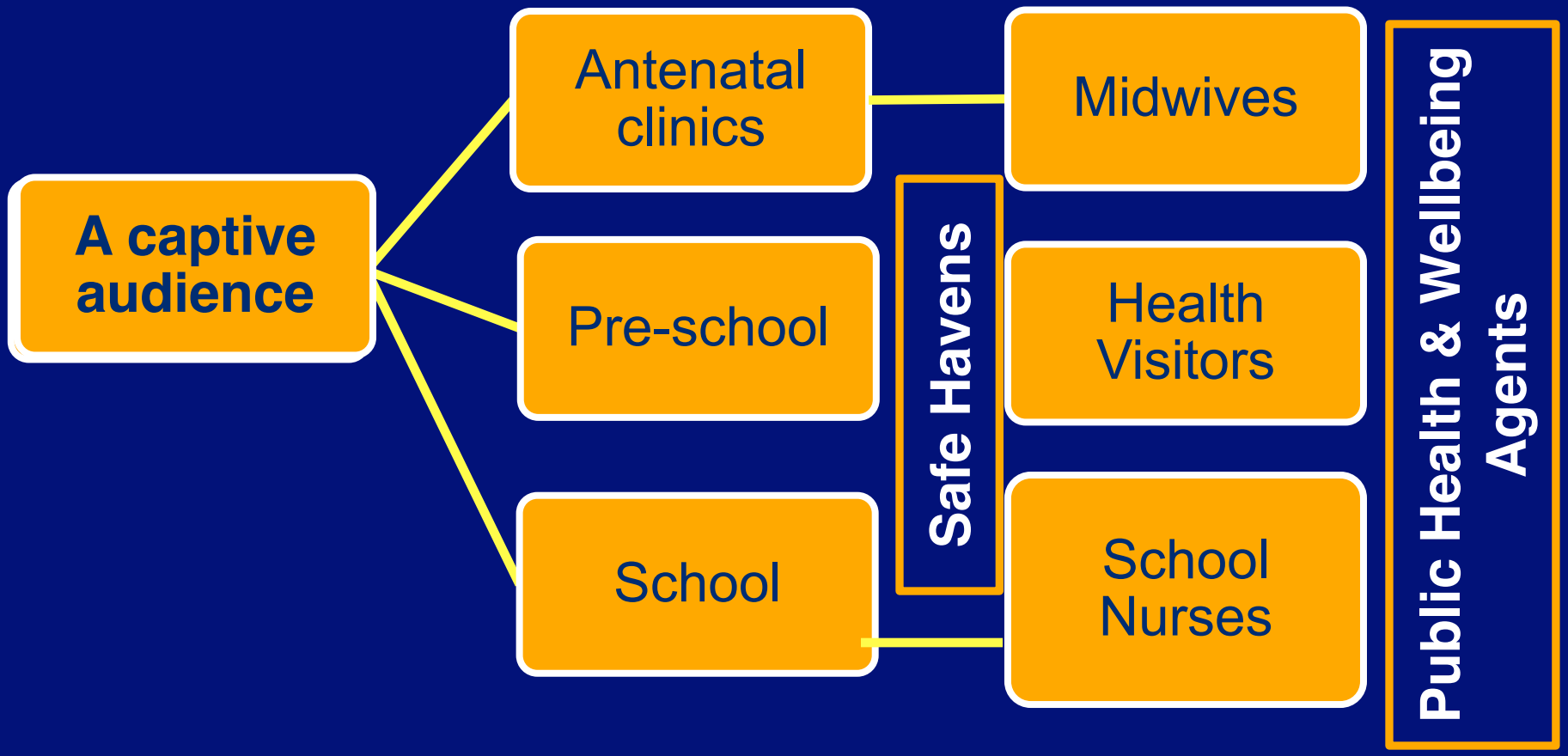
We need to raise the bar in all aspects of Children's health & education



This means raising the bar

- When setting the threshold of what we consider high quality standards of health & education systems
- In the quality of policy & management of these systems
- In selection of students entering professional training programmes
- In the quality of their training programmes
- In the respect & esteem we hold them in
- In remunerating them appropriately

Develop an integrated & comprehensive strategy




Education
Health

Sustained synergistic actions on both health & education of ALL children

Health & wealth of future generations relies on what priorities we give children TODAY

Children are the GUARDIANS of our genome

Children are this country's insurance policy

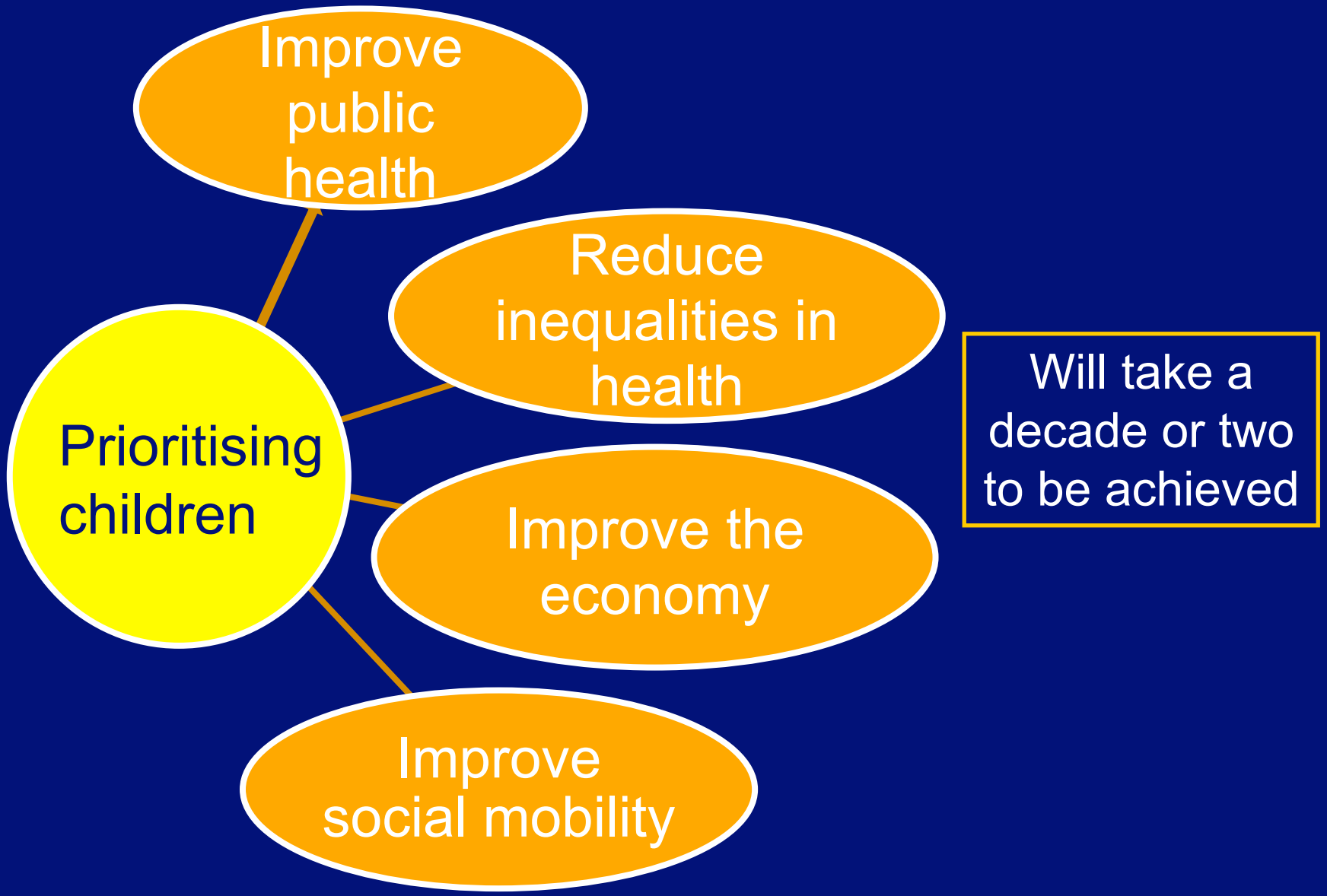
Prioritising children should be enshrined in LAW

Extending the UNCRC to include a statement of intent to place children's health, well being & education as the first priority of our public policy to sustain future generations

Why enshrining prioritisation of children in law is essential?

- It shows that strong convincing evidence have been sought & found.
- It obliges ministers, organisations, groups & individuals to give it its rightful place.
- It will raise the society's awareness, changing the culture & attitudes which are pre-requisite of any big societal change that is required to give children their rightful place in society.
- It will strengthen other children' laws & circumvent the need to have a new law banning the smacking of children as extending UNCRC law will encompass that & go beyond that important principle.

- A bill that follows the example of Scandinavian countries in being broad in nature that create conditions for children's health & well being to be at the forefront of policies in every governmental department & every public, private & voluntary organisation will reduce inequalities in health in Wales.
- Will ensure wide coverage of this important area
- Give it the gravitas it deserves
- It shows unity of purpose for the whole country to achieve this good cause.

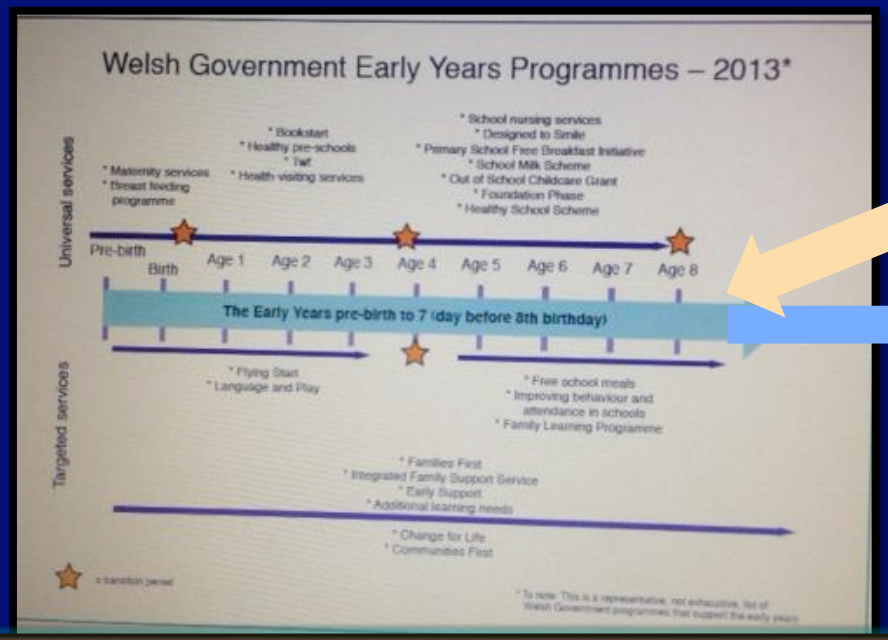

Improve public health
Reduce inequalities in health
Prioritising children
Improve the economy
Improve social mobility
Will take a decade or two to be achieved

Comparing the new policy to the existing one

- It is based on cutting edge genomic science
- Leading to a positive cultural change in society's choices, that are not necessarily resource laden
- An acceptable message to sell & easier to explain to the public
- The best policy we have to prevent further deterioration in people's health & improve the prospect for future generations
- A Universal Policy that will shift the whole health outcome curve improving the prospect for low socioeconomic groups, as well as improving outcomes for those in the middle & top of the social curve propelling Wales into a new economic horizon.

The Overarching Integrated Strategy

PRIORITY to sustained synergistic actions on children's health & education



Fiscal measures
'The Living Wage'

17-18 years

Prioritising children should be enshrined in LAW


Welcome to Wales
Croeso i Gymru


Welcome to Wales
Croeso i Gymru
Our children are our future

The end