Growing up with GUSTO

Yap-Seng CHONG

Associate Professor, Dept of Obstetrics & Gynaecology, NUHS

*Executive Director, Singapore Institute for Clinical Sciences, A*STAR*
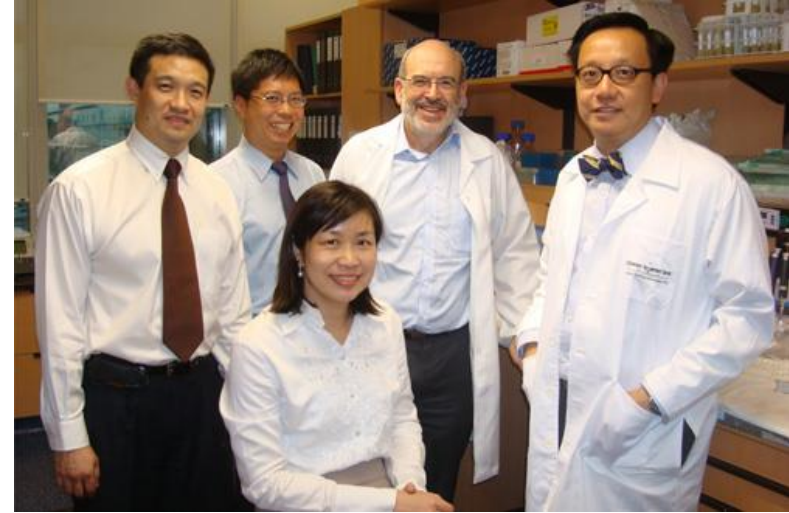
24 February 2016

Research

Clinical Care

Education

# Translational and Clinical Research Flagship Programme

$25 million over 5 years, awarded end 2008; renewed end 2013

Developmental Pathways to Non-Communicable Diseases

- To study how **pregnancy** and **early childhood** conditions (development) influence the tendency of individuals to develop non-communicable diseases (obesity, diabetes, neurodevelopmental disorders) later on in life.

- To study how **ethnicity** influences the tendency of individuals to develop NCDs.

- Main aim is to find ways to **prevent** these chronic diseases rather than just treating them or preventing their complications.

DeVOS
Developmental Origins : Singapore

Windows of opportunity to promote health

M. A. Hanson, and P. D. Gluckman Physiol Rev 2014;94:1027-1076
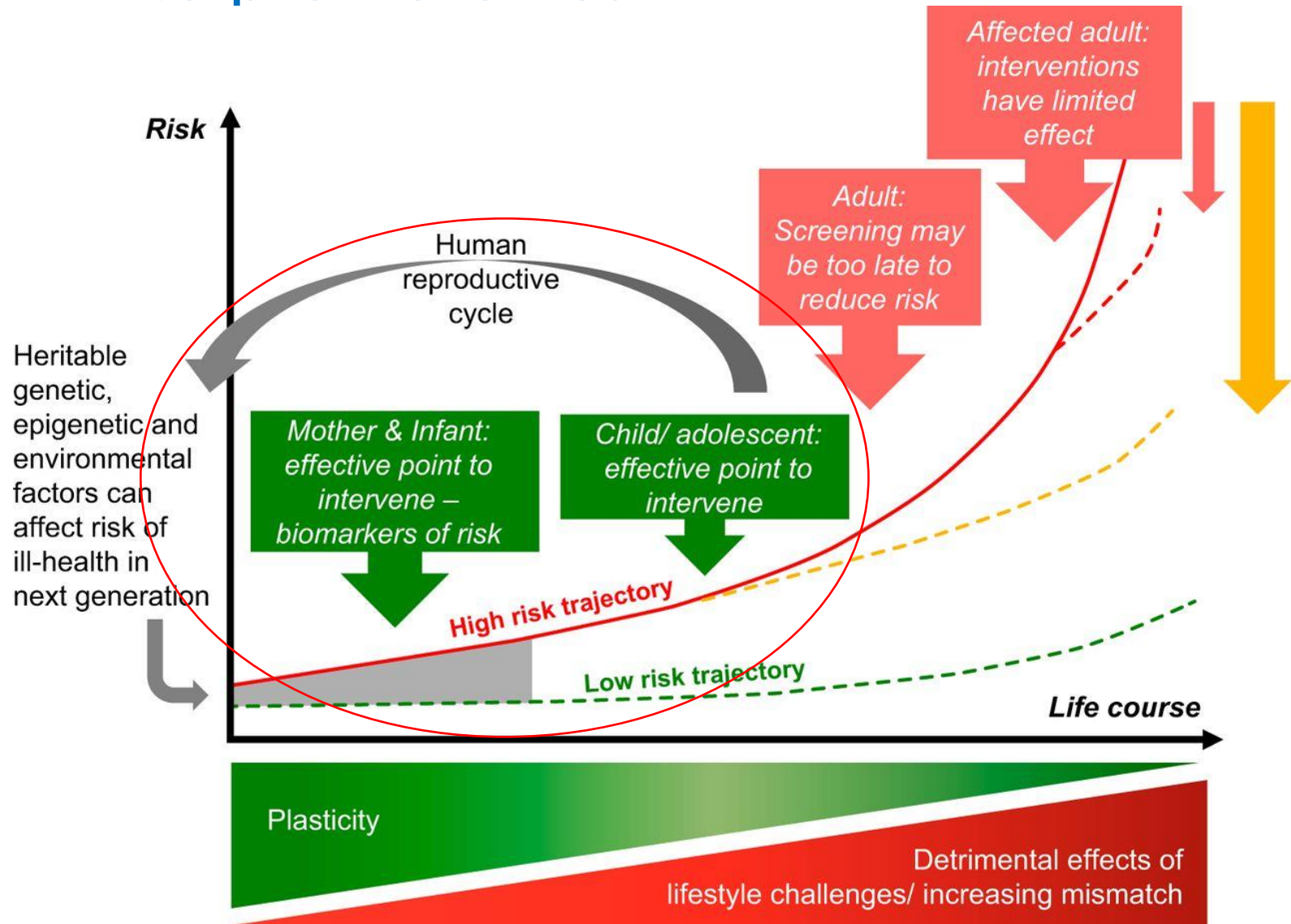
If you mess up your children, nothing else you do really matters.
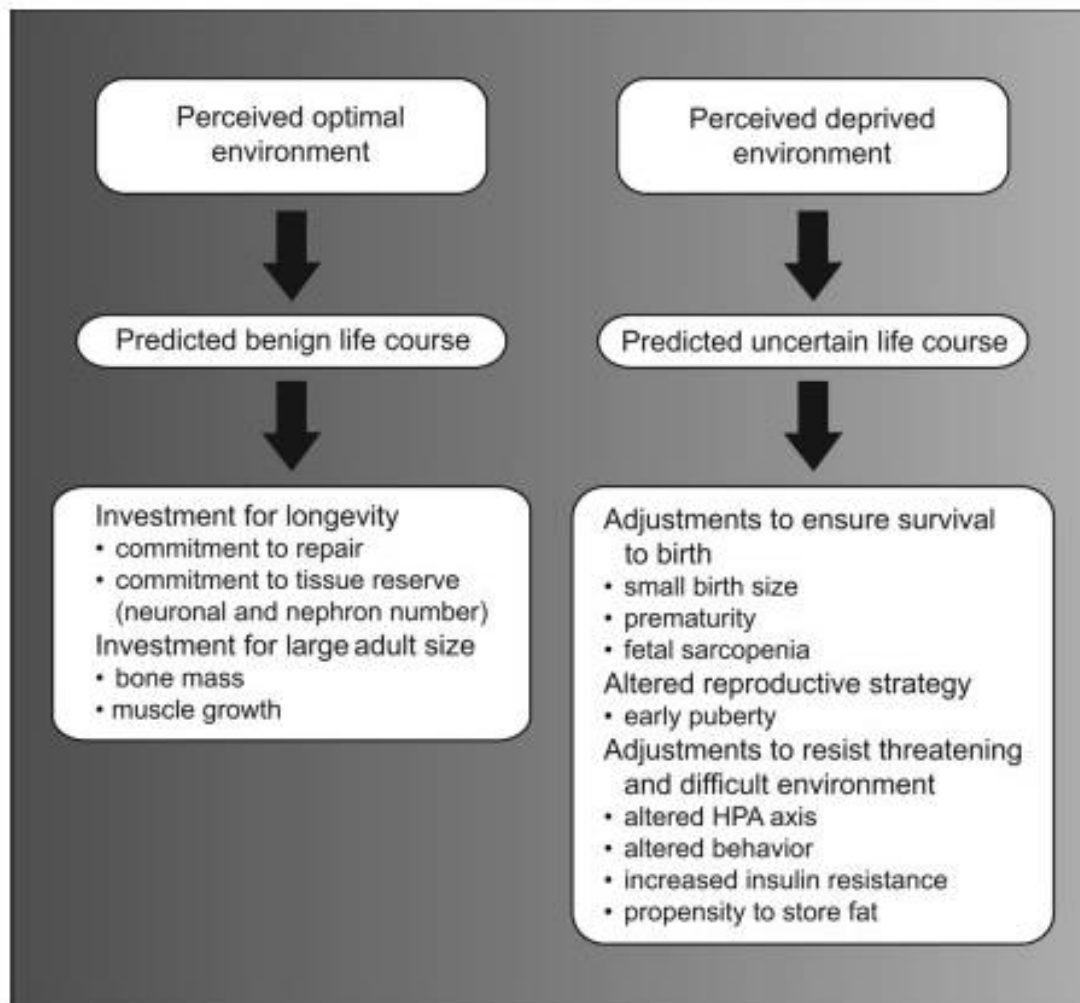
Jacqueline Kennedy Onassis, 1929-1994

How does early life affect long term health?
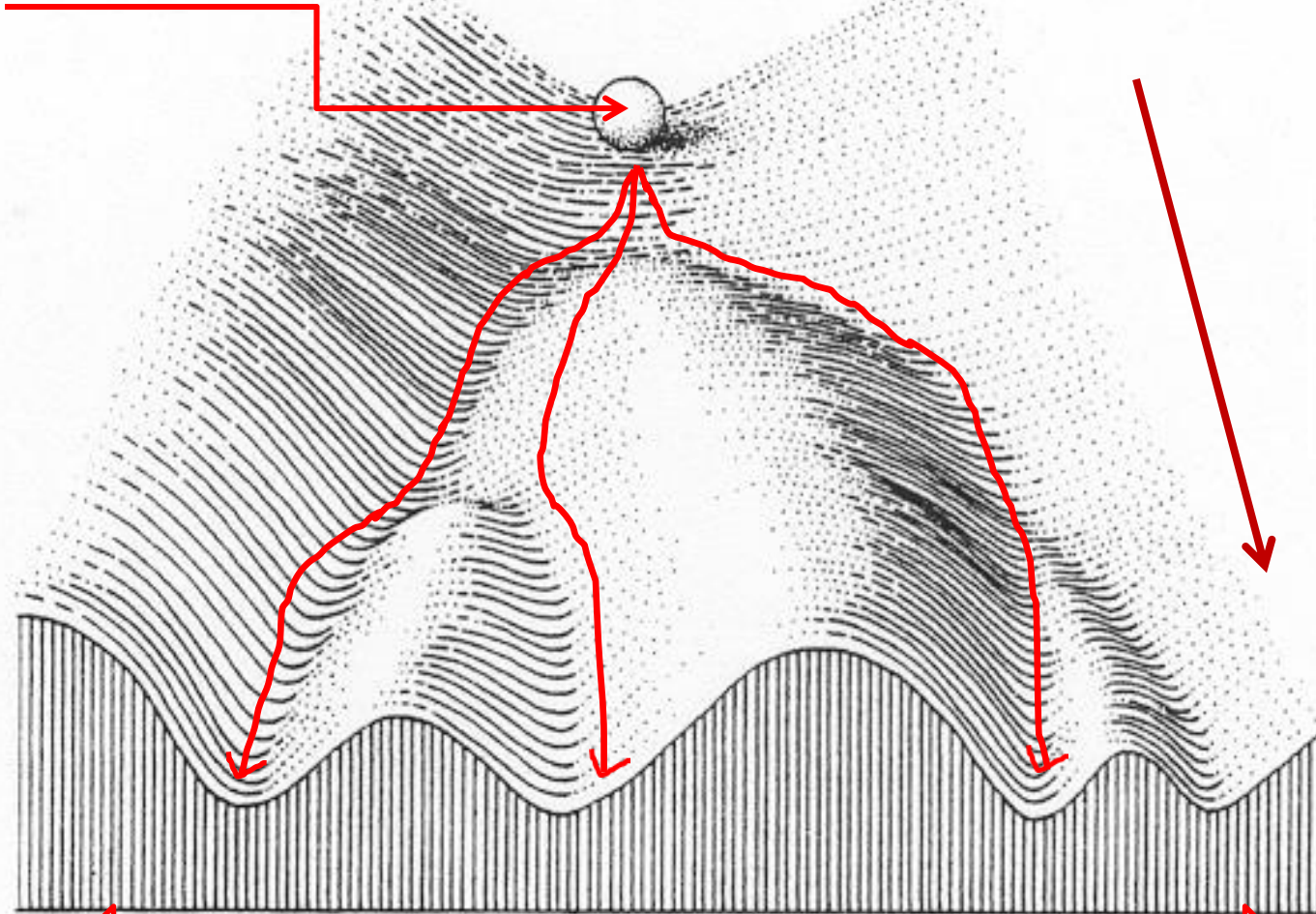
Pregnancy

Early childhood

First 1000 days

How the pregnancy period affects the baby's future development
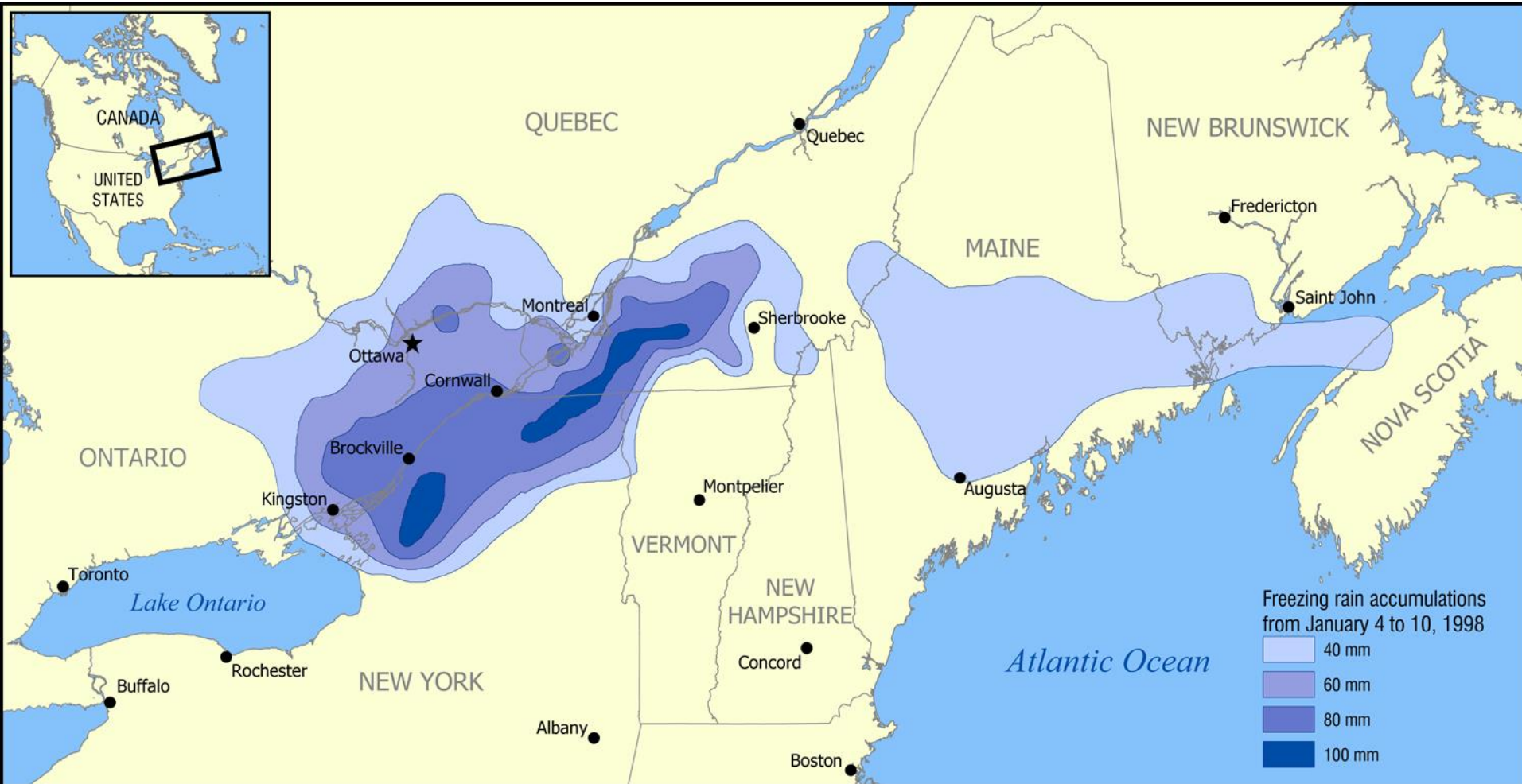
Development from a phenotypic perspective

Genotype

Development
(epigenetic modification)

Phenotype

Great Ice Storm of 1998

Freezing rain accumulations from January 4 to 10, 1998

- 40 mm
- 60 mm
- 80 mm
- 100 mm

The **North American Ice Storm of 1998** was a massive combination of five smaller successive ice storms, which combined to strike a narrow swath of land in eastern Canada and northeastern USA in January 1998.

Insurance Bureau of Canada / Bureau d'Assurance du Canada

January 1998

6 days of freezing rain
4.7 million Canadians without power
792,514 insurance claims
$1.6 billion paid by insurers

Loyola High School Gym Shelter Closes it doors Jan 16th 1998 after serving Notre Dame De Grace area of Montreal for 9 days

Montreal Ice Storm Loyola Gym/shelter Kitchen ©Patrick McDonn

Some of the volunteers and Emergency staff have time to talk   Overview of the Shelter Dinning Room

One of the many volunteers helps the refugees   Montreal DownTown never closes during the Storm

Long term effects of antenatal maternal stress on their children

- The Great Ice Storm of 1998 caused **extensive infrastructural damage** to parts of Atlantic Canada and northeastern USA and left millions of people **without electricity for weeks**.

- Studies of **pregnant women exposed to this natural disaster** later found that their young **children's neurodevelopment were negatively affected**, reflected by lower general intellectual and language abilities.

Taylor & Francis
Taylor & Francis Group

The effects of prenatal maternal stress on children's cognitive development: Project Ice Storm

SUZANNE KING[1,2] & DAVID P. LAPLANTE[2]

[1]Department of Psychiatry, McGill University, Québec, Canada, and [2]Douglas Hospital Research Centre, Verdun, Québec, Canada

Prenatal maternal stress predicts autism traits in 6½ year-old children: Project Ice Storm

CrossMark

Deborah J. Walder [a], David P. Laplante [b], Alexandra Sousa-Pires [b], Franz Veru [b,c], Alain Brunet [b,c], Suzanne King [b,c,*]

[a] Department of Psychology, Brooklyn College and The Graduate Center of The City University of New York, 2900 Bedford Avenue, Brooklyn, NY 11210, USA
[b] Psychosocial Research Division, Douglas Mental Health University Institute, 6875 LaSalle Boulevard, Verdun, Quebec, Canada H4H 1R3
[c] Department of Psychiatry, McGill University, 1033 Pine Avenue West, Montreal, Quebec, Canada H3A 1A1

GUSTO
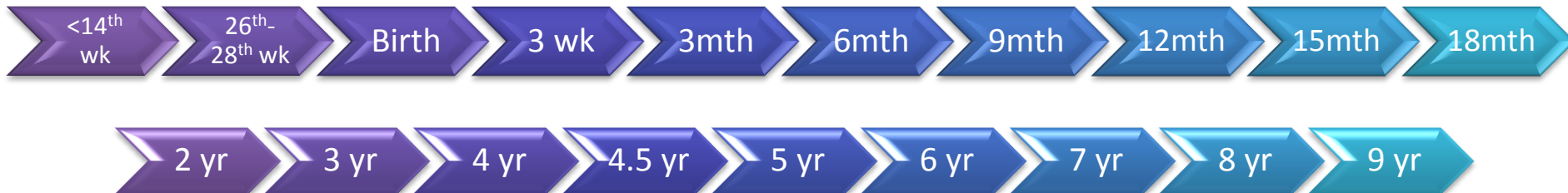## GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

- **Launched in 2009**
- **1247 mother-child pairs**
- **3 Asian ethnic groups**
- **Closest longitudinal follow-up ever**
- **Deepest phenotyping & biosampling**

IN UTERO   **BIRTH**   **INFANCY & CHILDHOOD**

<14th wk	26th-28th wk	Birth	3 wk	3mth	6mth	9mth	12mth	15mth	18mth

2 yr	3 yr	4 yr	4.5 yr	5 yr	6 yr	7 yr	8 yr	9 yr

26-28wk clinic visit

Blood taking
   Oral Glucose Tolerance Test
   Biochemical markers (CRH, CRH binding protein,
      cortisol, leptin, alpha-feto protein etc)

Collection of hair sample

Non-mydriatic retinal photograph & autorefraction

Anthropometry (Ht, Wt, Skinfold thickness, MAC)

Pulse wave velocity (BP)

Questionnaires
   Life style, family background and breastfeeding
   Food diary (24 hour recall and 2 days food diary)

Self administered questionnaires
   STAI, EPDS, BDI-II, LYDON & Question on domestic helper
   Pittsburgh Sleep Quality Index (PSQI)

Deep phenotyping of mothers in mid-pregnancy

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

24/7 on-call team

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Collection of specimens at delivery

Umbilical cord & placenta

Preparation

Snap freezing

Placenta (baby side) Processing

a. Wear new gloves

b. Pour fresh PBS into the container

Note: Process within 30 min

c. Cut 5 pieces of baby side placenta (2-3cm each)

d. Rinse tissue sections in PBS

e. Transfer 1 tissue section into a prelabeled Nalgene cryovial.

f. Snap freeze Nalgene cryovial immediately in liquid nitrogen: repeat step e until all tissues are snap frozen

g. Transfer frozen Nalgene cryovials into labeled Zip-lock bag and keep in -80C immediately

Store all Zip-lock bags in -80°C

Placenta (mother side) Processing

a. Wear new gloves

b. Pour fresh PBS into the container

Note: Process within 30 min

c. Cut 5 pieces of mother side placenta (2-3cm each)

d. Rinse tissue sections in PBS

e. Transfer 1 tissue section into a prelabeled Nalgene cryovial

f. Snap freeze Nalgene cryovial immediately in liquid nitrogen: repeat step e until all tissues are snap frozen

g. Transfer frozen Nalgene cryovials into labeled Zip-lock bag and keep in -80C immediately

Store all Zip-lock bags in -80°C

CORD BLOOD 02-8008

CORD TISSUE 02-8008

MOTHER DELIVERY 02-8008

BABY 02-8008

FATHER 02-8008

Maternal, Paternal, Cord blood, etc

Interrogating the BioSamples

DeVOS
Developmental Origins : Singapore

Umbilical cord
and placenta

Maternal and fetal blood

Longitudinal buccal swabs
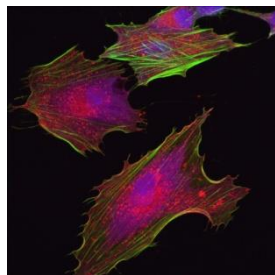
Cord derived MSCs

Longitudinal microbiota
sampling

welcome to
GUT
POP:100 TRILLION

Blood chemistry
Including micronutrients, metabolomics

Genotyping
Omniexpress+ exome arrays
SNP and CNV

Methylome assessment
Infinium 450K arrays
RRBS
Methyl-capture-seq

Chromatin and histone assessment
TaCH / DNAase protection
Native ChIP-seq
Mnase-seq

Transcriptome assessment
Infinium HT12 v4 arrays
RNAseq
miRNAseq

Microbiome assessment
16S RNA sequencing
Metagenomics

14

Day 1 – Body Composition

Skinfold measurement

Bioelectrical impedance

Air displacement plethysmography

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

In GUSTO, we measured neonatal brain function right after birth

EEG on Day 1 of life
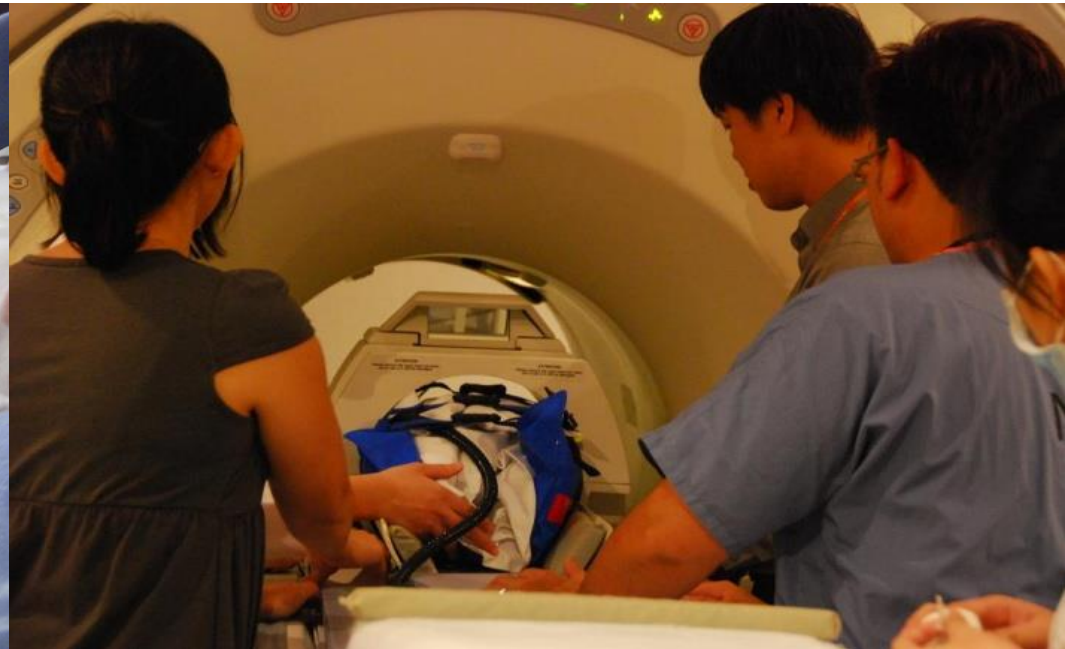
MRI on Day 7 of life

Reconsent

Preparation

Now used for sick infants in KKH

KK Women's and Children's Hospital
SingHealth

Skinfold & Anthropometry

386 MRIs done **without** sedation

BIA

For a subset, MRI is repeated at:
Week 6
Month 6

Into the MRI

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

MR Imaging

Whole Body Study: Head & Chest, Abdomen & Lower Limbs
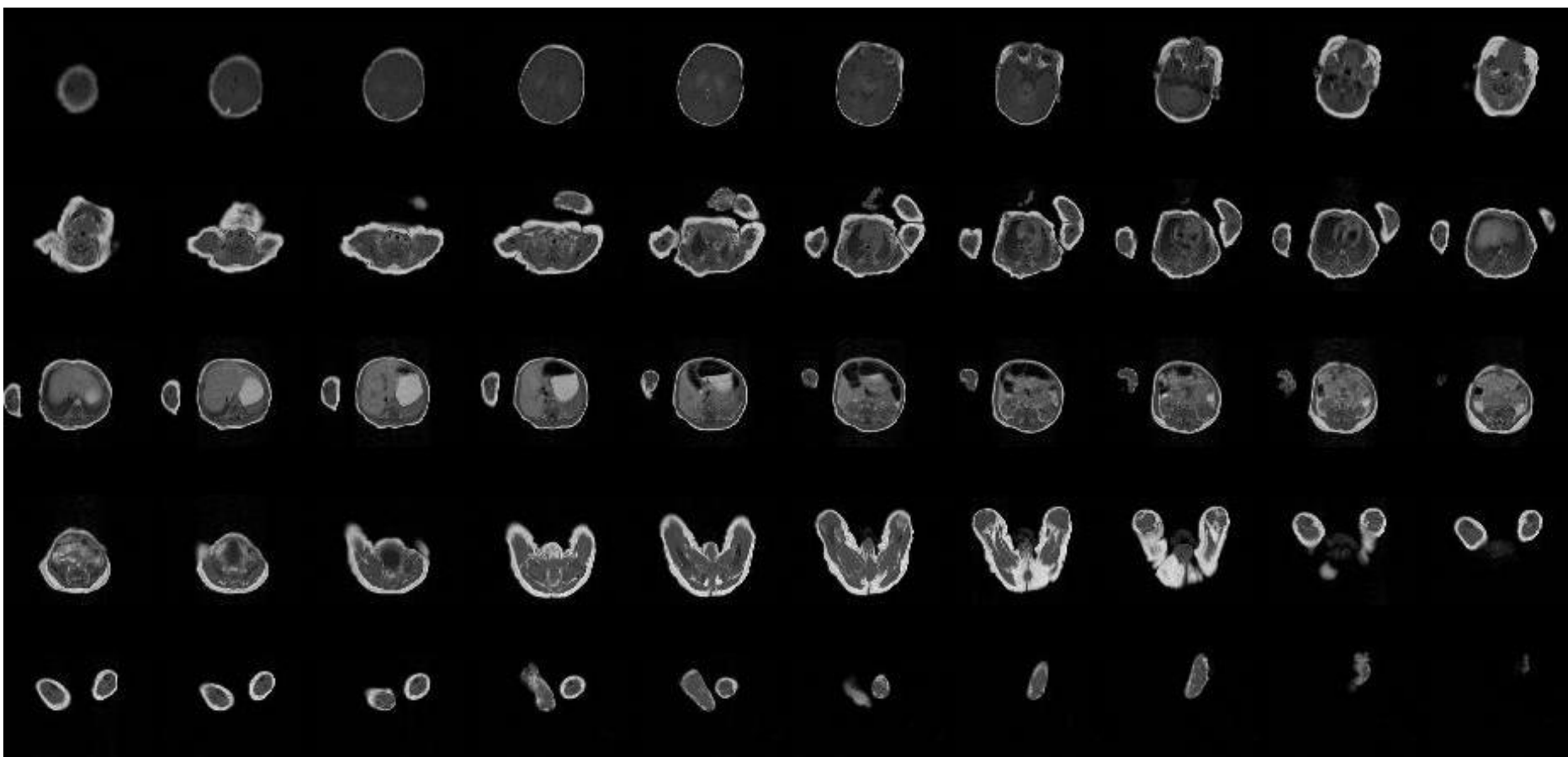
FRACTIONAL ANISOTROPY:
INTEGRITY OF AXONS, IMPORTANT IN MEDIATING NEUROLOGICAL FUNCTIONS
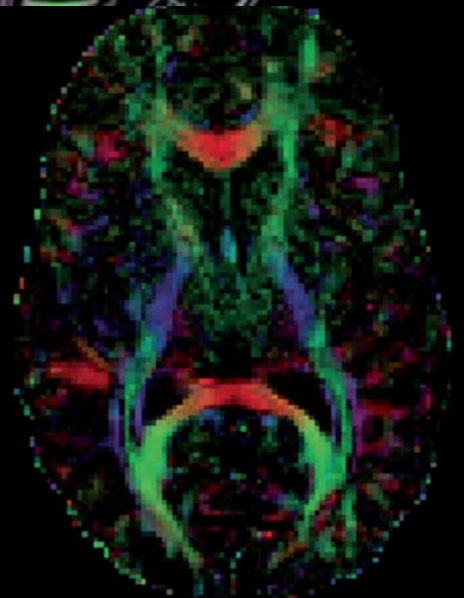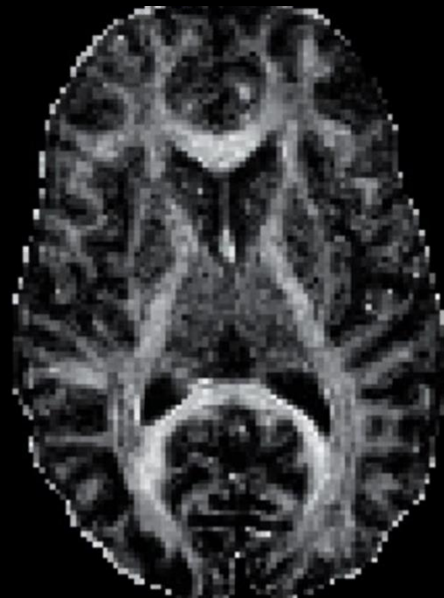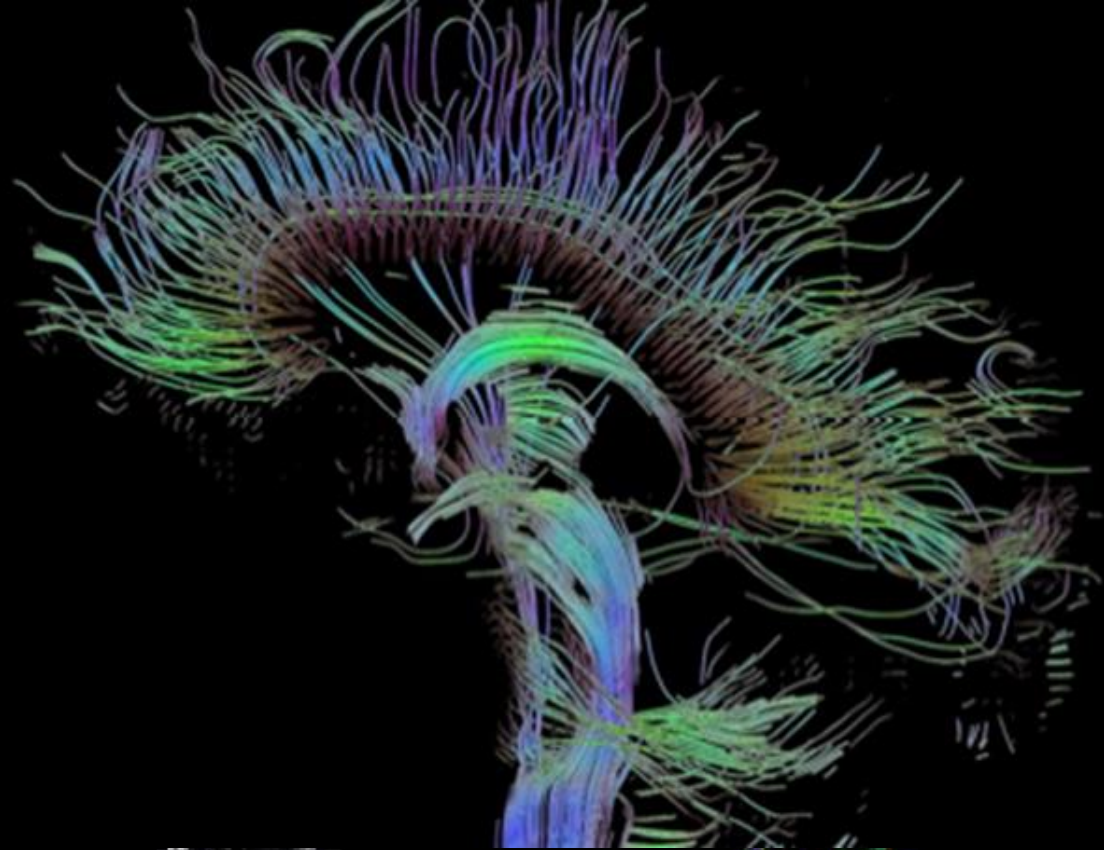
Clinic Visits at 6, 18, 24, and 36 months:
Neurodevelopmental and other detailed assessments
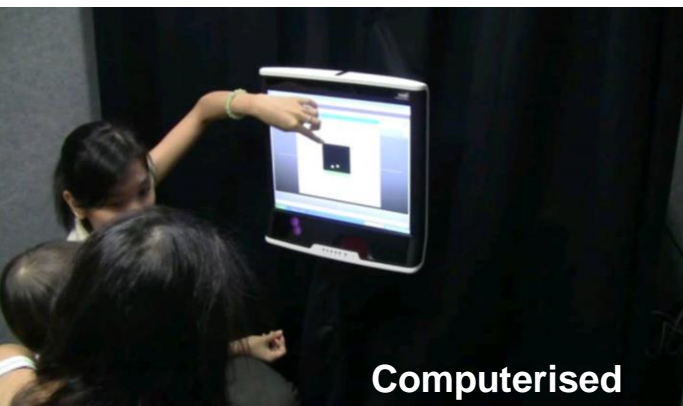
Computerised Eye Tracking

Electrophysiology
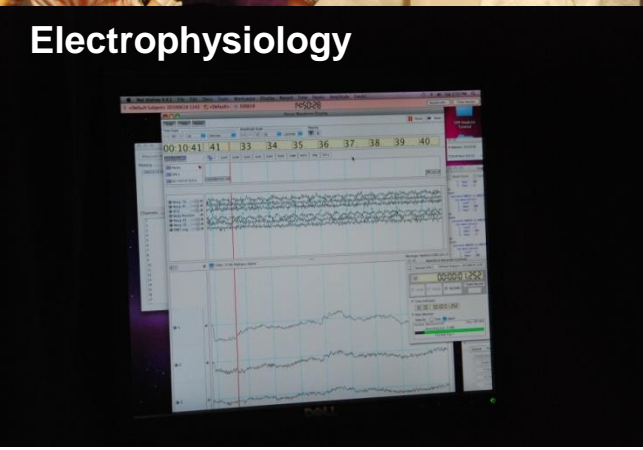
Behavioural Observation

KK Women's and Children's Hospital
SingHealth

now one of the top centres for early neuro-developmental research

4 Years

School Readiness Test

Peabody Picture Vocabulary Test

This is a test of **receptive vocabulary** which assesses the child's vocabulary acquisition.

Lollipop Test

This test assesses the child's ability to **identify colours, shapes, numbers and letters**.

Number Knowledge Test

This test assesses the child's **intuitive knowledge of numbers**.

Visually Cued Recall Test

This test evaluates the child's **working memory** through visual images and verbal information.

Random Object Span Test

This test assesses the child's **visual working memory**.

Comprehensive Test of Phonological Processing- 2

This test evaluates the child's **phonological processing** as a prerequisite to reading fluency.

Panamath

This test measures the child's **number sense** and approximate number system (ANS) which underlies the ability to produce abstract number representation.

Child Behaviour Checklist

This checklist measures the child's **behavioural and socio-emotional functioning** as reported by parents.

These tasks carried out during the **48 Months Home Visit** help to assess the child's 'school readiness' in Singapore.

MRI: *SAFARI ADVENTURE!*

SIEMENS MAGNETOM Skyra syngo MR D13

4.5 Years

MRI Abdominal Compartment at 4.5 years

GUSTO — GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

KK Women's and Children's Hospital
SingHealth

now one of the top centres for early childhood imaging research
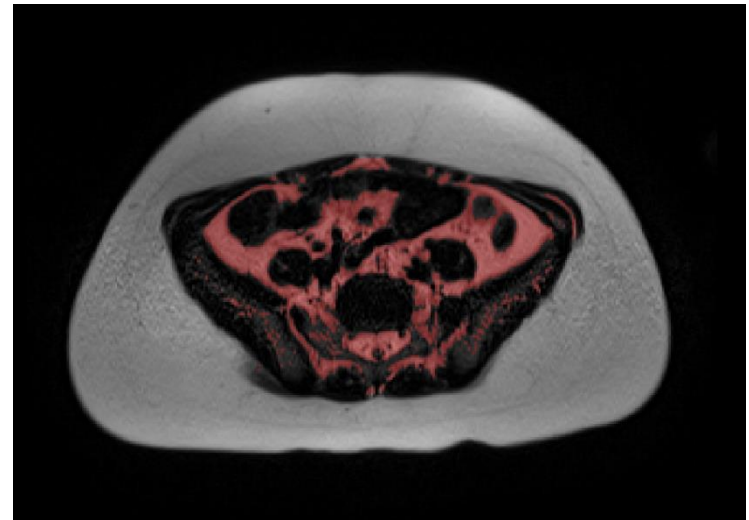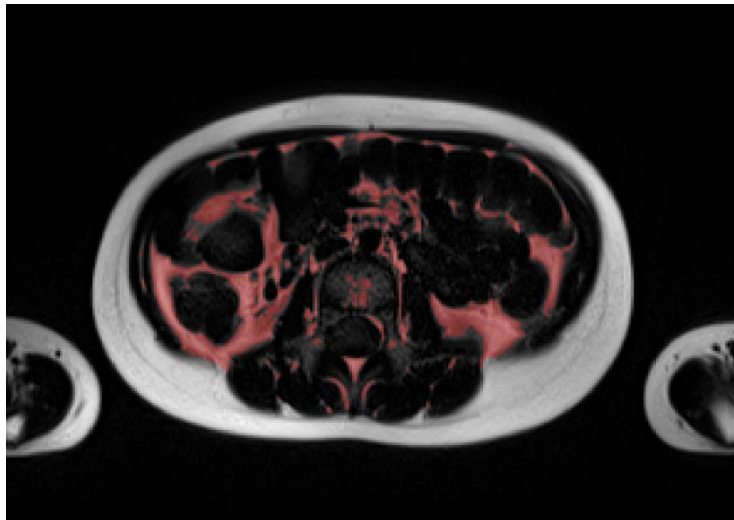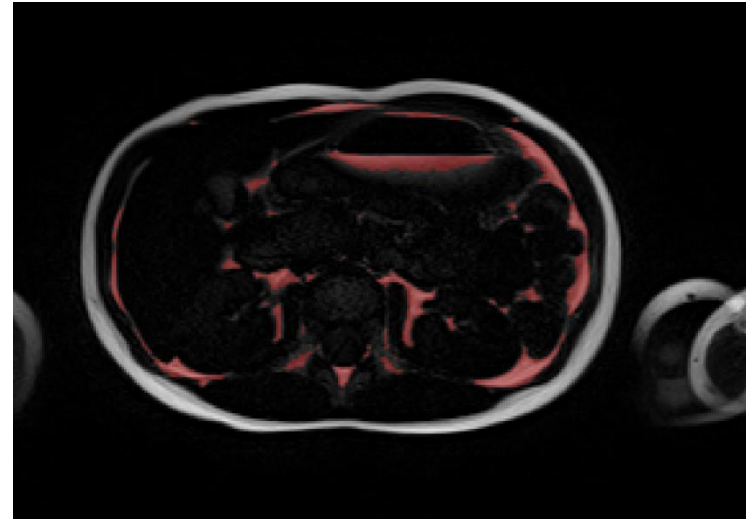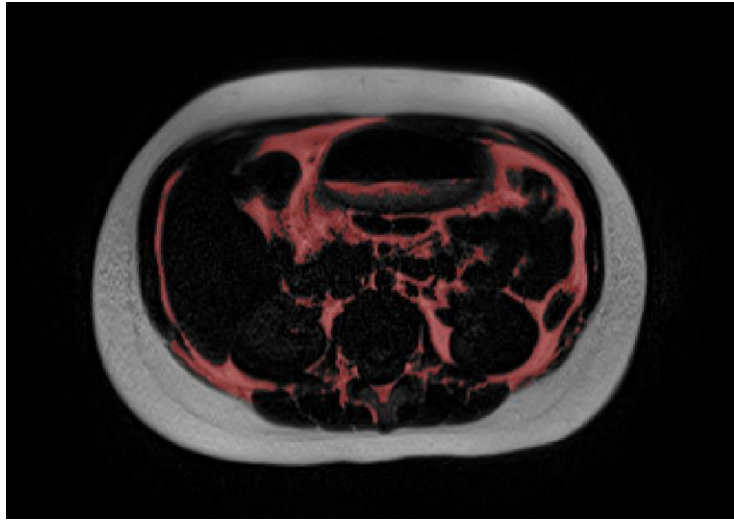
BOD POD:
Spaceship adventure!

Quantitative Magnetic Resonance Technology
QMR: *Fun with sea animals!*

Visit	Status	Visit completed	BOD POD performed	QMR performed (KKH)
Year 5	Ongoing	647	329	193
Year 6	Just started	29	5	21

Translational impact
Turning research into action

GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Importance of Early Mental Health

Short-Term Memory, Working Memory, and Executive Functioning in **Preschoolers**: Longitudinal Predictors of Mathematical Achievement at **Age 7 Years**

Rebecca Bull
School of Psychology, University of Aberdeen, Aberdeen, United Kingdom

Kimberly Andrews Espy and Sandra A. Wiebe
Office of Research & Department of Psychology, University of Nebraska-Lincoln

Moffitt et al, *PNAS, 2010*

Israel et al, *PNAS, 2014*

For Education

For Financial Responsibility and Criminality

Our neonatal MRIs have yielded much new information

ORIGINAL ARTICLE

Maternal anxiety and infants' hippocampal development: timing matters

A Qiu[1,2,3], A Rifkin-Grabo...

ORIGINAL ARTICLE

Prenatal maternal depression alters amygdala functional connectivity in 6-month-old infants

A Qiu[1,2], TT Anh[1], Y Li[1], H Chen[1], A Rifkin-Graboi[2], BFP B...
MJ Meaney[2,8,9]

ORIGINAL ARTICLE

Maternal sensitivity, infant limbic structure volume and functional connectivity: a preliminary study

A Rifkin-Graboi[1], L Kong[2], LW Sim[1], S Sanmugam[1], BFP Broe...
PD Gluckman[8,9], MV Fortier[10], D Pederson[11], MJ Meaney[1,2,11...

ARCHIVAL REPORT

Prenatal Maternal Depression Associates with Microstructure of Right Amygdala in Neonates at Birth

Anne Rifkin-Graboi, Jordan Bai, Helen Chen...
Mya Thway Tint, Birit Leutscher-Broekman,
Marielle V. Fortier, Michael J. Meaney, and ...

Article

COMT Haplotypes Modulate Associations of Antenatal Maternal Anxiety and Neonatal Cortical Morphology

Anqi Qiu, Ph.D.
Ta Anh Tuan, M.S.
Mei Lyn Ong, Ph.D.
Yue Li, B.S.
Helen Chen, M.D.
Anne Rifkin-Graboi, Ph.D.
Birit F.P. Broekman, M.D.
Kenneth Kwek, M.D.
Seang-Mei Saw, Ph.D.
Yap-Seng Chong, M.D.
Peter D. Gluckman, Ph.D.

Marielle V. Fortier, M.D.
Joanna Dawn Holbrook, Ph.D.
Michael J. Meaney, Ph.D.

⊙ PLOS | ONE

RESEARCH ARTICLE

Gestational Age and Neonatal Brain Microstructure in Term Born Infants: A Birth Cohort Study

Birit F. P. Broekman[1,2], Changqing Wang[3], Yue Li[3], Anne Rifkin-Graboi[1],
Seang Mei Saw[4], Yap-Seng Chong[5], Kenneth Kwek[5], Peter D. Gluckman[2,7],
Marielle V. Fortier[8], Michael J. Meaney[3,9], Anqi Qiu[3,10*],
for the GUSTO Study Group[1]

Abstract

Objective: Understanding healthy brain development in utero is crucial in order to detect abnormal developmental trajectories due to developmental disorders.

We are examining the influence of unique Singaporean factors on infant functioning

Cultural Differences in Mirror Self-Recognition in 18
month-old Singaporean Toddlers

Maternal Glycaemia and Influence on Infant Cognition

Effect of GDM on conditional difference in EP max amplitude towards oddball and standard stimuli, stratified by hemispheres.

	Adjusted mean condition difference*† (95% CI)	
6 months (n=104 control, 25 GDM)		p value
Left Hemisphere (µV)	**-0.76 (-1.49 to -0.04)**	**0.039**
Right Hemisphere (µV)	-0.02 (-0.80 to 0.77)	0.964

Maternal glycemia levels influence infant neural activity predicting vulnerability for attentional difficulties such as ADHD

EPmax amplitude condition difference‡ in left hemisphere (µV)	Fasting PG	2 hours PG
	Adjusted† β (95% CI)	Adjusted† β (95% CI)
6 months	-0.04 (-0.78 to 0.70)	-0.19 (-0.42 to 0.04)
18 months	-0.36 (-1.04 to 0.31)	-0.27 (-0.49 to -0.06)

†Adjusted for maternal age, maternal education, sex and gestational age of child, ethnic group, 26 weeks STAI-state, maternal pre-pregnancy BMI and gestational weight gain at 26 weeks gestation. ‡ Condition difference= oddball - standard

Maternal Stress
and
Brain Development
of the Newborn

Maternal anxiety and depression

	During pregnancy	Postpartum
Singapore	• 12.2% with depression • 11% with major depression and 7% with minor depression in high-risk group • 12.5% with anxiety disorder in high-risk group	7% with depression
GUSTO cohort study	• **12% with depression** • **12% with high anxiety symptoms** • **21% with high anxiety personality traits**	• **11% with depression** • **13% with high anxiety symptoms** • **20% with high anxiety personality traits**

- **At least 1 in 9 women in Singapore experience anxiety and/or depression during and after pregnancy.**
- **Anxiety rates in Singapore are higher than what was reported by other groups (roughly double).**

Depression is *the leading cause of disability worldwide* and a major contributor to the global burden of disease (WHO: http://www.who.int/mediacentre/factsheets/fs369/en/)

Neurodevelopment

Maternal depression during pregnancy affects the brain of the newborn

(less ordered neural pathways in a brain region closely associated with **vulnerability for mood anxiety disorders**).

Suggest the transmission of vulnerability for depression from mother to child.

Archival Report

Prenatal Maternal Depression Associates with Microstructure of Right Amygdala in Neonates at Birth

Anne Rifkin-Graboi[a], Jordan Bai[c], Helen Chen[c], Waseem Bak'r Hameed[a], Lit Wee Sim[a], Mya Thway Tint[d], Birit Leutscher-Broekman[a, d], Yap-Seng Chong[d], Peter D. Gluckman[a], Marielle V. Fortier[c], Michael J. Meaney[a, e], Anqi Qiu[a, b].
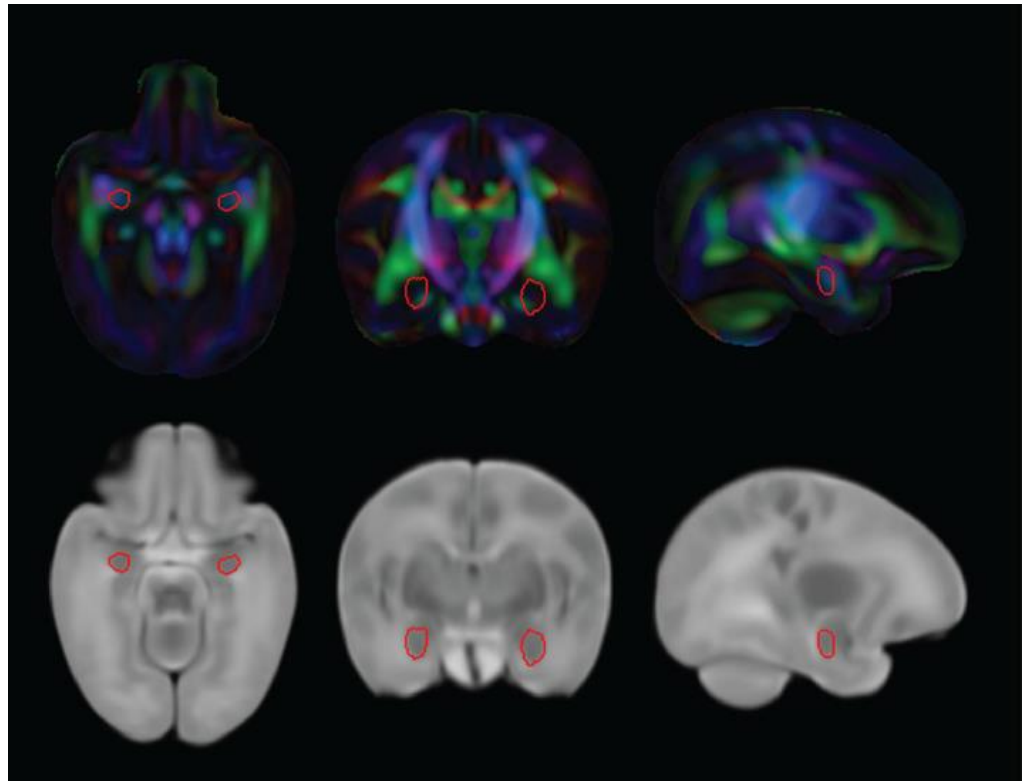
Figure 1: The red contour indicates the __amygdala__ on diffusion tensor imaging and T2-weighted magnetic resonance imaging.

Catechol-*O*-methyltransferase (COMT) Haplotypes Modulate Associations of Antenatal Maternal Anxiety and Neonatal Cortical Morphology
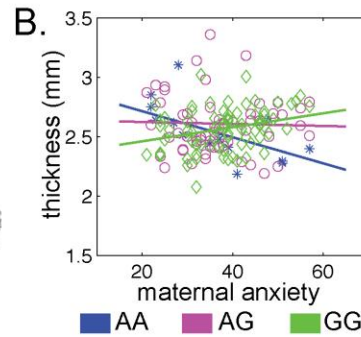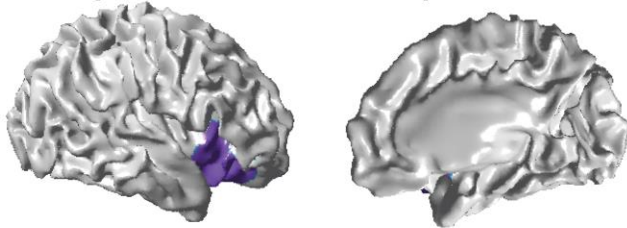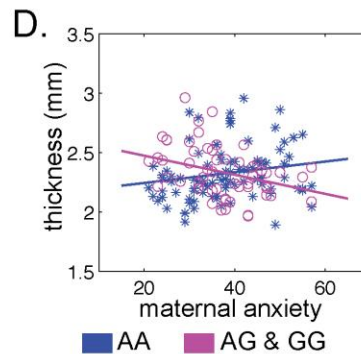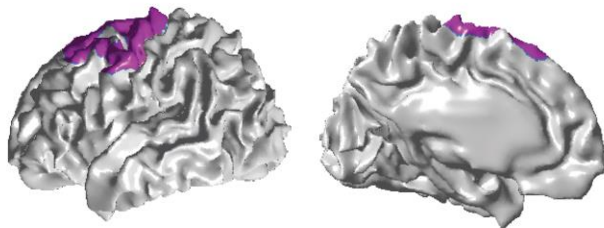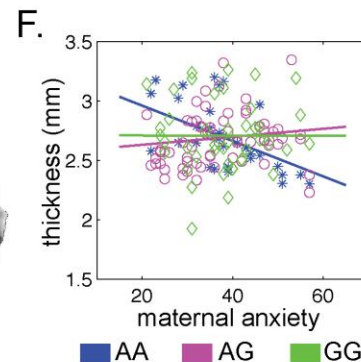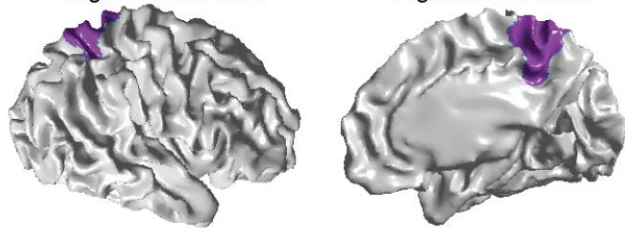
Antenatal **maternal anxiety** affects the prefrontal and parietal **cortical thicknesses** of neonatal brains (involved in **executive functioning & sensory processing**).

This association is modulated by the babies' COMT SNPs (val158met, rs737865, and rs165599).

Recognition of GUSTO's value

FEBRUARY 2015 | VOLUME 172 | NUMBER 2

The American Journal of
Psychiatry

Treatment of Psychosis and Mania in the Postpartum Period

Uncovering the Hidden Risk Architecture of the Schizophrenias:
Confirmation in Three Independent Genome-Wide Association Studies

Paraprofessional-Delivered Home-Visiting Intervention for
American Indian Teen Mothers and Children:
3-Year Outcomes From a Randomized Controlled Trial

COMT Haplotypes Modulate Associations of
Antenatal Maternal Anxiety and Neonatal Cortical Morphology

Official Journal of the American Psychiatric Association
ajp.psychiatryonline.org

- An editorial in the February 2015 issue of the prestigious *American Journal of Psychiatry* lauded the study, remarking that **"the GUSTO design is unique in that it** (doing MRI at 1 week of life) **removes the biggest scientific obstacle that faces most birth cohort studies that aim to examine antenatal factors."**

- **Deputy Prime Minister Teo Chee Hean**, in his speech at the 30th anniversary of Institute of Molecular & Cell Biology on 8 May 2015, described GUSTO as **"a national birth cohort study of Singaporean mothers and babies on how environmental factors affect the development of diseases in later years.**

- **For example, the research findings showed how a mother's anxiety from pregnancy could affect her child intellectually and emotionally from birth."**

**Mr Teo Chee Hean
Deputy Prime Minister**

FINDINGS

- **More than 1 in 9 Singaporean women suffer from anxiety and depression** during and/or after pregnancy.

- Findings from GUSTO show that poor maternal mental health may be associated with **increased neurodevelopmental disorders in the offspring** including anxiety, depressive or disruptive behavior disorders, **even in sub-clinical ranges of maternal anxiety and depression.**

RECOMMENDATIONS TO MOH, 3 SEP 2015

1. Integrate **screening** for anxiety and depression into routine prenatal and postnatal care across all government and private maternity hospitals.

2. Provide professional emotional health **support** for women during pregnancy and continuity of care services from hospital to home.

3. Identify risk factors and **social determinants** for perinatal anxiety and depression and provide targeted help for high-risk groups.

GUSTO
GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Maternal Emotional Well-being:
Screening and Management may benefit
Singapore's future generations.

3 September 2015

Prepared by:

Dr Cai Shirong, NUHS; Prof Michael Meaney, SICS & McGill University; Dr Anne Rifkin-Graboi, SICS; Dr Birit Leutscher-Broekman, NUHS & SICS, Dr Qiu Anqi, NUS; Dr Soh Shu E, SICS; Prof Kenneth Kwek, KK Women's & Children's Hospital; and A/Prof Chong Yap Seng, NUHS & SICS

Collaborators:
KK Women's and Children's Hospital
SingHealth

NUH
National University Hospital

a*
A*STAR
Singapore Institute for Clinical Sciences

Administered by:
NUHS
National University Health System

EVERY WOMAN
EVERY CHILD

Special Communication | **USPSTF RECOMMENDATION STATEMENT**

Screening for Depression in Adults
US Preventive Services Task Force Recommendation Statement

Albert L. Siu, MD, MSPH; and the US Preventive Services Task Force (USPSTF)

DESCRIPTION Update of the 2009 US Preventive Services Task Force (USPSTF) recommendation on screening for depression in adults.

METHODS The USPSTF reviewed the evidence on the benefits and harms of screening for depression in adult populations, including older adults and pregnant and postpartum women; the accuracy of depression screening instruments; and the benefits and harms of depression treatment in these populations.

POPULATION This recommendation applies to adults 18 years and older.

RECOMMENDATION The USPSTF recommends screening for depression in the general adult population, including pregnant and postpartum women. Screening should be implemented with adequate systems in place to ensure accurate diagnosis, effective treatment, and appropriate follow-up. (B recommendation)

Author Affiliations: Author affiliations are listed at the end of this article.

Authors/Group Information: The USPSTF members are listed at the end of this article.

Corresponding Author: Albert L. Siu, MD, MSPH (albert.siu@mssm.edu).

True Translation:
GUSTO findings inspire cartoon

May 5, 2014 The Straits Times

thesunday times

home 17

May 4, 2014 thesundaytimes

Anxious mums = smaller babies

Study finds that the mental state of pregnant women can affect their infants' brain development

Feng Zengkun

Singaporean women who feel stressed, depressed or anxious while pregnant may give birth to children who are more easily distracted and have poorer memory, according to the preliminary findings of a landmark study.

The mental distress may even cause the babies to be born physically shorter, which is an issue as Asian children tend to have higher IQs when they are born longer, heavier or with larger head circumferences.

Scientists from the Agency for Science, Technology and Research's Singapore Institute for Clinical Studies (Sics) said more research is needed, but the findings suggest that looking after expectant women is critical to ensuring their children get the best start in life. "To really help our children grow, we need to take care of soon-to-be mothers and their families early, even before any difficulties arise," said principal investigator Anne Rifkin-Graboi.

PUNCH LINES

NEWS ITEM

Anxious mums = smaller babies

Study finds that the mental state of pregnant women can affect their infants' brain development

Children tend to have higher IQs when they are born longer, heavier or with larger head circumferences.

Since anxious mums give birth to smaller babies, I am keeping my wife as stress-free as possible.

Does a baby with a bigger head lead to a more painful birth...?

AHHH!

Deep Phenotyping

GUSTO , **PRESTO** Singapore PReconception Study of long-Term maternal and child Outcomes **& Nipper** Nutritional Intervention Preconception and During Pregnancy to Maintain Healthy GlucosE Metabolism & OffspRing Health

Demographics & Social Determinants

Maternal Health e.g. gestational diabetes mellitus

Maternal Emotional Well-Being

Nutrition & Metabolism

Cardiovascular changes (including retinal vessels changes)

Endocrine changes

Body Composition (e.g. MRI) & Growth (including fetal ultrasounds

Oral Health

Neurodevelopment

Child Health & Allergy

Longitudinal measures   throughout the Life Course

Pre-conception   Pregnancy   Postnatal and non-gravid   Early childhood and later life

| Genomics | Epigenomics | Transcriptomics | Proteomics | Metabolomics |

Interaction with environment e.g. the Exposome   Microbiome   Metagenomics & Metatrascriptomics

Preconception influences on **maternal** and **offspring** outcomes

Singapore PREconception Study of long-Term maternal and child Outcomes

S-PRESTO
pre-conception cohort

n=1000 women
↓
Mother - 1st generation
Fetus - 2nd generation
Reproductive cells - 3rd generation
n=400 pregnancies
↓
Postpartum women & Offspring (0 - 2 yrs)

- Unprecedented opportunity to study how a woman's health, nutritional and emotional state *before* pregnancy can influence:
  - Their pregnancy outcome
  - Their child's health and development
  - Their own health after pregnancy
- Help us develop guidelines for all reproductive-age women:
  - to give their **babies** the **best start to life**
  - **improve the nation's health**
- **Launched Q2 2015, with over 300 pre-pregnant women enrolled, 50 pregnancies, and 4 deliveries so far.**
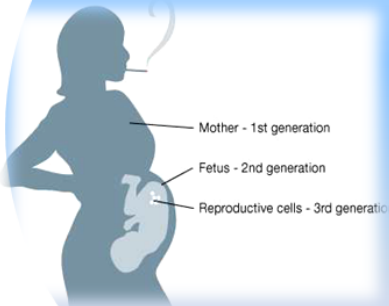

KK Women's and Children's Hospital
SingHealth

Singapore Institute for Clinical Sciences
A*STAR

NUS
National University of Singapore

NUHS
National University Health System

EpiGen
GLOBAL RESEARCH NETWORK

Nipper

Nipper

CHF 22m deal signed Oct 2014

Nutritional Intervention Preconception and During Pregnancy to Maintain Healthy GlucosE Metabolism & OffspRing Health

NIPPER
pre-conception cohort

n=600 women

Mother - 1st generation
Fetus - 2nd generation
Reproductive cells - 3rd generation

n=200 pregnancies

NZ
SG
UK

Postpartum women & Offspring (0 - 2 yrs)

- **High rate of micronutrient deficiency in GUSTO mothers with Gestational Diabetes.**

- **Randomised controlled trial of a pre-pregnancy nutritional drink:**
  – Healthier blood glucose levels in mothers
  – Healthier babies
  – Better long term health for mothers

- **Validate findings across 3 populations:**
  – Auckland, Singapore, Southampton **(EpiGen)**

- **Launched August 2015: 144 subjects randomised, with 13 pregnancies so far.**

Taken orally, twice a day

Directions for use:
Empty content of the sachets in a small glass (200 mL) of water at room temperature

Stir well with a spoon and consume immediately

14.17.NRC

Nipper

The NiPPeR nutritional drink is designed to assist in maintaining healthy glucose levels in the body and to provide standard vitamins and minerals recommended for pregnancy. In the clinical study, 50% of the participants will receive a control drink, which only includes standard vitamins and minerals recommended for pregnancy

Product   Expiry Date

Rising obesity among young set to worsen diabetes rate

The Straits Times, February 22, 2016

Experts warn that 34% of those aged 24 to 35 this year may become diabetic by age 65

Salma Khalik
Senior Health Correspondent

Rising obesity in children and young adults will push up the rate of diabetes in Singapore – already among the highest in the developed world – going by recent studies.

for some children, there is a cycle of weight gain during long holidays followed by weight loss during term time as a result of physical activities and weight-management programmes in school.

Stallholders in school canteens have been encouraged to use healthier ingredients, and drinks

Key Area Going Forward:
Early detection & prevention of Diabetes

GUSTO revealed alarming rates of missed GDM and subsequent development of T2D

S-PRESTO designed to study factors leading to development of GDM and subsequent T2D

NIPPER designed to prevent GDM and subsequent T2D with pre-pregnancy nutritional supplementation

Deep Phenotyping

Longitudinal cohorts throughout the Life Course
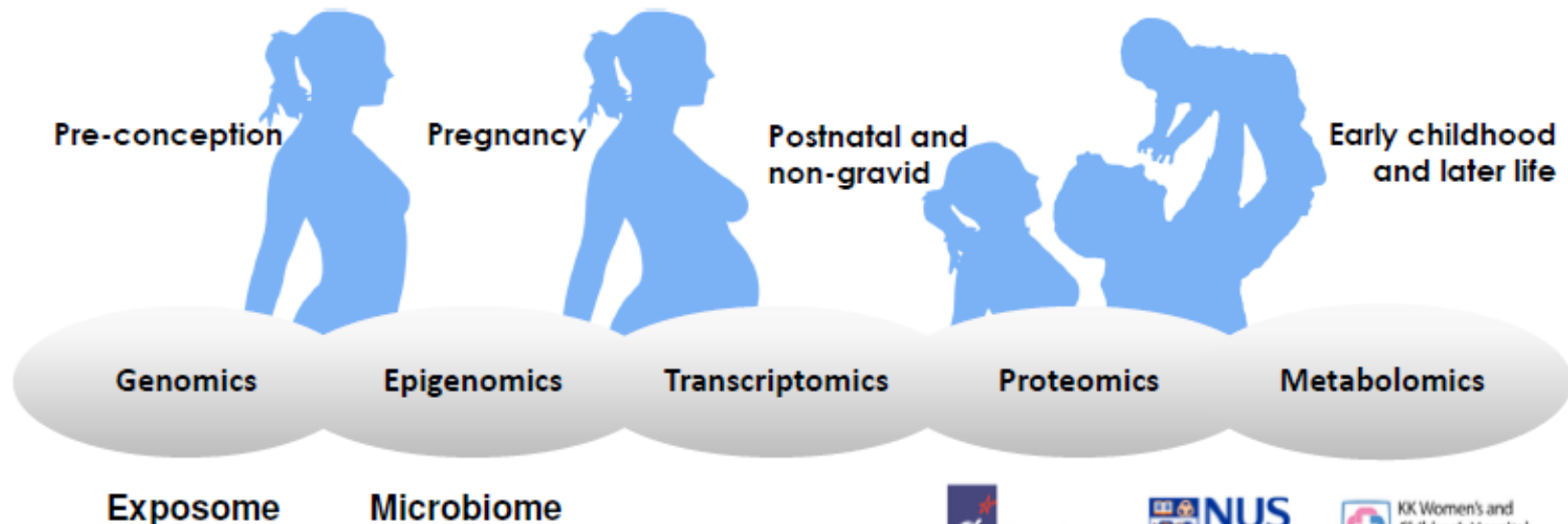
Achievements to date

*Metabolic TCR Flagship Programme, NUS Medicine
Singapore Institute for Clinical Sciences, A*STAR,
Singapore Centre for Nutritional Sciences, Metabolic Diseases,
and Human Development (SiNMeD) and
KK Women's & Children's Hospital*

ACADEMIC IMPACT

- **>350** scientific papers
- **> $120M** in grant funding secured
- Nestle 2015 R&D Award, Innovation Partnership Category
- **12** patent filings
- **47** Students (Masters, PhD & Post doctoral)
- **>200 staff + 35 Faculty members + 3 new faculty recruits**

RESEARCH CAPABILITIES

- GUSTO Birth Cohort (launched 2009)
- Neurodevelopment Research Centre (launched 2010)
- Clinical Nutrition Research Centre (launched 2014)
- S-PRESTO & NIPPER Pre-conception Cohorts (launched 2015)

SOCIETAL VALUE

- *Advancement in MRI technique to improve the quality of patient care*
- *Optimising maternal & offspring health through changing national health policy*
- *Improving understanding of factors influencing early school performance*
- *Community engagement & education for health & nutritional literacy*

ECONOMIC VALUE

- **12** patent filings at the national phase, including 9 with major industry partners
- Deep collaborations with major nutrition companies like Abbott, Danone & Nestle have led to establishment of new research facilities in Singapore
- **>S$28M** in direct industry funding for R&D in Singapore with another $10M in the pipeline

We are doing all this to benefit Singaporeans and to
Change Tomorrow's Health, *Today*. . .

Name	Affiliation	Name	Affiliation	Name	Affiliation
CHONG Yap Seng	NUHS	Walter STÜNKEL	SICS	Elizabeth SPELKE	Harvard, US
LEE Yung Seng	NUHS, SICS	Neerja KARNANI	SICS	YONG Eu Leong	NUHS
QIU Anqi	NUS	SAW Seang Mei	NUS	Arijit BISWAS	NUHS
Kenneth KWEK	KKH	Lynette SHEK	NUHS	TAN Heng Hao	KKH
Bryan Emmett OGDEN	SEMC, Duke-NUS	Stephen HSU	NUHS	Shephali TAGORE	KKH
Joanna D. HOLBROOK	SICS	CHAN Yiong Huak	NUS	Bernard CHERN	KKH
Fabian YAP	KKH	Jonathan CHOO T.L.	KKH	SU Lin Lin	NUHS
Peter GLUCKMAN	SICS	QUEK Swee Chye	NUHS	Melvin LEOW	SICS
Marielle FORTIER	KKH	Robert GRIGNANI	NUHS	HUANG Zhongwei	NUHS
LING Lieng Hsi	NUHS	Sendhil VELAN	SICS, SBIC	Claudia CHI	NUHS
Jeyakumar HENRY	SICS	Philip LEE Teck Hock	SBIC	LI Jun	NUHS
Mary CHONG	SICS	Jeevesh KAPUR	NUHS	Philip BAKER	UoA, NZ
Rob Martinus VAN DAM	NUHS	Micheal LIM C.M.	KKH	Paul ROBSON	GIS
LEK Ngee	KKH	HAN Wee Meng	KKH	NG Huck Hui	GIS
CHEUNG Yin Bun	Duke-NUS	Keith GODFREY	Southampton, UK	HAN Weiping	SBIC
Michael MEANEY	SICS	Mark HANSON	USoton, UK	Mark VICKERS	UoA, NZ
Birit Broekman	NUHS, SICS	Wayne CUTFIELD	Auckland, NZ	DING Chun Ming	SICS
Anne Rifkin-Graboi	SICS	John WONG	NUS	TAN Chuen Seng	NUS
Leher SINGH	NUS	Daniel FUNG	IMH	CHNG Chai Kiat	KKH
Joshua GOOLEY	Duke-NUS	Michael CHEE	Duke – NUS	Cheryl NGO	NUHS
Helen CHEN	KKH	Eric FINKELSTEIN	Duke – NUS	LEE Bee Wah	NUHS
Prathiba AGARWAL	KKH	Cornelia CHEE	NUHS	Hugo van BEVER	NUHS
CHONG Shang Chee	NUHS	Iliana MAGIATI	NUS	QUAH Boon Long	KKH/ SNEC
TAI E Shyong	NUHS	Daniel GOH	NUHS	Tony PLEASANTS	AgResearch, NZ
TAN Kok Hian	KKH	Mahesh RAMAMURTHY	NUHS	Sheila BARTON	USoton, UK
George YEO SH	KKH	Mary DANIEL	KKH	Allan SHEPPARD	UoA, NZ
Jerry CHAN Kok Yen	NUHS, KKH	LIM Sok Bee	KKH	Karen LILLYCROP	USoton, UK
Citra MATTAR	NUHS	Anne GOH	KKH	Laurent FAY	Nestlé
		Oon Hoe	KKH	Thomas BECK	Nestlé
Victor Samuel RAJADURAI	KKH	Pauline TAY STRAUGHAN	NUS	James KAPUT	Nestlé
Anne Ferguson-Smith	Cambridge			Irma SILVA-ZOLEZZI	Nestlé