National Science Challenges

Centre for High-Value Nutrition

HIGH-VALUE NUTRITION

Ko Ngā Kai Whai Painga

Ministry for Primary Industries
Manatū Ahu Matua

NEW ZEALAND

Translational Science for Food and Health

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Chief Scientist HVN

November 1st 2016

Host Institution

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

MASSEY UNIVERSITY
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agresearch

Plant & Food RESEARCH
RANGAHAU AHUMĀRA KAI

National SCIENCE Challenges

SCIENCE OF FOOD

METABOLIC HEALTH

GUT & IMMUNE HEALTH

WEANING FOOD

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HIGH-VALUE NUTRITION

Ko Ngā Kai Whai Painga

Science

NZ Foods

Metabolic Health

Immune Defence

GI Comfort

Special Casein Milk

Natural Milk

Kiwifruit

Grass-fed beef lipids

Green-shell mussels

Combined Proteins

Food Bioactives

Fibres for Sleep

Asian Consumers

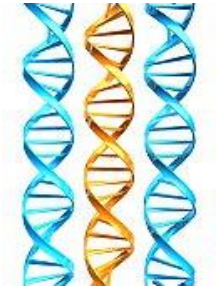
IP Retail Regulatory

Business

HIGH-VALUE NUTRITION

Ko Ngā Kai Whai Painga

« Inner Health » : Where Genes meet Environment



- EpiGenomics
- Transcriptomics

EpiGenotype

PREDISPOSITION PROGRAMMING DEVELOPMENT

PHYSIOLOGY PATHOLOGY

Molecular Phenotype

- *Proteomics*
- *Metabonomics*
- *MicroNutrients*

- MicroNutrients
- Physical Activity
- Cognitive Activity

Diet and Lifestyle

ENVIRONMENT

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« Inner Health » across Life Stages

ELDERLY
Longevity

ADULTS
Weight
Management

BABIES
CHILDREN
Diabetes

EarlyBird DIABETES

Nipper

obesity
diet
genes
diogenes

ALMA MATER STUDIORUM A.D. 1088
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International Clinical Trial

Study to examine the impact of nutrients before and during pregnancy on the health of mothers and their babies

The NiPPeR study involves researchers in the United Kingdom (Southampton), Singapore and New Zealand (Auckland) from the EpiGen Global Research Consortium who are trialling the use of a combination of nutrients and probiotics before and during pregnancy to improve the health of mothers and their babies.

Increasing evidence shows the mother's nutritional state as she enters pregnancy is important for the baby's development. For example, if the mother has high blood sugar levels it can predispose the baby to having increased body fat in later life. The researchers will evaluate the benefits of the nutrients to the mother and baby. They will study the effects on maintaining healthy blood sugar, vitamin and mineral levels in the mother, and the potential to promote a healthy pregnancy and healthy growth and development of the child. In addition, the study will evaluate the impact on the activity of the baby's genes (so-called "epigenetic" mechanisms). Read more

TRIAL COUNTRIES

- Auckland, New Zealand
- Singapore
- Southampton, United Kingdom

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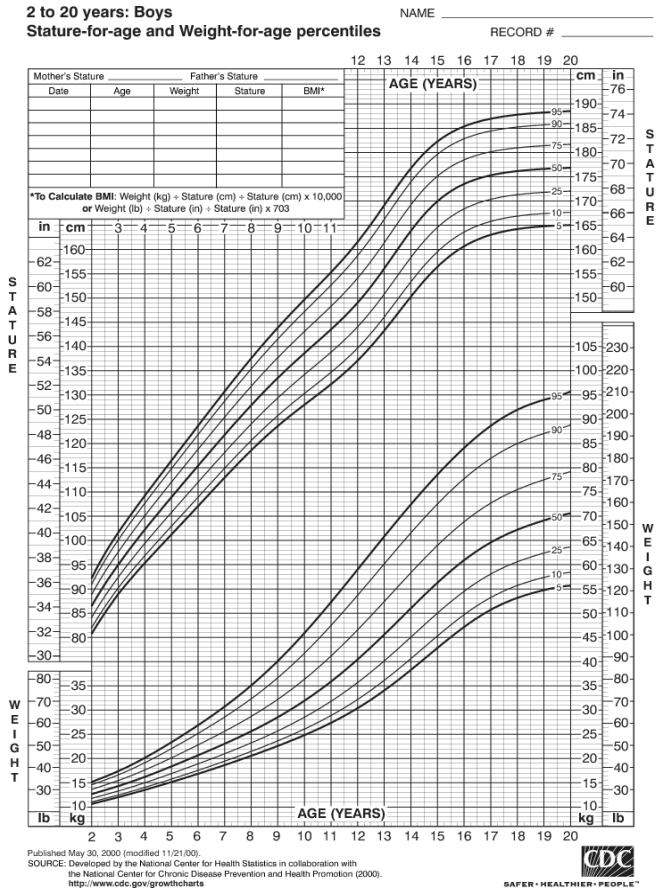
Multidim. Growth Curves



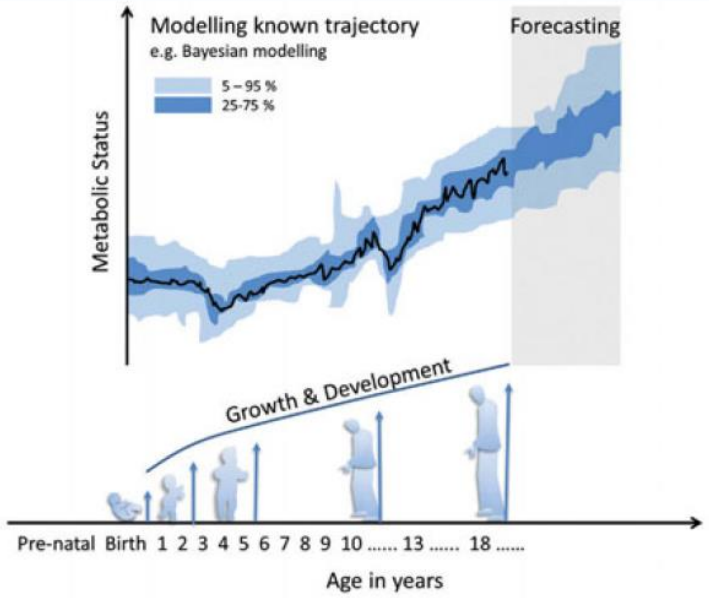


Figure 1. A comprehensive system biology approach of individual trajectory across childhood is needed to capture the influence of all major influential factors during growth, development and pubertal staging. The identification of early biomarkers might help in stratifying different childhood conditions and metabolic disease risks.
Legend: The black line delineates an individual metabolic trajectory, with light and dark blue areas delineating the distribution of the metabolic status observed at population level, at 5-95 percent and 25-75 percent confidence interval, respectively. Based on data collected from birth till adulthood, modelling may be relevant to predict future disease development risks, highlighted as Forecasting.

Cominetti, Martin. Agro FOOD Industry 2014.
Sperisen, Cominetti, Martin. Frontiers Mol. Biosci. 2015

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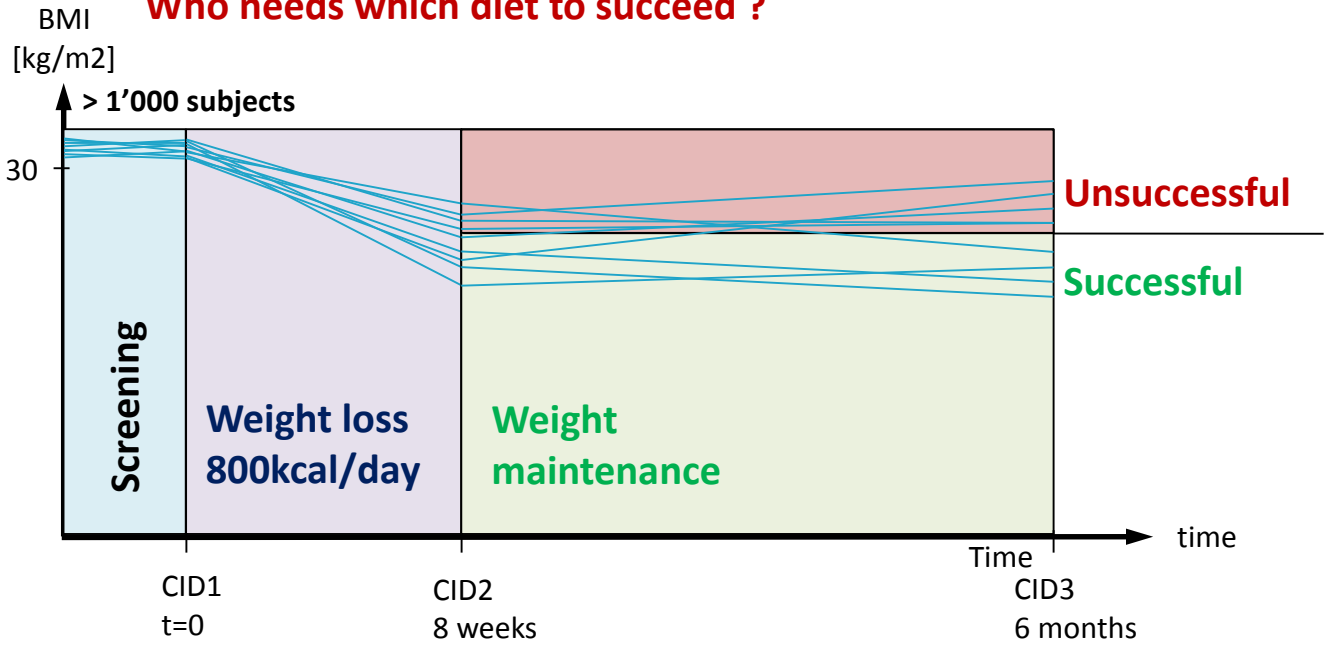
DiOGenes – Diet, Obesity and Genes

- **EU program incl. weight loss/maintenance in obese**
- **NIHS questions:**
  Can we predict success in weight loss/maintenance at baseline ?
  Who needs which diet to succeed ?

≈ 1'000 subjects
> 4'000 samples
> 7'000 variables
(clinical, food diaries, behavior, molecular)



Quantitative Multivariate Analysis

www.diogenes-eu.org

Rubio-Aliaga…Kussmann, MNFR 2011. *Larsen et al., N. Engl. J. Med., 2010, 363, 2102–2113*

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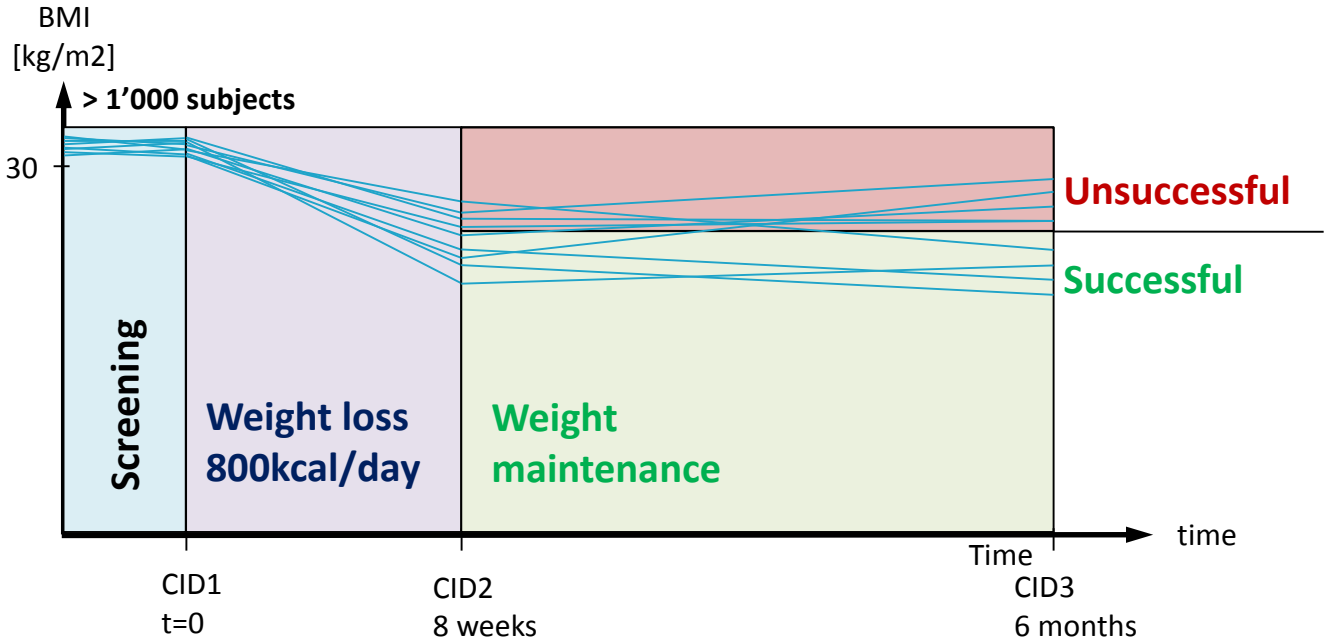

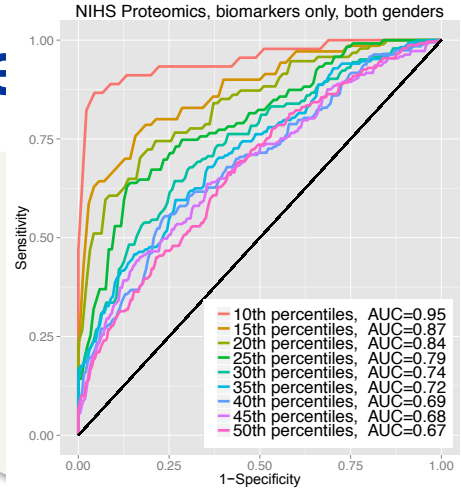

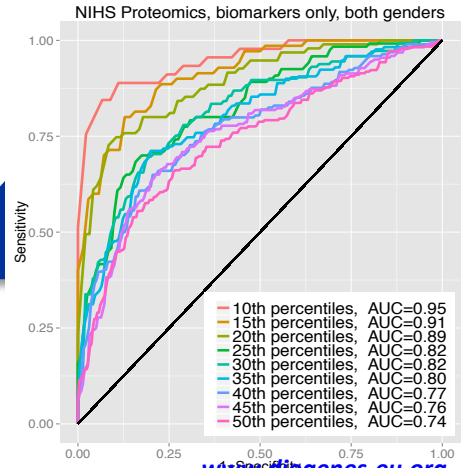

www.diogenes-eu.org

Irincheeva, Cominetti, Dayon, Kussmann….Hager in prep. ***Larsen et al., N. Engl. J. Med., 2010, 363, 2102–2113***

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Centenarians as a model of healthy ageing

Factor	Centenarians	Elderly	Young	Pvalue
BMI, *kg/m²*	24.2±3.8 (13.3-31.2)	26.9±4.6 (16.7-54.7)	22.1±2.0 (18.3.24.6)	a(***), b(***)
HOMA, *μU/mL*	1.77±1.1 (0.20-23)	2.81±2.57 (0.20-28.9)	n/a	a (***), n/a
Diabetes[1], *n*	1	25	n/a	n/a
Cholesterol, *mg/dl*	185.0±32.7 (112-264)	201.0±37.2 (5-335)	162.3±28.4 (133-207)	a (***), b (***)
Triglycerides, *mg/dl*	114.4±46.1 (60-283)	129.9±65.7 (44-530)	71.7±32.1 (28-143)	a (*), b (***)
HDL, *mg/dl*	48.2±13.1 (25-99)	55.2±20.4 (20-147)	51.8±8.7 (38-66)	a (**), b (**)
LDL, *mg/dl*	105.6±35.1 (75-165)	118.7±45.7 (23.8-199)	89.8±51.5 (49-144)	a (**), b (***)
CRP, mg/L	5.0±5.3 (0.28-28.2)	2.7±3.6 (0.11-25.7)	0.72±0.4 (0.28-2.08)	a (***), b (***)
A-SAA, *μg/ml*	437.6±483.7 (15.5-851)	149.1±204.6 (0.01-186)	n/a	a(***), n/a
IL-6, *pg/ml*	46.9±41.6 (7.5-225)	35.4±54.9 (0.28-28.2)	20.3±17.5 (2.70-28.2)	a, b (***)
IL-8, *pg/ml*	20.9±20.8 (6-71)	22.72±27 (2.3-100)	19.3±13.3 (4.4-46.6)	a ,b (*)
IL-10, *pg/ml*	3.93±4.3 (0.6-19.9)	6.07±15.4 (1.5-20)	2.38±2.58 (0.80-3.80)	a,b (***)
TNF-alpha, *pg/ml*	23.5±4.3 (0.40-113)	49.1±153.1 (0.1-80)	18.5±28.5(5.80-65.5)	a,b (***)
MMSE[2]	20.4±7.04 (1.3-30.3)	27.3±1.3 (1.3-31.0)	n/a	n/a

Our centenarians are lean, youthful-looking, energetic, independent, and have low rates of heart disease and diabetes

Centenarians appear to be capable of neutralizing/diminishing the deleterious effects of low-grade, chronic inflammation, characteristic of the aging process

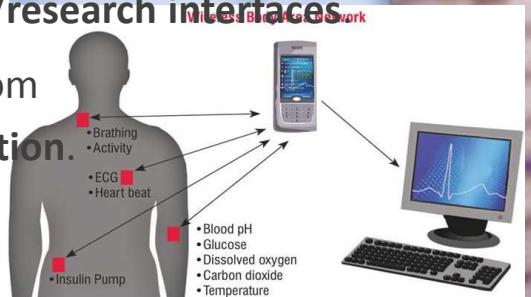
Franceschi et al. 2007

Healthy ageing involves the **interaction** between **genes**, the **environment**, and **lifestyle** factors, particularly **diet**

Rampelli S. et al, Aging 2013, Montoliu et al, Aging 2014, Collino et al. MAD 2014
Santoro et al. MAD 2014, Garagnani et al. Biomed Research 2014, Cominetti et. al. 2014, AgroFoodTech

Translational Genomics & Personalized Health

- **System approach to human health**: rethinking models with regard to translatability.
- Classical case/control designs of human studies: complement by **crossover, longitudinal studies**, in which every subject is its own case and control.
- Humans should not only be assessed fasting, i.e. when the metabolic system is “at rest”, but also during a (**nutritional, physical, or cognitive**) **challenge**.
- Quantitative monitoring of the **human environment**, including diet, lifestyle, and socio-economic status can now be done by attractive and precise image-based **consumer/research interfaces**.
- The bottleneck in knowledge generation has moved from **acquisition to processing, visualization and interpretation**.
- This requires innovative **biological network analysis**.



Kussmann, Kaput. Appl. Transl. Genomics 2014

Future Health Care « Quantified Self »

- Empower consumers to **self-monitor** their **health and lifestyle**, and to take informed decisions on **maintaining and improving** their health.
- Discover and validate **(bio)markers for healthy physiology, activity and eating.**
- Deliver research lab-derived panels of markers that monitor **health trajectories of consumers who share genomics, lifeystyle and diet.**
- These consumer groups are homogeneous enough to be addressed by a common **«personalized» solution**, and large enough to be **economically relevant.**
- Translate these research analytics into **hospitals**, **medical cabinets**, and – eventually – **hand-held devices** and **body bugs.**
- From «measuring everything» in study subjects to «**measuring what matters**» in consumers.
- Develop app's for **consumer-end monitoring and communication** with health practitioners.
- Develop app's that **guide consumers to diet and lifestyle solutions.**
- ***https://en.wikipedia.org/wiki/Quantified_Self*** ; ***http://quantifiedself.com/***

Kussmann, Kaput. Appl. Transl. Genomics 2014

Quantified Self