LENScience Teacher Professional Development Seminar Series

Nutrigenomics in the Classroom

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Teacher Professional Development Series 2010
Teacher PD Series 2010
Regional Venues

100 NZ schools and growing...
Nutrigenomics in the Classroom

Nutrigenomics – What, why and how?
An appropriate context for teaching?
Folate: A controversial biological issue for NZ
Curriculum, Assessment and Support
Question and Answer Session
Live Chat throughout the workshop

Technical Support

Lynn Ferguson
Michal Denny
Lynn Ferguson
Michal Denny
Jacquie Bay
Helen Mora
Matt Barnett
Anna Lehmann
Nutrigenomics

The study of the response of humans to food and food components
Different Elements of Nutrigenomics

Effect of an *environmental* exposure on health and disease risk in people with different *genotypes*

Effect of a *genotype* on health and disease risk in people with different *environmental* exposures

Why are some people healthier than others?

- Calculated risk for the general population
- Calculated risk for the people carrying genes that may increase the risk
The Goal of Nutrigenomics New Zealand

To develop foods that can be matched to individual human genotypes to benefit the health of those individuals and enhance normal physiological processes.
Studying Nutrigenomics

- Genetics
- Epigenetics
- Genomics
- Proteomics
- Metabolomics
Genetics

- The study of human variability

- Methods
  - SNP detection
Genetics

• The study of human variability

• Methods
  ◦ SNP detection
  ◦ Copy number variant detection
Genetics

• The study of human variability

• Methods
  ◦ SNP detection
  ◦ Copy number variant detection
  ◦ Gene Chips
Genetics

• The study of human variability

• Methods
  ◦ SNP detection
  ◦ Copy number variant detection
  ◦ Gene Chips
  ◦ DNA Sequencing
Epigenetics

- The study of heritable changes in gene function that occur without a change in the sequence of nuclear DNA.
  - X Chromosome inactivation
  - Gene silencing

- Mechanisms
  - DNA methylation
  - Chromosome remodeling
Genomics

• The study of genomes
  ◦ Patterns of Gene Expression

• Biotechnological Techniques
  ◦ Microarrays
  ◦ Gene Expression Verification via PCR
  ◦ Bioinformatics
Proteomics
Proteomics

- Human genome
  - 30,000 genes that generate about 500,000 proteins.
- Linear association between the genome, transcriptome and proteome does not exist.
- Using a “multi-omics” approach is important.
RNA extraction | Histology | Protein extraction

Colon tissue

Microarrays

qPCR

Proteomics

Histology
RNA extraction → Microarrays → qPCR

Colon tissue

Histology

Protein extraction → Proteomics
Metabolomics

Genome → Transcriptome → Proteome → Metabolome

Biomarker discovery

• Effects of foods on metabolism
• Metabolite markers showing effects of foods on our health
Metabolomics

• Effects of foods on metabolism
• Metabolite markers showing effects of foods on our health
Nutrigenomics Capability
• Collaborative Research Programme

• Currently funded by the New Zealand government through the Foundation for Research, Science and Technology
Factors Influencing Choice of Teaching Context

Student Interest

Curriculum

Assessment
Factors Influencing Choice of Teaching Context

Resource Access

Student Interest

Assessment

Curriculum
Factors Influencing Choice of Teaching Context

- Resource Access
- Relevance to Society
- Culture of Science

Curriculum
Folate Debate

Links Curriculum Concepts
Can Be Assessed
Accessible Resources
Student Interest
Relevant Contextual Learning Experiences

Non-Contextual Learning Experiences

Passive Learning Experiences

Active Learning Experiences

Transformational Learning
Students encounter the culture of science

Non-Contextual Learning Experiences
The Folate Debate

• What is folate?
• Why do we need folate in the diet?
• Why do some people need more than others?
• Folic acid fortification – an easy or complex answer?
• B-group Vitamin
• Source – diet (cannot be synthesised within the human body)
• Essential for synthesis of nucleic acids
• Enzyme co-factor
• Involved in synthesis, function, and repair of DNA
Where is folate found in the diet

- Green Vegetables
- Citrus Fruits
- Dietary Supplements
- Whole Grain Cereals & Breads
- Nuts and Pulses
Folate and Neural Tube Defects

http://www.cdc.gov/ncbddd/birthdefects/SpinaBifida-graphic.htm
Folate and Neural tube Defects

- ~50 NZ children per year born or terminated with NTD
- US ~ 4,000 neural tube defects per year (Live births, ignores terminations)
- Occur at 26-28 days post-conception
- 95% are spontaneous with no family history
- 1991 UK study showed 71% risk reduction in recurrences (4mg dose) (ref)
- In 1999 US Study 85% reduction in risk for primary prevention (0.4mg dose) (Nov 1999 NEJM)
Neural Tube Defects are not the only issue

- Cardiovascular Disease
- Cancer
- Brain Health
Biomarkers as risk indicators

- Premature Atherosclerotic Heart Disease
- Cancer
- Brain Health

High Levels of Homocysteine
Biomarkers as risk indicators

High Levels of Homocysteine

DNA & Cellular Damage

Good Cellular Function
Low Risk of Disease

Low Levels of Homocysteine

Folate with Vit B6/B12 + favourable genetics

Folate with Vit B6/B12 + favourable genetics
Prevalence of inadequate folate intake in New Zealand Children (females)

- Maori
- Pacific
- Pakeha

2002 National Childrens Nutrition Survey (MoH)
Prevalence of inadequate folate intake in New Zealand Children (females)

2002 National Children's Nutrition Survey (MoH)
Age-adjusted U.S.A. colorectal cancer incidence, 1996-2002, SEER database
Age-adjusted U.S.A. colorectal cancer incidence, 1996-2002, SEER database
Age-adjusted U.S.A. colorectal cancer incidence, 1996-2002, SEER database
TSER polymorphism and folate intake

![Bar chart showing odds ratios for different genotypes across low and high folate intake.]
TSER polymorphism and folate intake

Genotype Variant: A/A, A/B, B/B

Comparison of Odds Ratio:
- Low Folate
- High Folate

Odds Ratio:
- A/A: Low Folate (1.2) vs. High Folate (1.0)
- A/B: Low Folate (0.7) vs. High Folate (0.6)
- B/B: Low Folate (0.5) vs. High Folate (0.8)
A controversial issue for New Zealand

- Bakers and Millers
- Traditional Dieticians
- Clinicians
- Free choice
- People and families at high risk of dementia or cardiovascular disease
- Families who have suffered the consequences of NTD (Children or Termination)
Key scientists in the Field

- Bruce Ames
- Cornelia Ulrich
- Michael Fenech
Curriculum, Assessment and Support

• Curriculum
  ◦ Nature of Science
  ◦ Living World

• Assessment
  ◦ AS 90714
  ◦ AS 90769

• Resource Support