Epigenetics and Breastmilk: The Potential Impact of Breastfeeding on Genetic Expression
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Why am I interested in epigenetics?
It’s About History and Herstory

What is epigenetics?
Literally means above the gene.
Study of how our environment, internal and external influences genetic expression.
Genome=DNA
Epigenome=Phenotype

What is epigenetics?

How does epigenetics work?
Genome – Traditional Biology

How does epigenetics work?
Genetic Activity

How does Epigenetics Work?
Imprinting

How does Epigenetics Work?
Imprinting

How does Epigenetics Work?
Imprinting

How does epigenetics work?
Epigenome
Translator
Methylation

How does epigenetics work?
Developmental Origins
Metabolism
How does epigenetics work?
- Genetic Activity

How does epigenetics work?
- Epigenome
- Can be inherited
- The memory of the environment experienced is passed down
- Has been demonstrated in animal research up to 5 generations out

Why does it work?
- We are constantly adapting for optimal survival.
- The fetus is preparing for optimal survival outside the womb.
- The newborn is managing its new environment and adjusting to cues.

Breastfeeding and Epigenetics
- During pregnancy and early postpartum life babies are programmed nutritionally to adapt to their environment.
- Abundant resources, immune support, healthy food
- Limited resources, immune challenge, poor nutrition

How does epigenetics work?
- You are what you eat?
- You are what your mother and grandmother ate.
- Diet of grandparents linked to longevity in offspring
- What is the impact of breastmilk?
- The act of breastfeeding?

How does epigenetics work?
- "Nutritional status can influence epigenetic profiles by inhibiting enzymes that catalyze DNA methylation or histone modifications or by influencing dietary availability of substrates necessary for these enzymatic processes."
  Zaneta, 2011

Clear evidence that prenatal and early postpartum
environment influences the child lifelong.

23 Epigenetic Animal Studies

- Mouse studies
  - Agouti mice (Jirtle, 2000)
  - PCOS/BPA and rats (Nilsson, 2012)
  - Prescott 2012 reduced ability to release oxytocin

24 Study 1 – Mammary Growth Yields

- Role of Compensatory Mammary Growth in Epigenetic Control of Gene Expression – Chung 2005
- Rats on compensatory nutrition program
- Energy restriction (all essential nutrients but caloric reduction) has significant biological impact on animals
  - Retardation of aging
  - Reduction of cancer
  - Reduction late life disease
- Energy restriction shifts physiology to energy-conserving and away from energy wasteful metabolic pathways
- Refeeding then causes accelerated anabolism, increased growth

25 Study 1 – Mammary Growth Yields

- Role of Compensatory Mammary Growth in Epigenetic Control of Gene Expression – Chung 2005
- Majority of mammary growth occurs in developmental phase of neonate
- Dairy industry has been practicing this for years, called stairstepping
  - Energy restriction followed by refeeding during pre-puberty, puberty and gestation. Increases yields by up to 10%
- Two groups in trial - Rats
  - Group One-dietary restrictions for first 10 days gestation
    - Same minerals, protein and vitamin, just energy restriction at 60% of mean intake
  - Group Two
    - Regular diet
Study 1 – Mammary Growth Yields

Mammary Development and Epigenetic Expression in Prenate

Dietary restriction group showed improved mammogenesis and later lactation performance

Study 1 – Mammary Growth Yields

Restricted energy led to

- Increased cell proliferation
- Concurrent elevations of the expression of genes involved in cell proliferation and differentiation
- When diet improved in last trimester during epithelial cell proliferation this had significant impact
- Effect impacts subsequent lactations

Study 1 - Mammary Growth Yields

Duration of Breastfeeding and LEP

"Duration of breastfeeding and gender are associated with methylation of the LEPTIN gene in very young children." Obermann-Borst et al.

DNA methylation of LEP, a non-imprinted gene

Responsible for appetite regulation and fat metabolism

Duration of Breastfeeding and LEP

Study

Maternal Education, Breastfeeding Duration, Constitutional Factors at 17 mo. old

Measured DNA methylation of LEP in whole blood and also serum leptin

120 mother/child couplets (99 breastfeeding info0

75% breastfed

- 14% <1 mo.
- 22% >1-3 mo.
- 21% >3-6 mo.
- 18% >6 mo
Duration of Breastfeeding and LEP

Findings

- No assoc. maternal education and duration of bf
- Children who breastfed at least 1-3 mo (instead of receiving artificial milk) had higher serum concentrations of leptin
  - 2.8 vs. 2.6 mmol/l; P=0.025

Milk Kinship and Epigenetics

Epigenetics and Milk Kinship


Does wet nursing or milk sharing cause consanguinity?

Milk Kinship and Epigenetics

Epigenetics and Milk Kinship

Why is this a possibility?

- Exosomes in breastmilk
  - Genetic material such as microRNA
- Stem Cells
- Organic substances affecting epigenetic regulation mechanisms

Milk Kinship and Epigenetics

miRNA in Breastmilk

- MicroRNA in Breastmilk
- High levels of miRNA in breastmilk in first six months of lactation
Suggest that humans can transfer genetic material other than sexual reproduction

**miRNA in Breastmilk**

- Biggest Risk of Influence
- Before age of 2
  - Inadequacy of immune system to reject genetic material
  - Increased plasticity
  - Increased vulnerability of epigenome during developmental period

**Questions to ponder**

- Might prenatal and preconception nutrition make stronger environmental signals on epigenetic breastmilk programming than supplementing only during critical periods?
- Short term supplement may mimic short term environmental conditions. Humans are highly plastic and adaptive.

**Questions to Ponder**

- Very clear data that stress has epigenetic impact, and is multigenerational.
- Very clear evidence that social standing and hierarchy has very clear impact on health gradient.
- Very clear evidence that in western societies, low income, higher stressed mothers have shorter duration of breastfeeding?
- What epigenetic influence is this cumulative effect having on babies and their future offspring?

**Thank You**

- Questions:
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- [www.thegreatestpregnancyever.com](http://www.thegreatestpregnancyever.com) list of research, updated slide outline