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MOTHER'S MILK AND THE MICROBIOME

Tiffany Weir, PhD
Associate Professor
Food Science and Human Nutrition
Colorado State University

The Gut Microbiota

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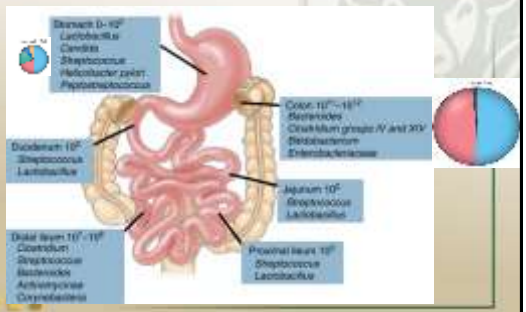

Am J Gastroenterol Suppl (2012) 1:15–21

Gut Microbiota: Fun Facts

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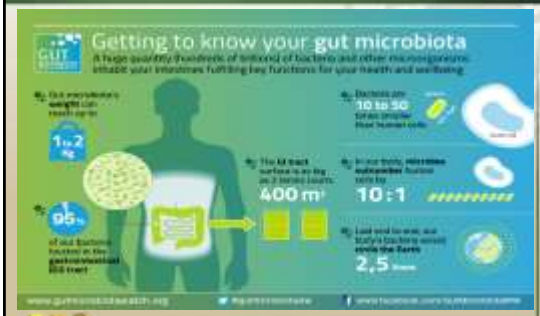

Protection

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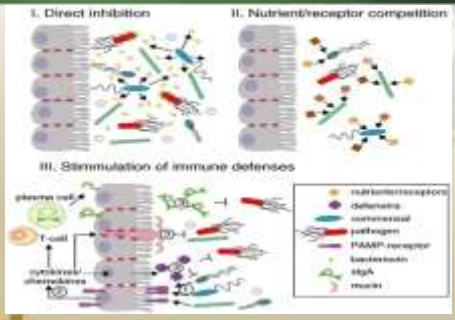

Digestion

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- Indigestible carbohydrates
  - Bacteria encode enzymes we lack
  - SCFA
- Fat
  - Can modify bile acids
  - Certain bacteria are thought to aid in fat digestion
- Protein
  - Proteolytic processes degrade proteins into amino acids
- Synthesis of essential amino acids
  - Microbially synthesized can contribute 19-22% of daily requirements.
- Synthesis of vitamins
  - vitamin K and B
  - B12: site of synthesis vs absorption
- Absorption of ions (Calcium, Magnesium, iron)

Obesity

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- Germ-free mice required 30% more calories to maintain same weight as normal littermates
- Germ-free mice transplanted with normal microflora gained weight.
- Increased energy harvest associated with higher levels of the phylum Firmicutes

* Turnbaugh and Bäckhed studies from Gordon lab (2006)

Obesity

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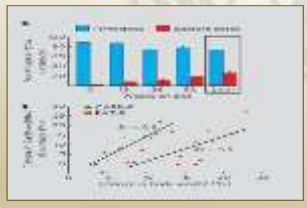

Ley et al. 2006. Nature

Obesity

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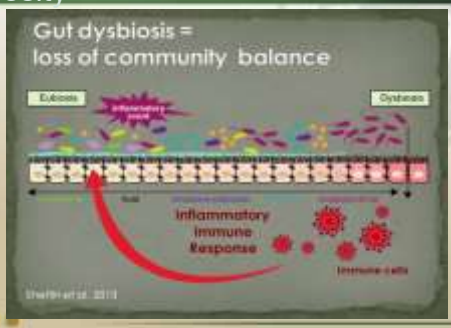

Sheflin et al. (2014) *Curr . Oncol. Reports* 16: 406.

Obesity

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When co-housed the "lean" mice transferred their microbes and their phenotype to the "obese" animals!

Ridaura, V. K. et al. Science 341, 1241214 (2013).

Developing Tolerance

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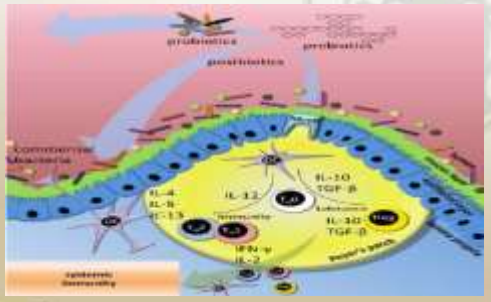

https://www.youtube.com/watch?v=gnZEge78_78

Microbiota and Health

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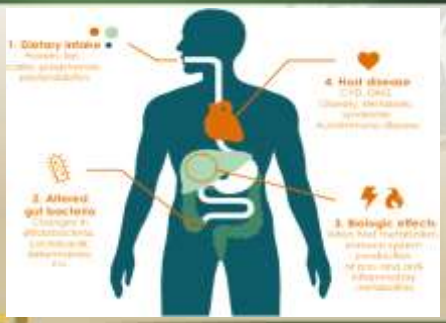

Singh et al. 2017. J Transl. Med.

Microbiota and Health

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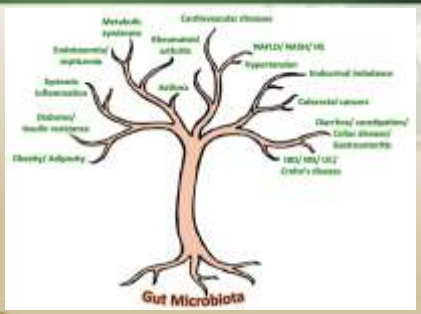

Nagpal et al. 2014 Front Med. dx.doi.org/10.3389/fmed.2014.00015

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HOW DO WE GET THESE MICROBES?

Birth influences and early feeding patterns are CRITICAL for a healthy adult microbiome.

Colonization Influences

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Putignani et al (2014) Ped Res 76, 2-10.

Gestational Diabetes

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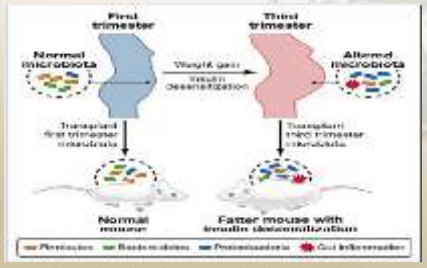

Pregnancy leads to alterations in a woman's microbiota that increase metabolic challenges.

Koren et al (2012) Cell 150:470

Fetal Programming

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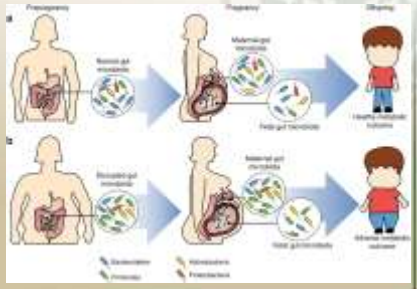
Maternal obesity is a strong predictive factor of childhood obesity and may be due to microbiota effects.



Gohir et al (2015) Ped Res 77:196.

Maternal Weight and Microbiota

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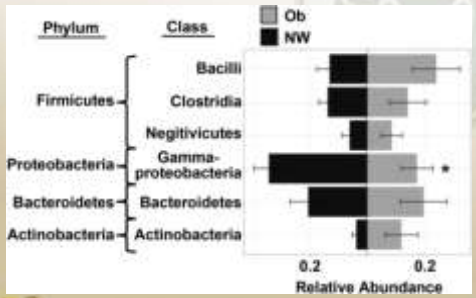

Malnutrition and Microbiota

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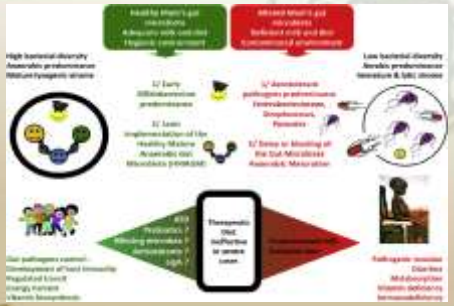

Placental Microbiome

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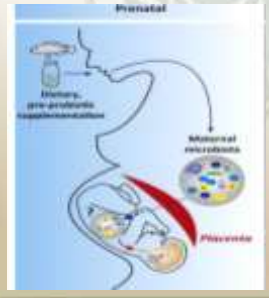
Small populations of microbes have been detected in the placenta.

Composition most closely mimics the mother's oral microbiota.

May lead to pre-natal exposures to microbes that start priming the immune system.

Link peridontal health and pre-term infancy?



Mode of Delivery

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Nature Rev Microbiol (2010) 9 :27-38

Table 1	
Cesarean Delivery Associated Childhood Diseases[1,2]	
Allergic Rhinitis	
All Cesareans	1.37 (1.14-1.63)
Repeat Cesareans Only	1.78 (1.34-2.37)
Asthma	
All Cesareans	1.24 (1.01-1.53)
Female	1.53 (1.10-2.10)
Female & Repeat Cesarean [3]	1.83 (1.13-2.97)
Celiac Disease	1.80 (1.13-2.88)
Diabetes Mellitus (Type 1)	1.18 (1.04-1.36)
Gastroenteritis [4]	1.31 (1.24-1.38)
Gastroenteritis AND Asthma	1.74 (1.38-2.23)

Clin Perinatol. 2011 38:321-331

Restoring Microbiota

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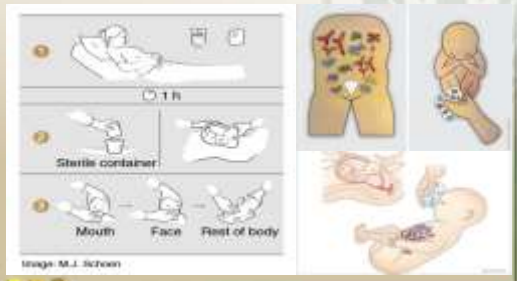

Image: M.J. Schoen

Dominguez-Bello et al. (2016) Nature Med 22:250.

Microbial Dynamics

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https://www.youtube.com/watch?v=Pb272zsixSQ

Arrieta et al, Front. Immunol.| http://dx.doi.org/10.3389/fimmu.2014.00427

Breast vs. Formula

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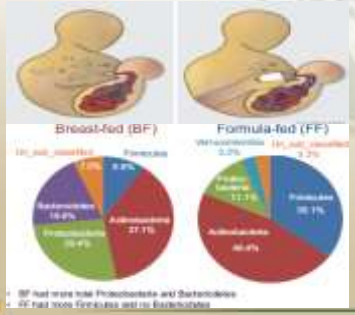

Donovan et al. (2012) *Advances in Nutrition* 3(3):450S-455S.

Milk Microbiome

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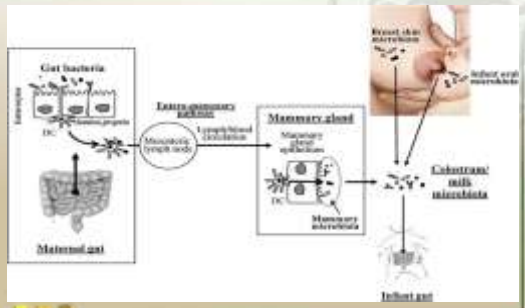

Mother's Milk Microbiome

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Oligosaccharides

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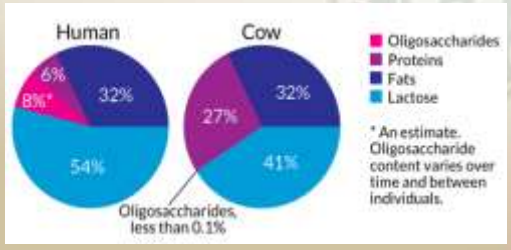

How they work…

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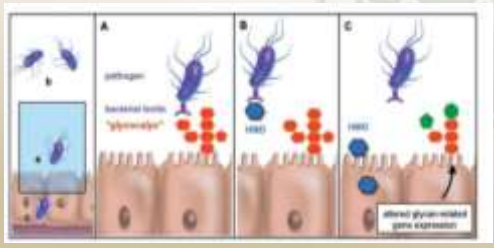

Directly prevent pathogen colonization and attachment.

Complementary Feeding

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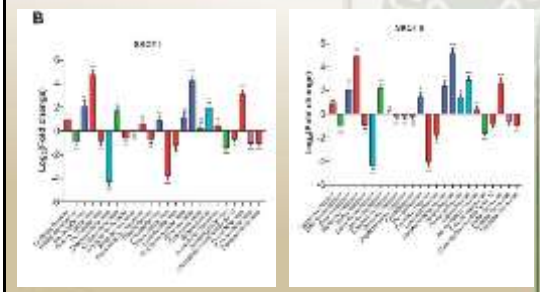

Laursen et al. (2016) mSphere **DOI:** 10.1128/mSphere.00069-15

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What should I eat?

Feeding the Microbiome of Mom and Baby.

Fiber

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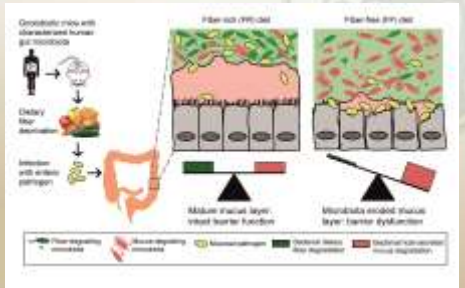

Desai, et al.(2015) Cell,167,1339 -1353

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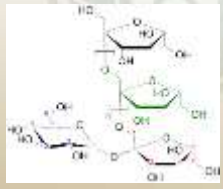
Prebiotics are non-living indigestible polysaccharides (food components) that stimulate the growth of beneficial bacteria (*Bifidobacterium*).



Prebiotic Sources

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- Diet
  - Major dietary sources are consumed in limited amounts in a typical American diet
- Supplements
- Fortification in foods
  - Yogurt
  - Infant formula
  - Artificial sweeteners

Foods with Prebiotics	Prebiotic Fiber by weight	Amount needed for 4g serving
Chicory Root	64.6%	6.2 g
Jerusalem Artichoke	31.5%	13 g
Dandelion greens	26.3%	24.7 g
Raw garlic	17.5%	34.3 g
Raw leek	11.7%	51.3 g
Raw onion	8.8%	69.8 g
Cooked onion	5%	120 g
Raw asparagus	5%	120 g
Raw wheat bran	5%	120 g
Whole wheat flour, cooked	4.8%	125g
Raw bananas	1%	600 g

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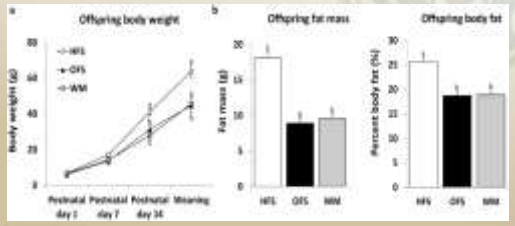
Maternal Prebiotics Reduce Offspring Weight Gain in Rats



Paul et al.2016. *Scientific Reports.* doi:10.1038/srep20683

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Omega 6:3 in BM

Increased ratios of Omega 6:3 in breast milk associated with higher INFLAMMATION, INSULIN RESISTANCE, OBESITY, and reduced NEUROPROTECTIVE EFFECTS.

Animal Sources:	Plant Sources:
Sardines	Walnuts
Wild Salmon	Chia Seeds
Sablefish/Black Cod	Hemp Seeds
Flaxseed/Flaxseed oil	Tofu+ Tempeh
Grass-fed Meats	Cauliflower
Grass-fed Dairy	Broccoli
Pasture-raised Eggs	Dark leafy greens

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Probiotics are live bacteria or yeast that when eaten in sufficient amounts can be beneficial for intestinal health.

Slide from Katie McGirr, CSU Extension

Probiotic sources

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- Food sources:
  - Fermented dairy foods like yogurt, kefir products, and aged cheeses
  - Some fermented non-dairy foods including kimchi, sauerkraut, ar kombucha
  - Supplemented non-fermented foods: Good Belly

Slide from Katie McGirr, CSU Extension

Summary:Pre/Probiotics

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- Prebiotic supplementation (2 months prenatal and during lactation) prevented excess adiposity and improved insulin sensitivity in offspring.
- Probiotics 2 weeks pre-natally activates immune responses and alters meconium microbiota.
- Probiotics given during the 3rd trimester and during lactation to mothers with skin allergies reduced eczema incidence in infants.

Summary (cont)

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- Probiotics administered to C-section babies in the first 6 months of life reduced allergies in children at 5 years.
- Systematic review of probiotic use in pre-term infants suggest little risk and possible benefits of probiotic supplementation on NEC.

Cautions

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- Antibiotics should not be overused, but have a lifesaving, important place in modern medicine.
- In the wrong place, even good bacteria go bad.
- We still have a long way to go
  - Many studies in animals rather than humans
  - Human studies on limited population size, ethnic/geographic/socioeconomic backgrounds

Key Points

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- Disturbances in the maternal microbiota are heritable and can influence child health outcomes.
- Breastfeeding provides the infant with pre- and probiotics necessary for early immune development.
- Dietary management of the microbiota is critical for mother and child in the pre and early postnatal period.

Useful info

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- Microbial changes during pregnancy, birth, and infancy. Nuriel-Ohayon et al (2016) Frontiers in Microbiology. Doi:10.3389/fmicb.2016.01031
- Consumerlabs: https://www.consumerlab.com/
- Natural Standards: https://naturalmedicines.therapeuticresearch.com/
- International Scientific Assocn of Probiotics and Prebiotics: https://isappscience.org/

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Mothers' Milk Bank

Colorado Based. Nationwide Reach.

a program of Rocky Mountain Children's Health Foundation

https://rmchildren.org/?gclid=CNjJhtyc4tMCFdO3wAodK78GJg


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