

Nutrition Strategies for Infants and Toddlers



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Continuing Education Information

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- **Webinar is being recorded**
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Objectives

- Translate existing data and evidence-based research into protein, zinc and iron recommendations for infants and toddlers.
- Provide context to the dialogue around the important role of meat/beef as a first food.
- Educate peers and consumers on the scientific evidence supporting beef's role as a complementary food for babies.

Jill Castle, MS, RD, LDN

- Registered dietitian and childhood nutrition expert.
- Owner of Castle Nutrition and the creator of The Nourished Child blog and podcast.
- Author of “The Smart Mom’s Guide to Starting Solids,” focused on introducing, advancing and nourishing babies with first foods.
- Co-author of “Fearless Feeding: How to Raise Healthy Eaters from High Chair to High School.”
- Over 25 years of experience in pediatric nutrition.
- Frequently quoted as a childhood nutrition and feeding expert in popular print and online presentations including U.S. News & World Report, WebMD and Parents magazine.



Disclosure Information – Jill Castle, MS, RD, LDN

Type of Support	Organization Name(s)
Consulting	The Beef Checkoff
Royalty	“Fearless Feeding: How to Raise Healthy Eaters from High Chair to High School”
Stock	Once Upon a Farm

Robert Murray, MD, FAAP

- Pediatrician and professor in the Department of Human Nutrition and associate member of the Food Innovation Center (FIC) at The Ohio State University.
- Consultant on projects involving pediatric nutrition and childhood obesity, and leader for FIC's efforts in overcoming specific barriers associated with overweight and undernourished children.
- President of the Ohio chapter of the American Academy of Pediatrics (AAP).



Disclosure Information – Robert Murray, MD, FAAP

Type of Support	Organization Name(s)
Consulting	The Beef Checkoff National Dairy Council Abbott Nutrition Dannon Co. Sabra Dipping Co. Hass Avocado Board Egg Nutrition Council

Complementary Feeding

Growth

Neurodevelopment

Immediate and Life-Long Health

“The process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants...” [such that] “other foods and liquids are needed, along with breast milk”

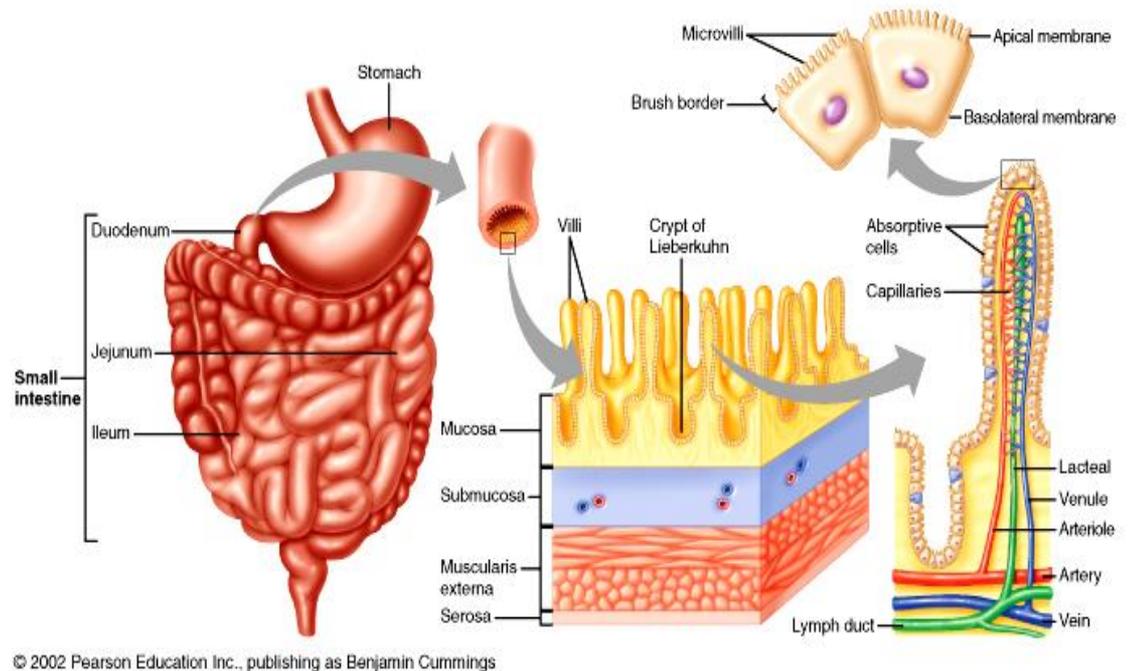
- World Health Organization

Protein's Function

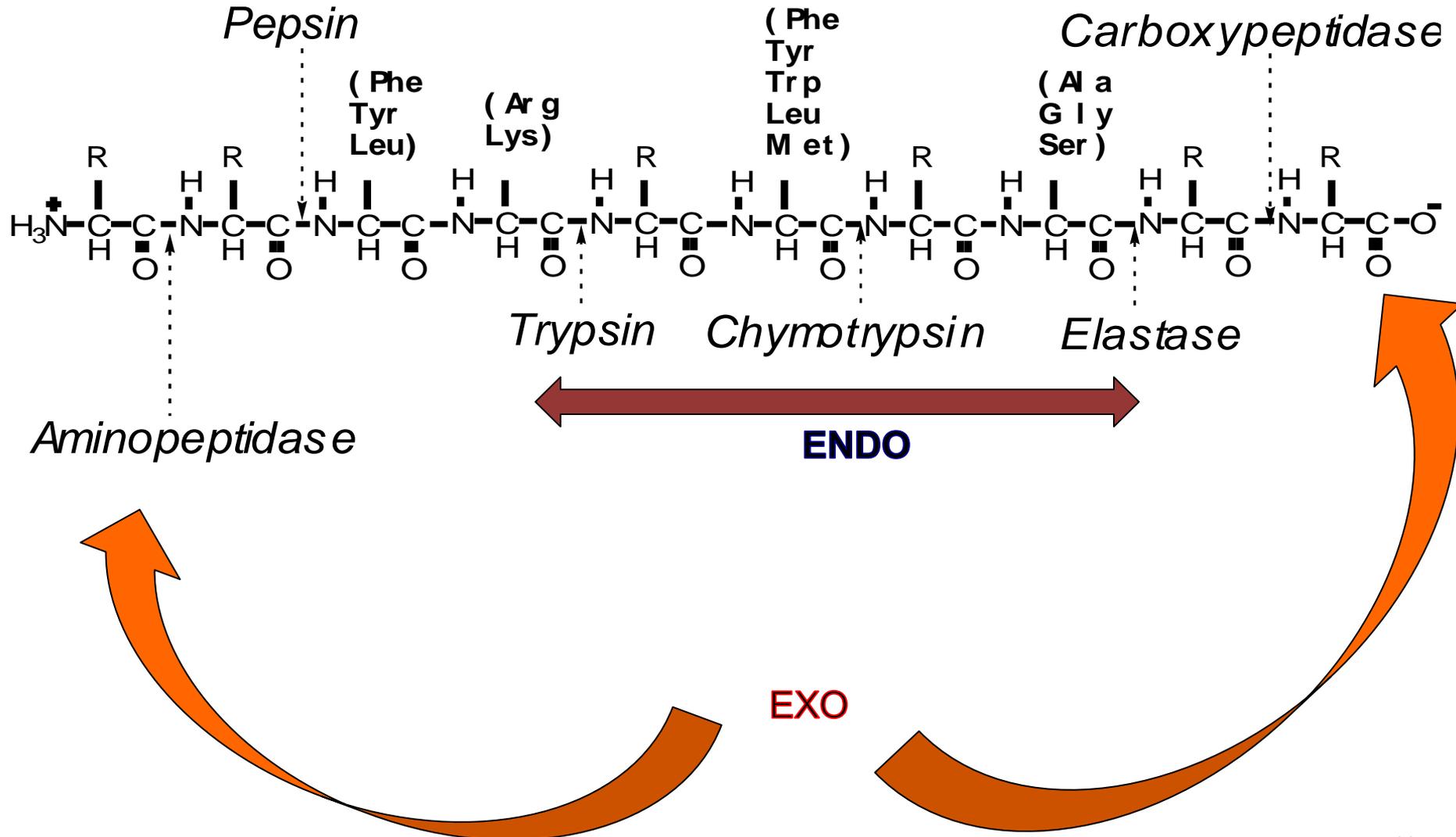
- Structural and functional components of *all* cells
 - Utilized for synthesis of bodily proteins & nitrogenous compounds
 - Only L-isomers are active
- Growth
 - Neurodevelopment
 - Health
 - Future Health

Protein Digestion

- Gastric: pepsin/HCl
- Duodenum: pancreatic and brush border enzymes
- Colon: microbiota digest “lost” proteins to ammonia recovered for AA synthesis



Dietary Proteins are Cut at Different Peptide Bonds



Amino Acids

Indispensable

- Leucine
- Isoleucine
- Valine
- Threonine
- Methionine
- Phenylalanine
- Tryptophan
- Lysine
- Histidine

***Conditionally* Indispensable**

- Arginine
- Glutamine
- Proline
- Glycine*
- Cysteine
- Tyrosine

Protein Quality

PDCAAS

- Protein digestibility-corrected amino acid score

Protein Quality

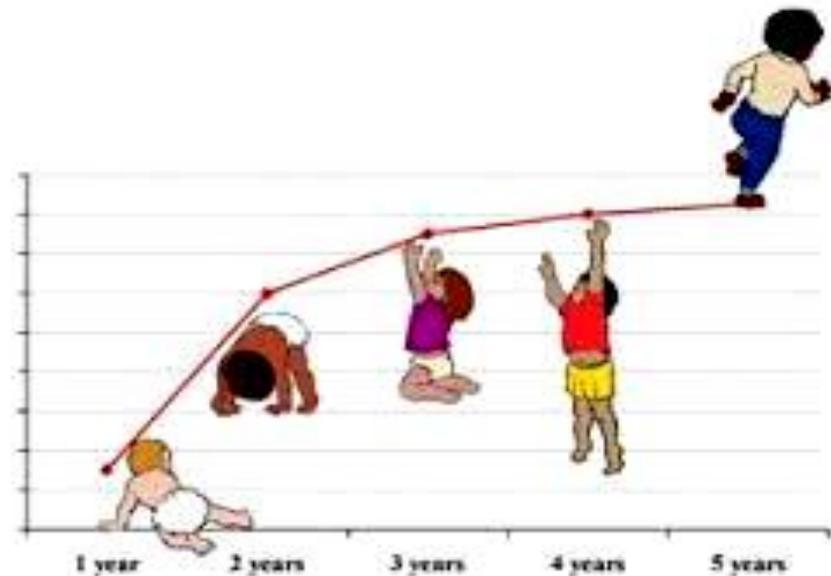
- Is based on both
the amino acid requirements of humans
and
*their ability to digest it **

PDCAAS Ranked Values

Protein Sources	Value
Egg	1
Cow's milk	1
Casein	1
Whey	1
Beef	0.92
Soy	0.91
Chickpeas	0.78
Black beans	0.75
Vegetables	0.73

Protein Utilization

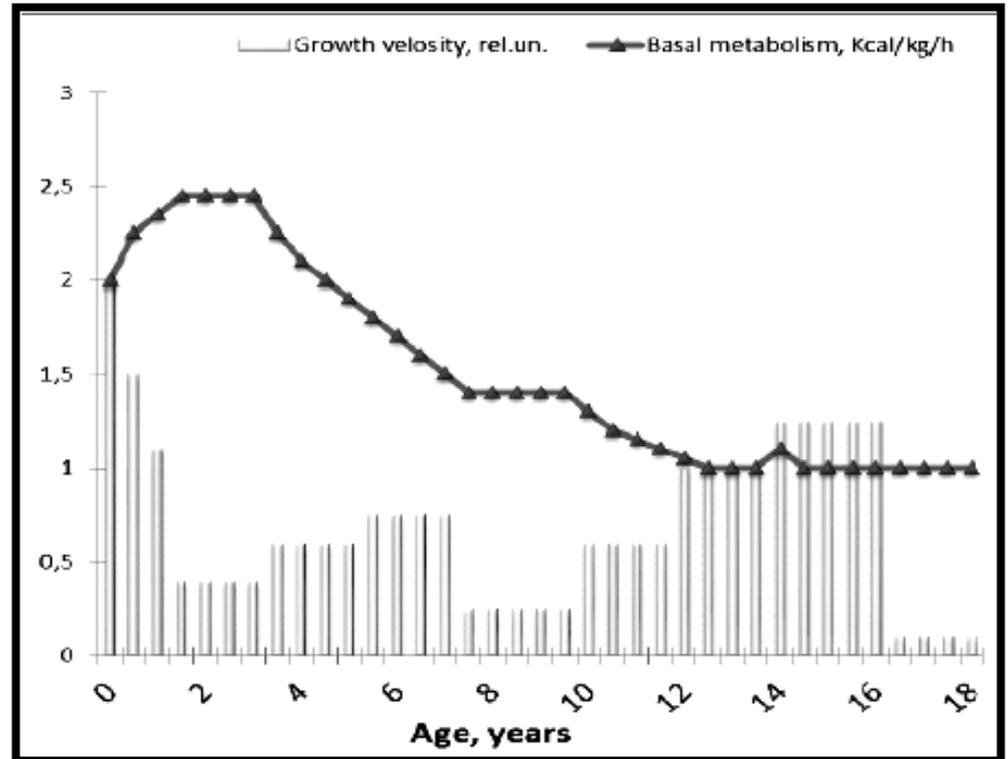
- Dietary AA absorption stimulates protein synthesis & growth
- IGF-1 and insulin are raised by AA absorption
- Excess AA cannot be stored for later use
- AA from bodily proteins are recycled or lost
- ***Basal protein needs:***
 - **Lean body mass**
 - **Basal Metabolic Rate**



Explosive Early Growth

Velocity of Length & Weight

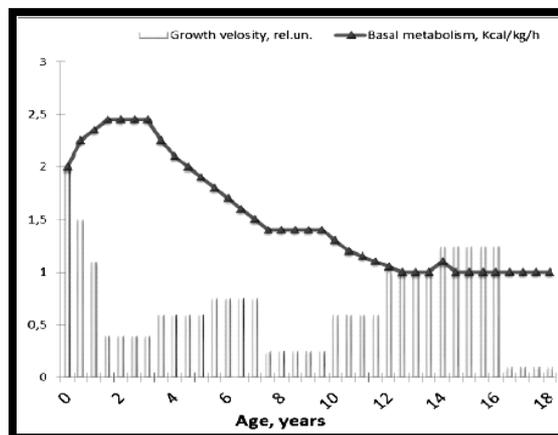
- Peak metabolic rate
- Linear growth
 - 10 in/25 cm in first yr
 - 4-5 in or 10-12 cm second yr
 - Doubles birth height by 5 yrs
- Weight:
 - Doubles by 4 months
 - Triples by 12 months
 - 5 lbs or 2.25 kg/year to 5 yrs



Growth Velocity and Basal Metabolic Rate x Age

Protein Needs for Growth

Age	Protein Gain (g/kg/day)	% of Total Intake GROWTH	% of Total Intake MAINTENANCE
0.5-3 mos	0.49	55	45
3-6 mos	0.30	43	57
6-12 mos	0.18	31	69
12-36 mos	0.10	20	80
36-48 mos	0.046	10	90



The Brain Accounts for >50% of the Basal Metabolic Rate in a 12 Month Old

At birth the brain has 85 billion neurons
Will double in volume by 12 months
Will triple in volume by 26 months



Birth



12 Months



3 Years



Adult

Many Nutrients Build the Brain



Vit B₁ - Utilize glucose, modulate cognition, language development, neurotransmitter synthesis

Vit B₆ and B₁₂, choline, tryptophan, tyrosine, phenylalanine, copper, histidine, threonine - Synthesis of neurotransmitters

Vit B₁₂ - Cognition, language, myelination

Vit C - Antioxidant, cognition, memory, myelination

Vit D - Prevents neurodegenerative disease

Vit E - Cell membrane integrity, antioxidant, protection of DHA

Iron - Oxygenation, synthesis of myelin and neurotransmitters, brain development, IQ

Magnesium - Energy and ion regulation, neural plasticity

Zinc - Neuromotor transmission, cell proliferation, taste

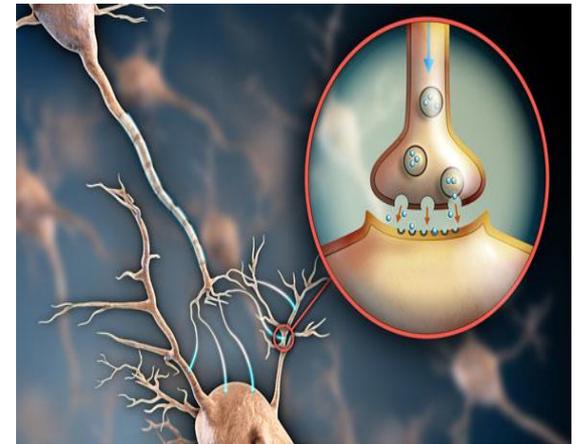
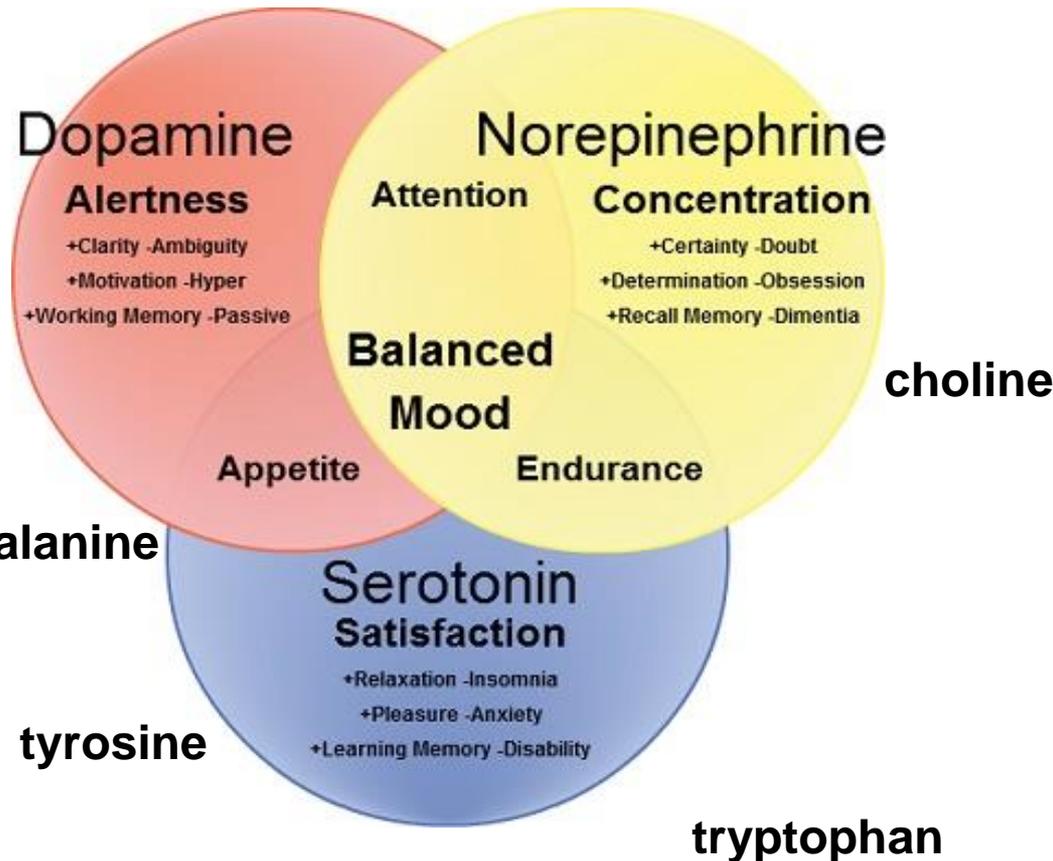
Iodine (via thyroid) - Cellular energy metabolism

Omega-3 PUFA - Cognition, visual development

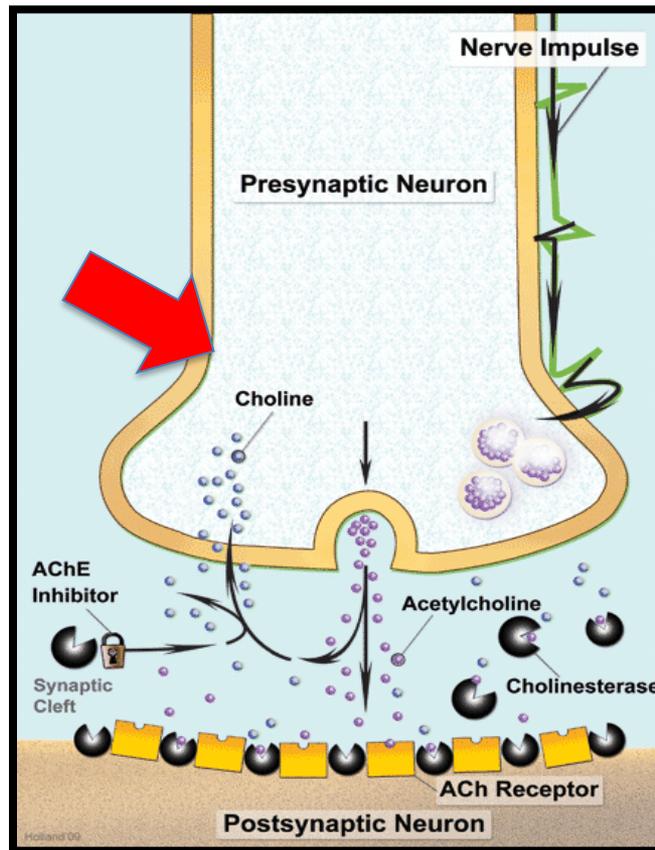
Lutein - Macular protection

Flavonoids - Protect and enhance neurons, anti-inflammatory, cognition

Brain Function Requires a **Consistent** Nutrient Flow



Acetylcholine is Produced *On-Demand* from Dietary Choline



Arousal, Attention, Memory, Motivation

Percentage of Energy as Protein (PE%)

- Breast milk 5%
- Formulas* 7-9%
- Whole cow milk* 20%
- Low-fat cow milk 28%
- Non-fat cow milk 39%

AMDR for Protein = PE% of 5-20%

- **Below:** protein-energy malnutrition, growth failure, immune dysfunction
- **Above:** osteoporosis, renal disease, obesity

Protein: Over- & Under-Consumption

- Under-consumption: protein-energy malnutrition (Kwashiorkor: edema and dermatitis)
- Normal infants in Western countries *over-consume* protein
 - FITS 2008 data from U.S.:
 - 9-13 PE% 6-12 months
 - 15-19 PE% 12-24 months
 - >20 PE% 5% of toddlers

Concern: convincing evidence that higher protein (PE% >15) intake in infants and toddlers CF results in higher BMI

The Conundrum

- Need for protein falls from birth to 24 months
- Breast milk contains only 5% PE%
- Protein requirement at 6 months is 5.6 PE%
- But CF contains 15-20 PE%
- Breastfed infants need bioavailable heme iron & zinc

Q: Which proteins are optimal and how much?

Breastfed infants need bioavailable heme iron & zinc

Iron Depletion is Common

Iron intake U.S. children 1-2 years of age:

- 26% had iron intakes less than the RDA

1-2 year olds positive for iron deficiency (low serum ferritin) without anemia:

- 2003-2006: 14.4%
- 2007-2010: 13.5%

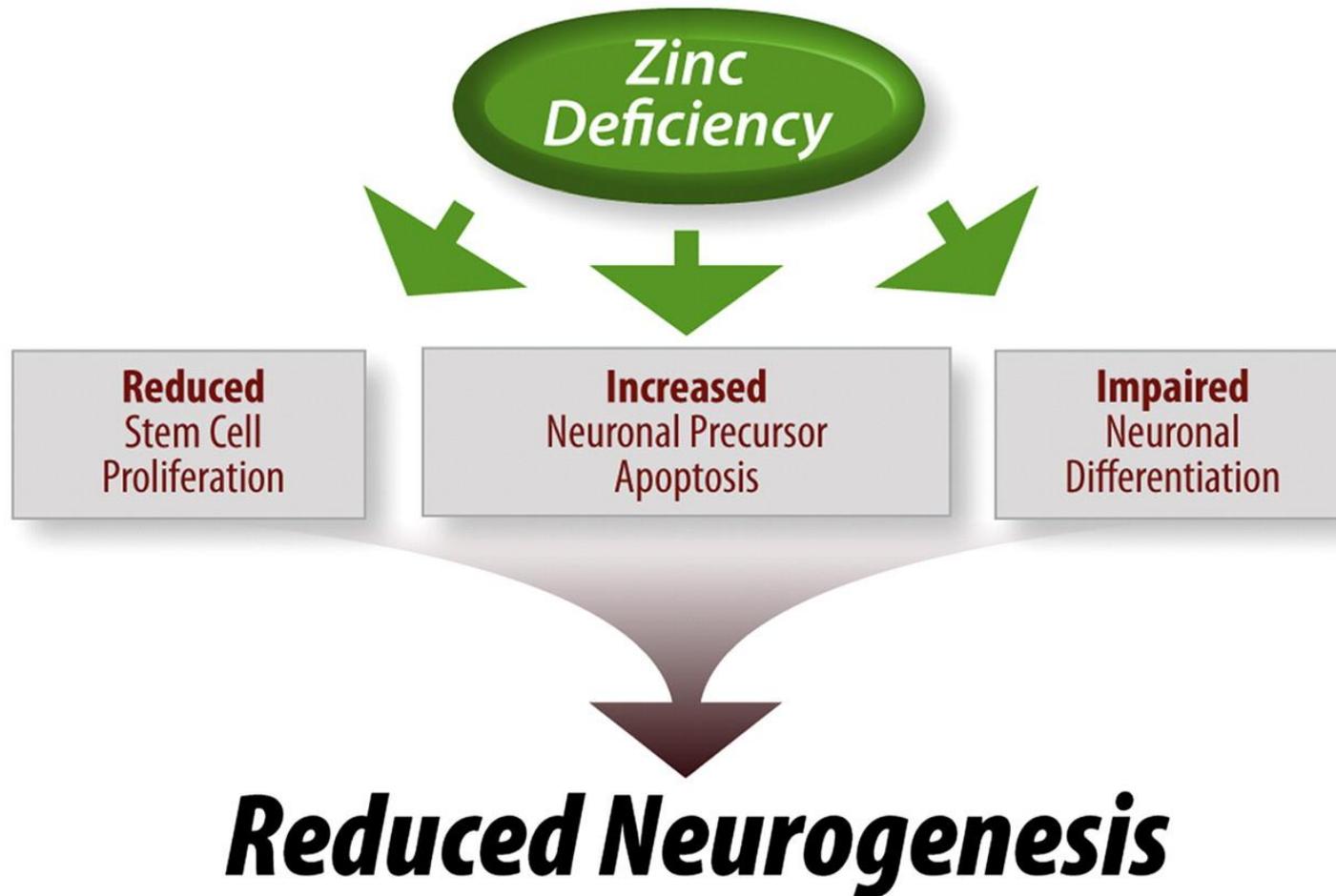
Iron Depletion Carries Risk

Multiple Functions:

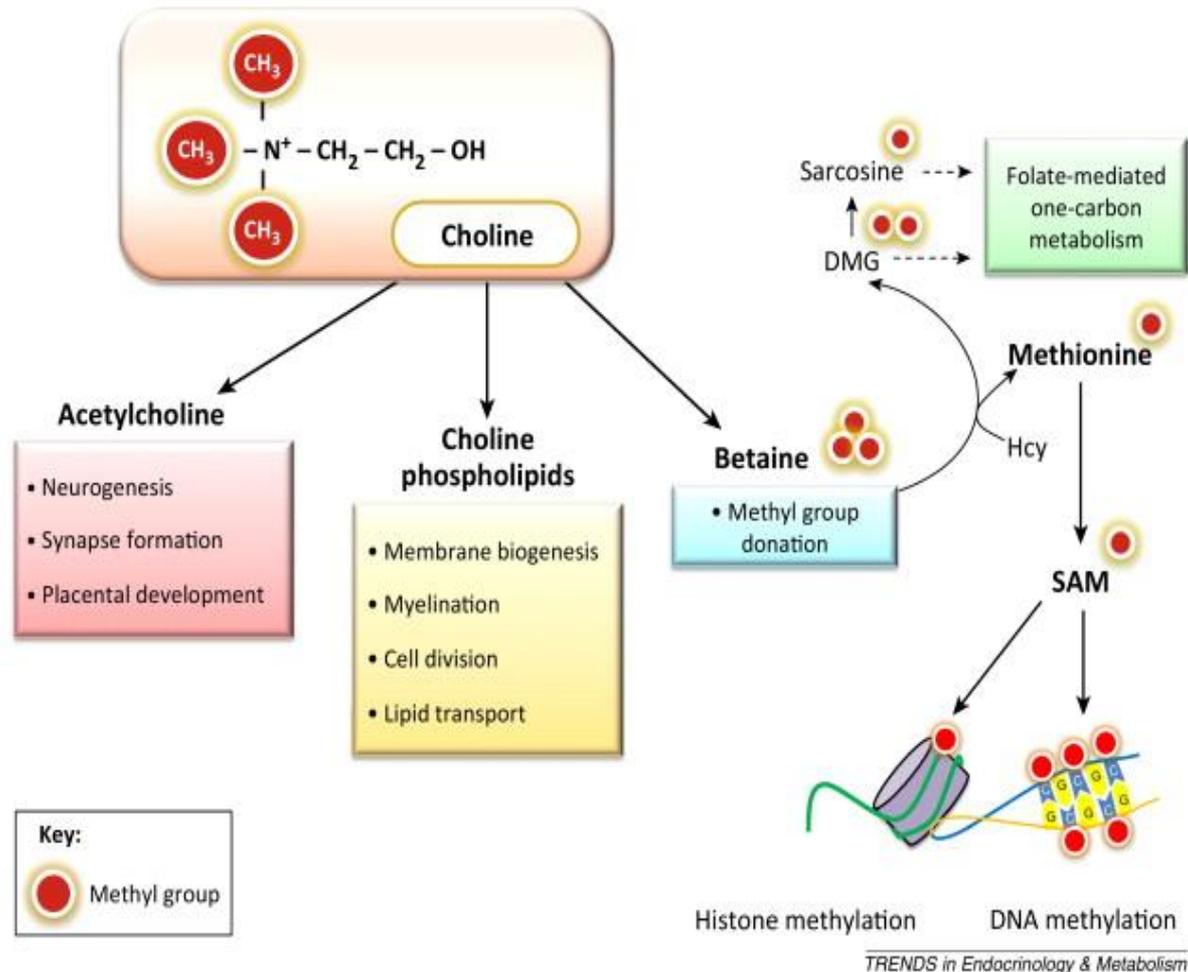
- Oxygen transport (hemoglobin)
- Oxygen use by muscles (myoglobin)
- Enzyme reactions
- Regulation of body temperature
- **Brain development:** neuronal and glial energy metabolism, neurotransmitter synthesis, myelination of axons



Zinc Regulation of Neurogenesis



Choline Depletion Carries Risk



Beef Nutrition

Excellent Source of:

- High-quality protein
- Vit B₁₂
- Selenium
- Zinc
- Niacin
- Vit B₆

Good Source of:

- Phosphorus
- Choline
- Iron
- Riboflavin



Beef may stimulate IGF-1 and insulin less than other protein sources, which may reduce risk of obesity

Typical toddler intake = 10-12 g/day
Adds little to daily PE%; many nutrients

Many Nutrients Build the Brain



Vit B₁ - Utilize glucose, modulate cognition, language development, neurotransmitter synthesis

Vit B₆* & B₁₂*, choline*, tryptophan, tyrosine, phenylalanine, copper, histidine, threonine - Synthesis of neurotransmitters

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Proteins During CF

Prevalence NHANES 2005-2012

	6-11 Months		12-24 Months	
	2005-2008	2009-2012	2005-2008	2009-2012
Beef	15.8	11.3	35.2	33.3
Poultry	27.0	28.0	66.5	65.2
Fish, shellfish	2.8	1.8	10.6	8.9
Hot dogs, sausage, deli	8.7	8.8	27.3	26.5
Pork	7.1	8.4	24.8	21.5
Pulses	8.2	9.0	14.3	16.0
Cheese	12.7	16.6	44.7	46.4
Eggs	13.6	11.0	37.3	35.5
Yogurt	9.3	15.6	27.1	24.5

Beef as a *First Food*

ESPGHN Committee on Nutrition

“Regardless of timing, it is important the first CF given to infants... should provide a good source of iron.”

“Meat is a good source of iron and zinc, but also arachidonic acid, which is important in brain development.”

AAP Committee on Nutrition

“The recommendations for protein intake assume that the sources of protein are highly digestible (>95%) and that the indispensable amino acid composition closely meets human needs. The AAP recommends iron-fortified infant cereals and puréed meats as good first foods because they contain ample protein, iron, and zinc.”

Robert Wood Johnson Expert Panel

“Iron/zinc fortified baby cereals or puréed/mashed meats are recommended as first solid foods...”

Health Canada Guidelines

“First complementary foods should be iron-rich meat, meat alternatives and iron-fortified cereal.”

Complementary Foods

- CF affects growth, development and health
- Proteins affect every cell in the body
- Overconsumption of protein: obesity
- Protein quality is crucial in CF
- Poultry and processed meats prevalent
- Particular need for iron, zinc, choline, DHA
- Beef: an important *first food* for CF
- Growth = *both* body and brain

Practical Application: Early Nutrition Matters!

Third Trimester

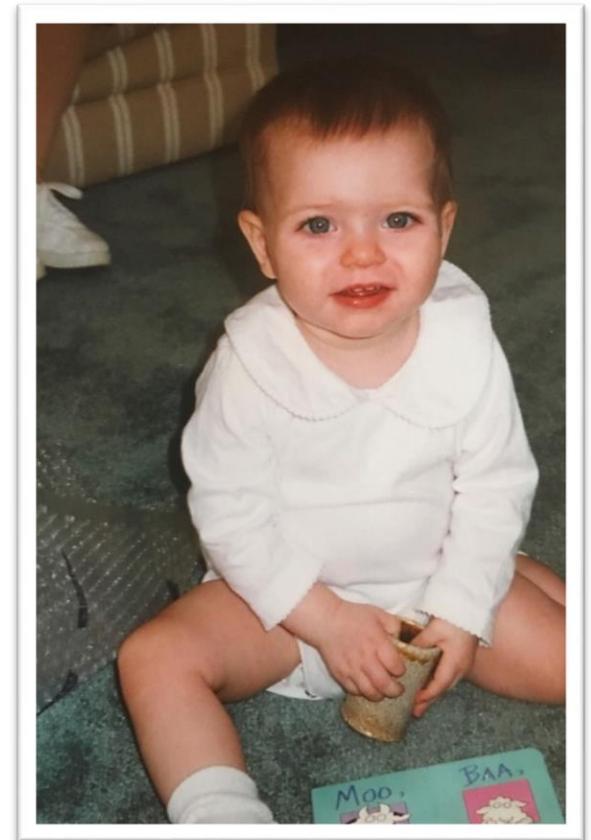
- Baby's iron stores accrue
- Babies born premature/low birth weight are at risk

Mother's Nutrition

- Low iron (9.5% anemic, 3% IDA)

After birth

- Iron endowment (highly variable) determines later risk of deficiency in baby
- Delayed vs. early cord clamping
 - Delayed: baby receives 30-50% more blood volume → more iron



Breastmilk: Nutrient Content

Protein, Iron & Zinc

Nutrient	RDA	Breastmilk Content
Protein	0-6 months: 2.2 g/kg/d 6-12 months: 1.6 g/kg/d 1-3 years: 1.2 g/kg/d	Early lactation: 1.4-1.6 g/100 mL 3-4 months: 0.8-1.0 g/100 mL >6 months: 0.7-0.8 g/100 mL
Iron	0-6 months: 0.27 mg 6-12 months: 11mg 12-24 months: 7mg	0.35 mg/L
Zinc	0-6 months: 2 mg 6 months - 3 years: 3mg	Day 1: 8.12 mg/L Day 30: 2.65 mg/L 3 months: 1.35 mg/L 6 months: 0.93 mg/L

Complementary Foods

Starting Solids: Signs of readiness

- Head control and able to sit with support
- About 6 months old
- Loss of tongue thrust
- Desire to control eating; interested!

“Eating is a learned motor behavior” after 6 months

- Coordination of all 8 sensory systems
- Match development with food introduction

Babies need to be challenged!

- Upgrade textures
- Red flags: still on purée at 10 months, no table foods by one year
- Study: Lumpy solids after 9 months ↑ feeding problems at 7 years



Food Choice Matters

PROTEIN	IRON	ZINC
Beef, chicken, pork	Beef	Beef
Cottage cheese	Chicken	Baked beans
Tofu	Turkey, dark meat	Fortified breakfast cereal
Yogurt	Tuna, light	Pork
Cow's milk	Pork loin	Chicken, dark meat
Soy milk	*****	Yogurt
Peanut butter	Ready-to-eat cereal	Cashews
Beans	Instant oatmeal	Chickpeas
Egg	Soybeans	Cheese
Cheese	Lentils	Milk
Nuts	Beans	Almonds
	Tofu	
	Spinach	
	Raisins	
	Bread	

*Optimize non-heme iron absorption with vitamin C-rich foods; phytates in legumes, nuts, seeds and grains may inhibit absorption of minerals such as iron and zinc.

Feeding Transition: 6-12 Months

4 to 6 months:

- ✓ Transition from almost watery texture to puréed, smooth texture (infant cereal, meats, fruits, vegetables)

6 to 8 months:

- ✓ Transition from puréed to mashed/lumpy food
- ✓ Practice self-feeding skills with soft finger foods
- ✓ Avoid juice through first year

8 to 10 months:

- ✓ Transition from mashed/lumpy puréed to chopped finger foods
- ✓ Let baby play with the spoon and make a mess!

10 to 12 months:

- ✓ Eating mainly chopped table food; eat with family
- ✓ Use a spoon with quite a bit of mess

Baby-Led Weaning

Definition: *Exclusive breast feeding for 6 months prior to offering finger foods from 6 months on, ninety percent of the time. Spoon-feeding and puréed food is used less than ten percent of the time.*

- Whole, unmodified food offered in graspable pieces; “family food”
- First foods: vegetable, fruit, meat, cheese, cooked egg, bread, toast, pasta and fish

Pros	Cons
Babies more satiety-responsive; more likely to experience responsive feeding	Dependent on parent nutrition knowledge; more sodium-containing foods offered
Less risk for overweight	Underweight more common
Self-regulated, self-paced eating	High risk foods offered (choking) Baby not ready
Later introduction of solids	Nutrient intake unknown
Reported decrease in picky eating	

Goals: Educate, particularly on nutrient content of the diet; promote self-feeding!

Further evidence still needed to explore impact on nutrient and energy intake, child weight and eating behavior.

Combined Approach: Spoon + BLW

Baby Cereal: digestibility, low allergen content, iron-fortified, modifiable texture

- From 4-9 months, ID was prevented in almost all babies fed iron-fortified cereal
- In EBF infants, cereal-based first foods pose a risk for inadequate zinc

Whole Food: net consumption, nutrient absorption unknown

Practical Solution: use combination of meat (beef) and fortified cereals

- Early Meat: (only effective food strategy to provide zinc & iron in EBF babies), also offers iron, vitamins B₆ and B₁₂, and other nutrients
- Alternate single grain, fortified cereals: barley, oatmeal, brown rice and other whole grain-fortified cereals
- Other foods: eggs, fish, beans

Portion Sizes

Food Group	Starter Portions (8-12 months)	Servings per day	Starter Portions (2-3 years)	Servings per day
Protein Meat, chicken, turkey, fish, cooked beans Egg	3-4 tablespoons 1	2	1-2 ounces	2 ounces
Grains Baby cereal Bread, crackers	2-4 tablespoons 1/4 slice, 2	2-3	1/4 to 1/2 cup 1 slice	3 ounces
Fruit	3-4 tablespoons	2	1/2 to 1 small	1 cup
Vegetables	3-4 tablespoons	2	2-3 tablespoons	1 cup
Dairy Infant formula Breast milk Cheese Yogurt Cottage cheese	6-8 ounces On demand 1/2 ounce 1/2 cup 1/4 cup	Offer	1/2 cup	2 cups

Introducing Flavor

Flavor Window: between 4-18 months

- Sensitivity between 4-6 months
 - Single food vs. three veggie blend at 6 months → veggie blend group more accepting of new veggies
 - Rapid Variety: new veggie daily x 5 days x 3 cycles → increased liking of new food
 - Insight for all flavors: baby learns to like when exposed
- Low-salt, low-sugar, nutrient-dense diet recommended

Time-Sensitive Introduction of Flavor

- Before 6 months → 2.5x more likely to be food neophobic
- >6 months associated with less pickiness
- Breastfeeding + complementary foods at 6 months → less picky

Feeding: 12-24 Months

What We Want	The Reality
Continue variety of wholesome food including food the family eats!	By 15 months, 30% are consuming sugar-sweetened beverages; low fruit and veggie intake; diet excessive in calories, folic acid, preformed vitamin A and sodium
Keep on nutrient-rich diets, meaning no regular sweets until 2 years	By 18 months, most children having something sweet every day
Iron needs decrease, but still important (1-2 servings of iron-rich foods per day)	12-18 months: diet deficient in healthy fats, fiber, iron and potassium

Picky Eating

Rates: 8-50% of children, between 2-6 years

- 4-24 months: 17-47% males; 23-54% females (somewhat picky to very picky eaters)

Characteristics: Food refusal (vegetables), food jags, limited eating, not willing to try new foods, strong food preferences, not interested in food/eating, eats slowly

“It’s not whether it occurs, but how parents are equipped to deal with it.”

Goal: Get ready!

- What to expect
- How to react
- Keep nutrients, variety and food exposure high
- Avoid catering to food requests
- Monitor growth; acute weight loss/growth failure indicates bigger issue

Encourage Food Acceptance

Variety at the Start

- Early liking of fruits and veggies predicts higher intake later
- **High variety of veggies during first year** → higher acceptance of new foods, including veggies

The Magic of “8”

- Offering disliked veggies **8 subsequent times** → increased acceptance; persisted
 - At 15 months: 79% still liked disliked veggies
 - At 3 years: 73% still liked disliked veggies
 - At 6 years: increased willingness to try; 57% still like disliked veggies

Repeated Exposure to novel and previously rejected food is most powerful for food acceptance

Feeding Practices

Counter-Productive

- Prompting/Pushing
 - May drive overeating or under-eating, unregulated appetite, dislike of food
- Rewarding
 - Changes food value system to favor reward food
- May contribute to poor food choices over time, eating disturbances, weight changes

Productive

- Responsive feeding
 - Reciprocal relationship with feeding where parent is tuned into baby's appetite and feeding cues
 - Allows self-regulation of eating
 - May contribute to healthy body weight
 - More food variety

Thank You!

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Q&A

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