Nutrition and Learning in Early Childhood: The Cognitive Implication

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OUTLINE

- Introduction
- Nutrition and Brain Development
- Factors influencing Brain Development
- Human Milk Oligosaccharides
- Sphingomyelins
- Key messages

Introduction

- Adequate nutrition is necessary for normal brain development.
- Nutrition is especially important during pregnancy and infancy, which are crucial periods for the formation of the brain and lays the foundation for the development of cognitive, motor, and socio-emotional skills throughout childhood and adulthood.
- First 1000days

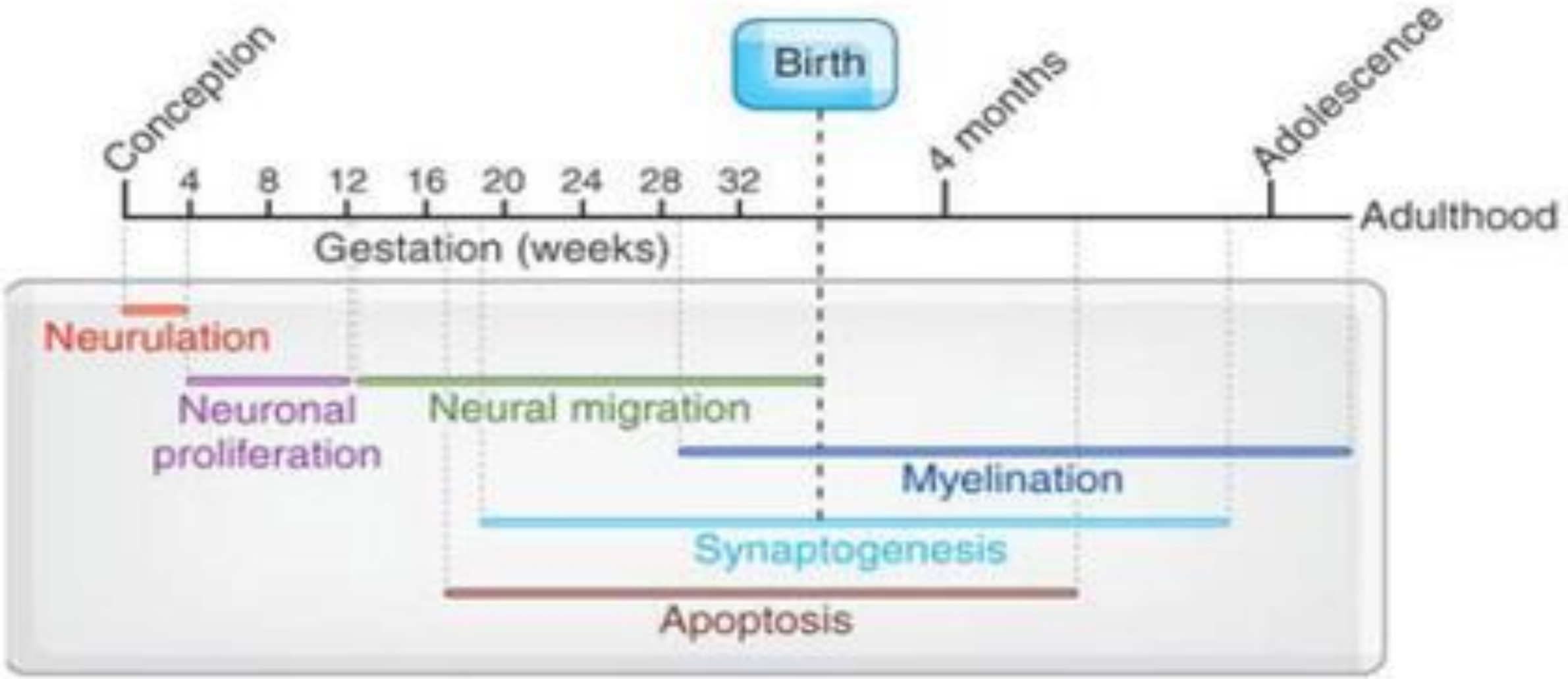
Nutrition from pregnancy-2years of life : a critical window of opportunity





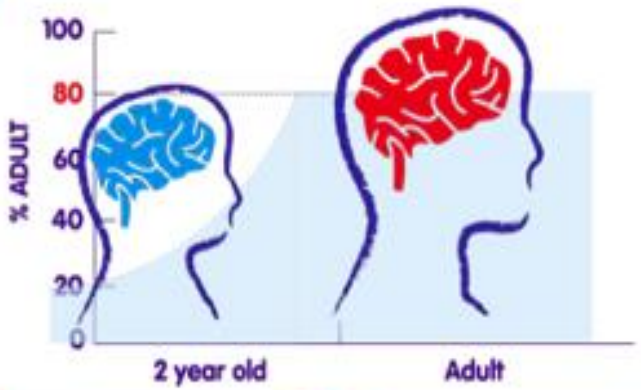
The First 1000 Days “continuum”

Stages of Brain Development



By 2 years the brain weighs between 1.04kg and 1.2kg and will have reached around 80% of its adult size of 1.2 to 1.5 kg

80% of brain size achieved around 2 years



Between 1 and 3 years of age, half of overall resting energy is consumed by the brain, compared with just 20% of adults.

Nutrition and stimulating interaction play a vital role in brain and cognitive development during the first years of life.

Change the First Five Years and You Change Everything"

PROGRESS CHECK 1

---------- percent of brain size is achieved around 2 years

A). 80%

B). 90%

C). 65%

D). 85%

Key Factors Influencing Brain Development

- General- nature and nurture
- Environment- Socioeconomic status
- Nutrition- Human Milk Oligosaccharides and Sphingomyelins

Kolb B, Gibb R. J Can Acad Adolesc Psychiatry. 2011;20: 265-76; 2. Hanson JL, et al. Plos One 2013;8:e80954; 3. WDR team 2018, using data from Nelson and others (2017). Available here: http://bit.do/WDR2018-Fig_S2

Human Milk Oligosaccharides (HMO)

- Human milk is the perfect food for infants; Contains countless bioactive ingredients such as immunoglobulins, hormones, oligosaccharides and other components

- One important component is human milk oligosaccharides (HMOs), which are multifunctional glycans, naturally present in human milk. They are particularly interesting because of their quantity and structural diversity.

- Dominant HMO in 80% of mothers is 2’- fucosyl-lactose (2FL)

Human Milk Oligosaccharides (HMO)

- HMOs are made of five basic monosaccharides: glucose (Glc), galactose (Gal), N-ethylglucosamine (GlcNAc), fucose (Fuc) and sialic acid (SA).

- Only 1-2% of HMOs can be absorbed in the intestine, 98-99% remain intact up to the colon, thus influencing the composition and activity of the infant's gut microbiota.

- For example, 3-gallactosyllactose (3-GL) and 2- Fucosyllactose (2FL) are breast milk oligosaccharides

METABOLISM OF HMOs

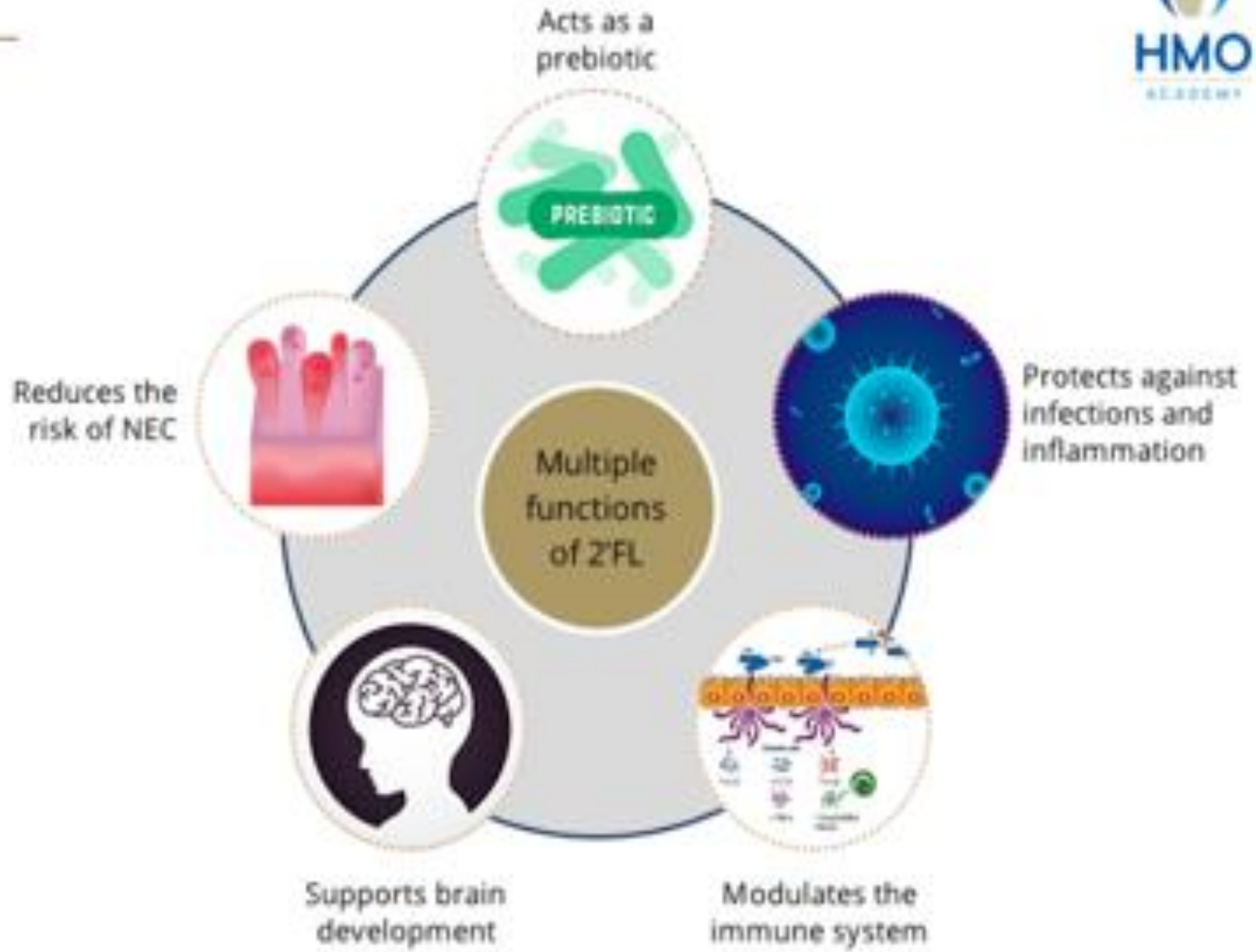
- An infant's gut cannot digest HMOs because of lack of production of the necessary enzymes and reach the lower gut unchanged.

- They are prebiotics i.e substances that the body cannot digest but act as food for the beneficial bacteria **(probiotic**) in the gut and encourage their growth especially Bifidobacteria—(fertilizer effect)

- Approximately 1-2% of HMOs are absorbed in the gut and reach the systemic circulation

Background

- 2'FL is the most abundant and most studied HMO
- Higher levels of 2'FL in breast milk were associated with lower rates of *Campylobacter* diarrhoea
- Preclinical studies suggest that 2'FL has multiple functions
- Synthesised 2'FL is structurally identical to that of human milk and is currently added in some infant formulae
- The use of 2'FL in infant formulae has been approved as safe by the European Union and the US-FDA



2'FL, 2'-fucosyllactose; FDA, Food and Drug Administration; GRAS, Generally Recognized as Safe; HMO, human milk oligosaccharide; NEC, necrotising enterocolitis.

PROGRESS CHECK 2

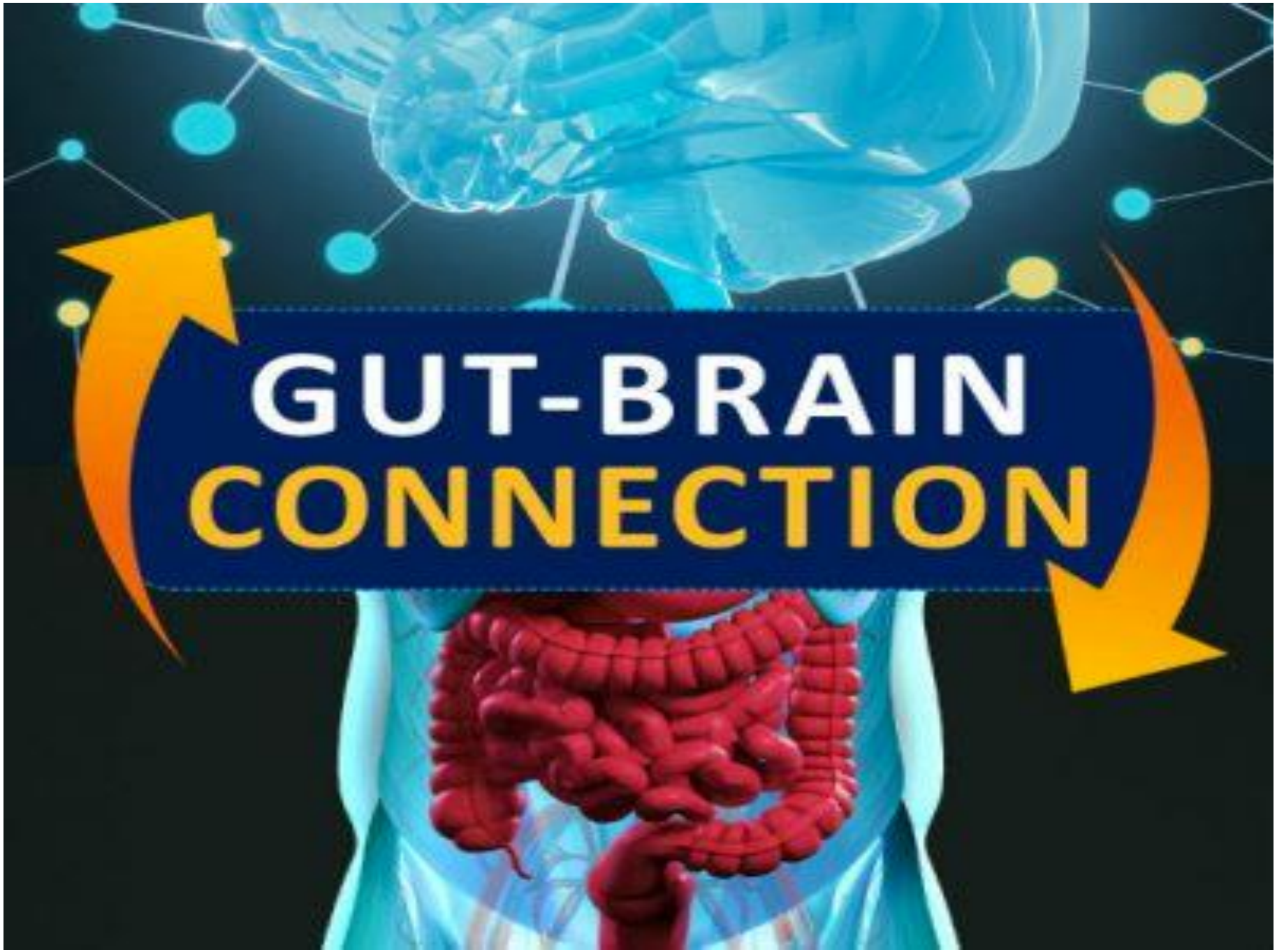
---------- is the most abundant and studied HMO

A). 3FL

B). 2FL

C). 6FL

D). 4FL

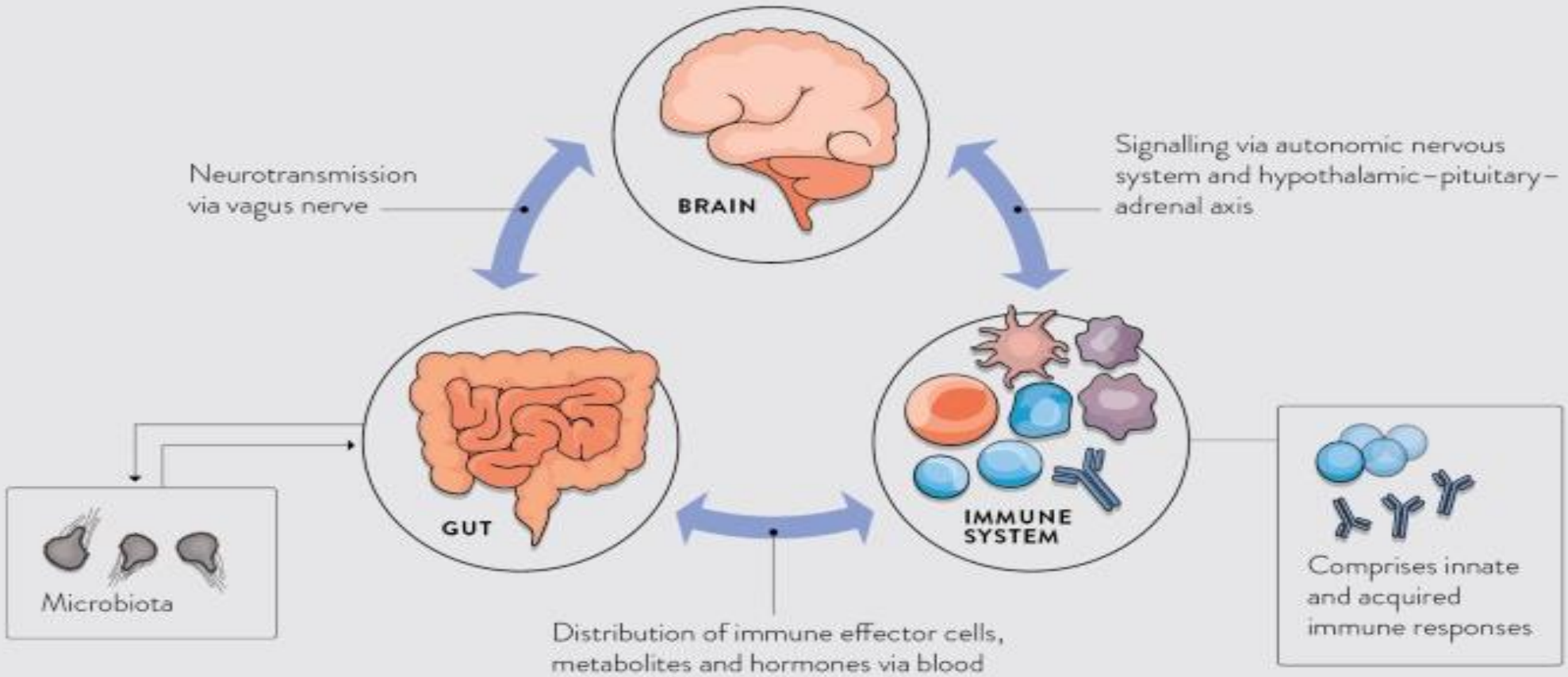

GUT-BRAIN
CONNECTION

HUMAN MILK OLIGOSACCHARIDES

SUPPORTING HEALTHY DEVELOPMENT

GUT–BRAIN–IMMUNE AXIS

The gut contains millions of neurons and comprises more than 70% of the body's immune system.



SPHINGOMYELINS

There are five major phospholipids in the brain

PHOSPHATIDYL INOSITOL

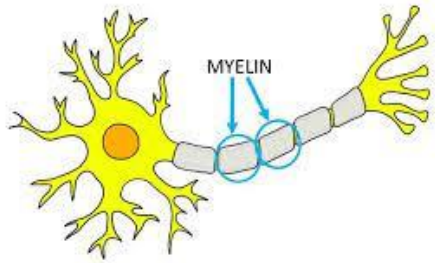
SPHINGOMYELIN

PHOSPHATIDYL CHOLINE

PHOSPHATIDYL ETHANOLAMINE

PHOSPHATIDYL SERINE

SPHINGOMYELINS



- Sphingomyelin is the structural building block of the brain
- It is naturally present in breast milk. It is the most abundant phospholipid in human milk
- SM levels in the brain increase from 2% at birth to 15% at 3 years. The increase is consistent with a progressive increase in neuronal myelination after birth-
- **During earliest brain development none of the brain is myelinated.**

Sphingomyelin- A Nutritional Contributor To Brain and Cognitive Development

- The brain uses 20% of the total energy requirement of the body

- Sphingomyelin and other polar lipids are vital nutrients for:

Brain structure: myelination, neuronal outgrowth and morphology, plasma membranes

Brain function: synaptogenesis and synaptic transmission

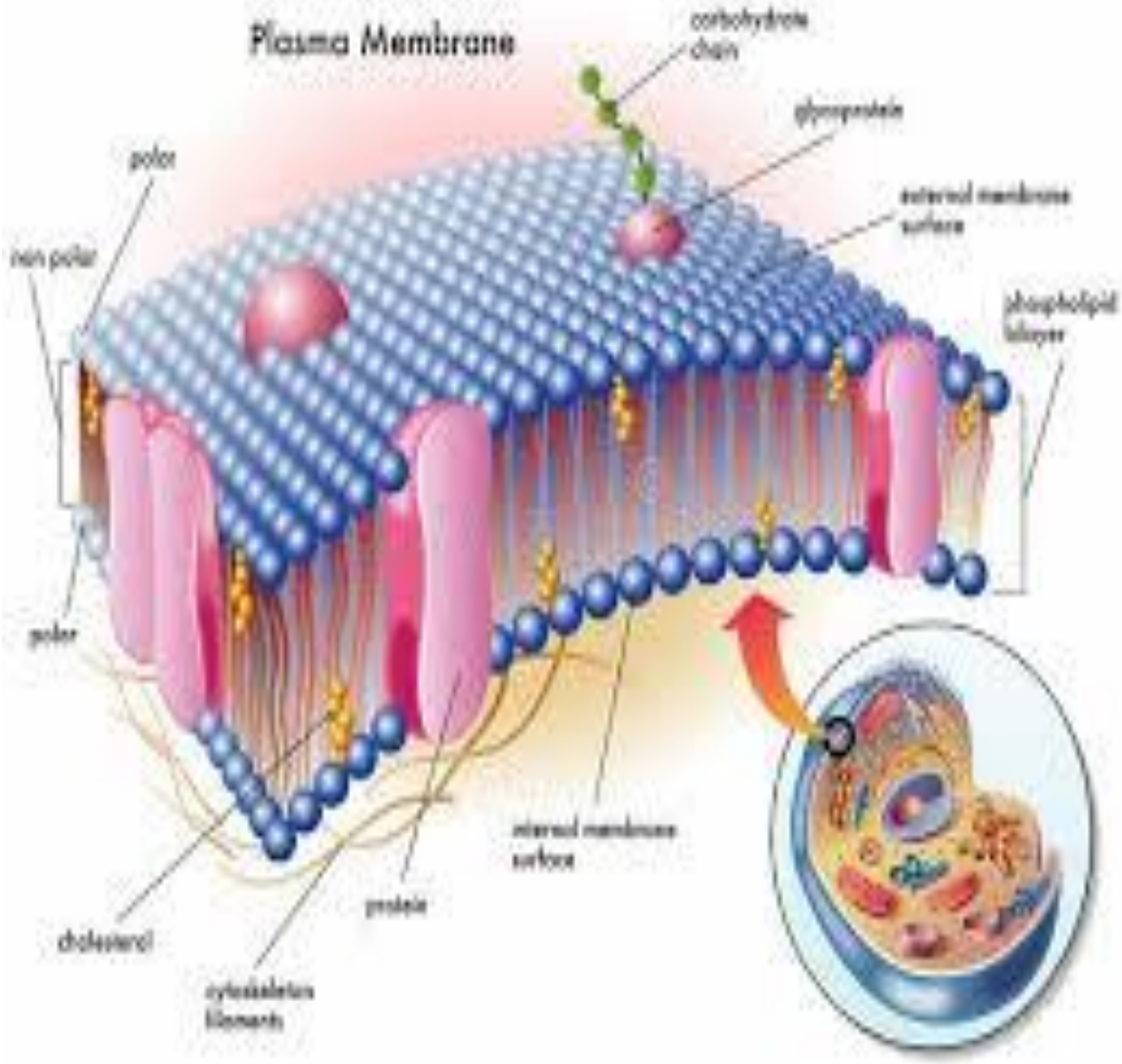
Brain metabolism

Sphingomyelin- A Regulator Of Cellular Events

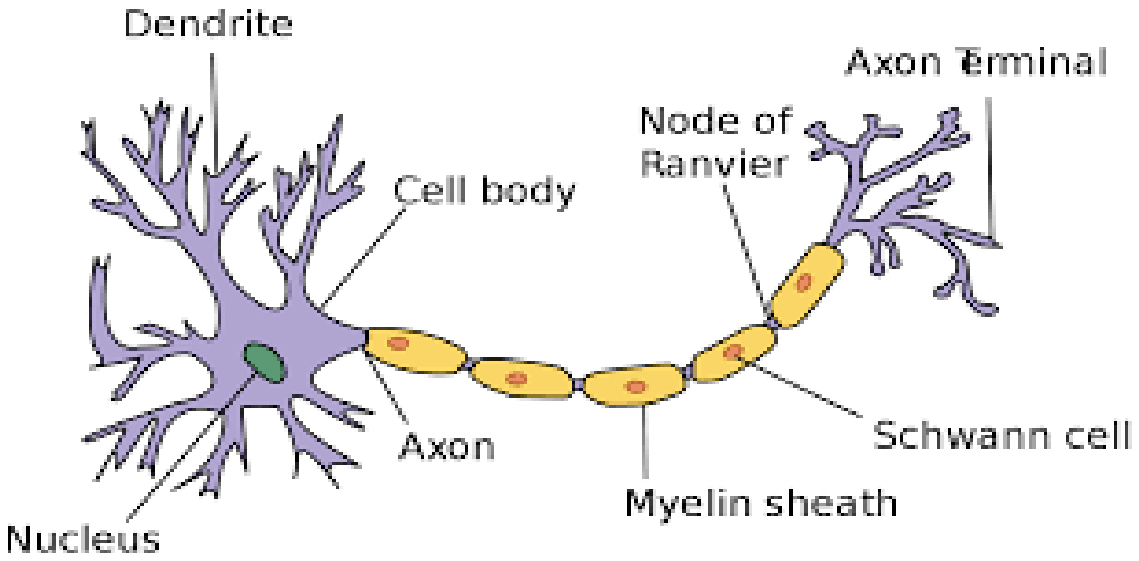
- Not just a structural element

- Recognized as a regulator of cellular events- microdomains in plasma membranes

- Plays a vital role in the differentiation of neurons and synaptic transmission to neuronal-glial interactions



Sphingomyelin- A Key Nutrient For Myelination



- Myelin protects the neurons
- Helps to conduct signals more efficiently
- Prevents erratic activation of neighboring axons

Benefits of Brain myelination

- Improves general cognitive ability
- Better language and reading ability
- Promotes working memory
- Higher processing speed
- Improved sensory reactivity

KEY MESSAGES

- Nutrition is crucial for brain development especially in the first 1000days of birth up till the first 5 years.
- Effective development of the brain requires *optimal nutrition* from conception. At birth newborn brain has 100 billion neurons.

- Human Milk is the gold standard nutrition for infants, supporting the development of a healthy immune system and brain development.

- Human Milk Oligosaccharides are the 3rd largest component of breast milk and are significant for the development of the gut-brain-immune axis. 2FL HMO is the most abundant HMO in human milk seen in 80% of mothers

KEY MESSAGES CONTD

- SM plays an important role in cognitive development via its structural and functional involvement in CNS myelination
- Infancy and early childhood are critical windows for brain growth and cognitive development
- Malnutrition in the prenatal & postnatal periods may decrease myelin-specific lipids in the brain with major consequences on brain structure & function
- ***Human milk is the preferred source of nutrition for infants and naturally contains sphingomyelin!***

THANK YOU