Sphingomyelin and its role in Cognition

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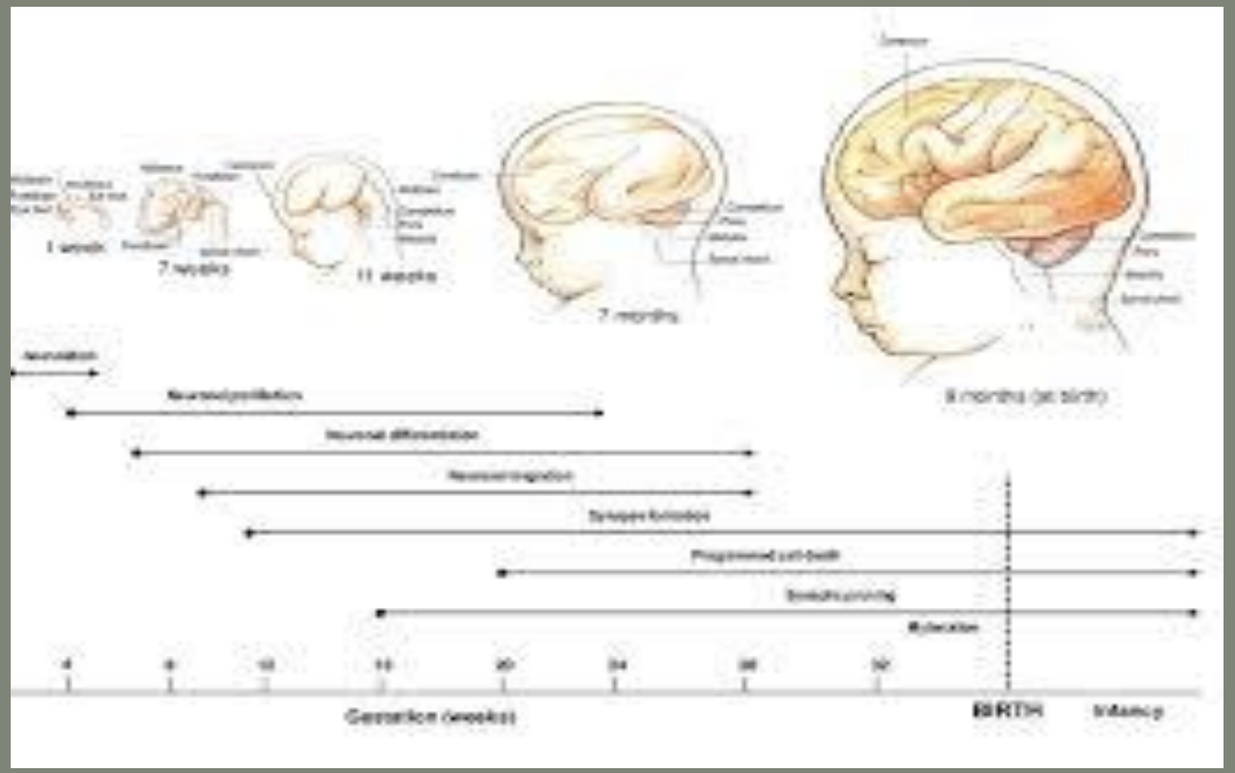
Main Goals

To enable participants to:

- Recognize infancy and early childhood as critical windows of opportunity for brain growth and normal child development
- Understand the role of sphingomyelin in brain development
- Become familiar with the emerging evidence on sphygomyelin as a vital nutrient for cognition and learning in early life

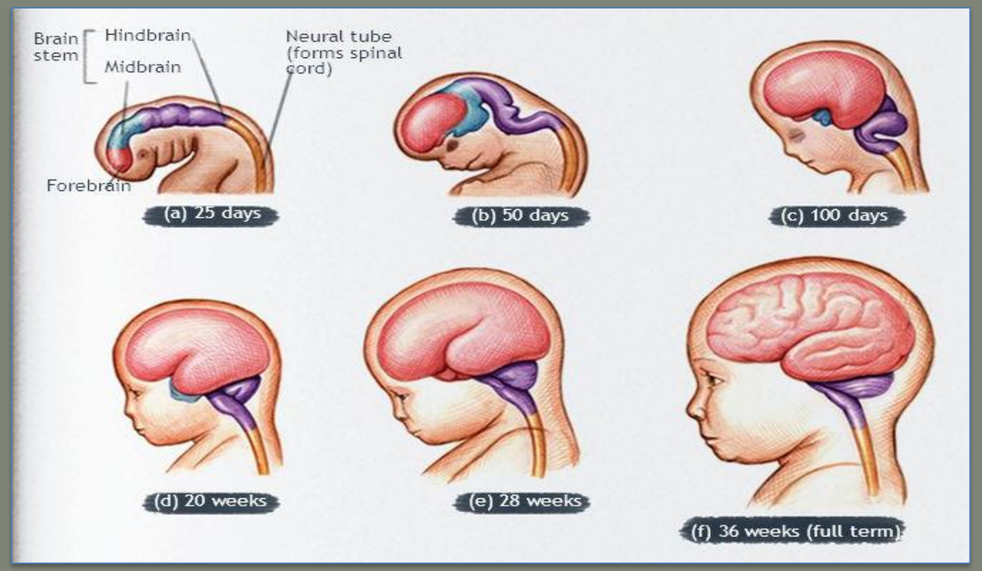
Development of The nervous system



The foetal nervous system is one of the very first systems to develop and the last to be completed after birth

The process generates the most complex structures within the embryo

Early life:
Key period for brain development



A newborn baby has all the neurones that he/she will have for the rest of his or her life

Brain growth after birth is mainly by the formation of millions of synaptic connections

It is the connections between these neurones that make the brain work!

Stages of Brain Development

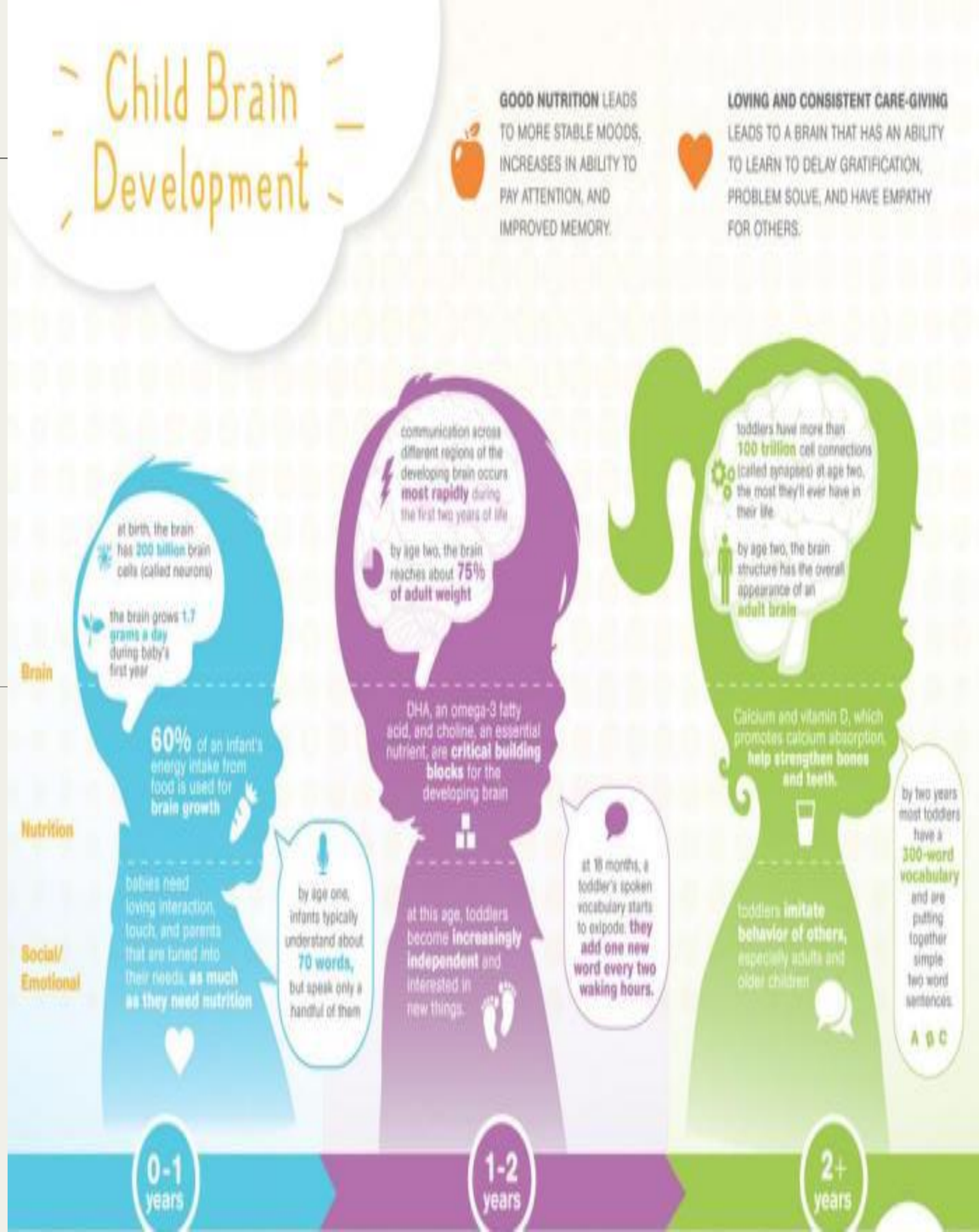
Phase 1

Key processes:

- Spans through the first half of gestation
- Creation of new neurones at rates up to 250,000 neurones/minute
- Migration towards the outer surface
- Cortical growth, both in thickness and surface area

Phase 2

- Neuronal migration
- Neuronal connectivity



Key factors in brain development

Genes

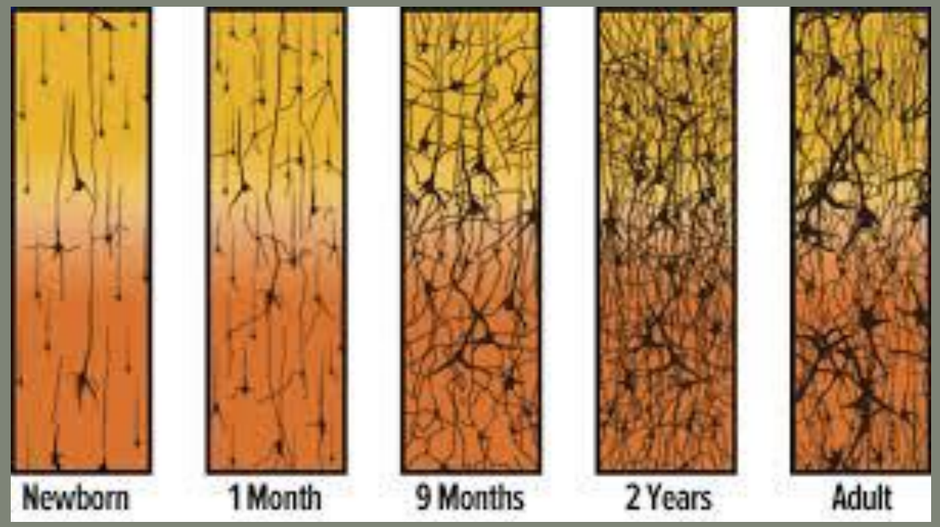
Environment

Early life: Key period for brain development

- The brain forms and refines a complex network of connections by synaptogenesis, pruning & myelination

Learning in infancy & early childhood

Prunning is a key process that shapes the brains of young children - the process of getting rid of wasteful neural connections & damaged neurones in order to strengthen the important ones



Learning is the process of creating and strengthening frequently used synapses!

Infancy and early childhood - a critical window for brain growth!

The developing brain is peculiarly vulnerable to modification by environmental factors

The quality of nutrition in early life significantly impacts the quality of brain development

Nutrition can directly influence and support the CNS through changes in the neuroanatomy and neurotransmission

The brain lipids

The nervous system is among the tissues of the mammalian body with the highest lipid content as well as the highest lipid complexity!

There are 5 major phospholipids in the brain

SPHINGOMYELIN

PHOSPHATIDYL-ETHANOLAMINE

PHOSPHATIDYL-CHOLINE

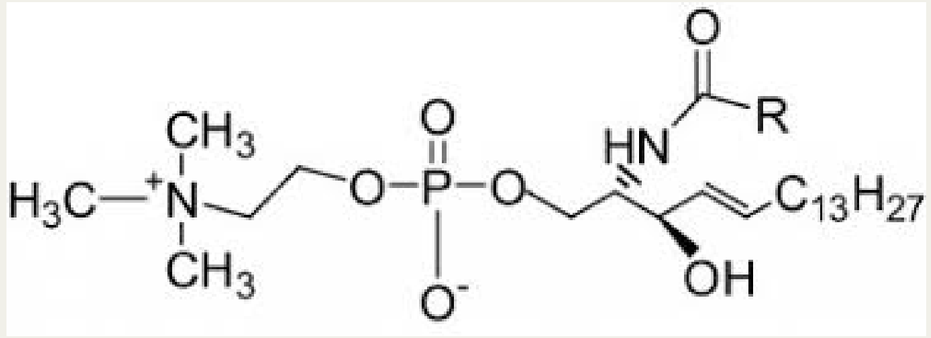
PHOSPHATIDYL-INOSITOL

PHOSPHATIDYL-SERINE

Sphingomyelin (SM):

a structural building block of the brain

The most abundant phospholipid in human milk



By the age of 4 weeks, SM accounts for 35% of phospholipids in human milk

SM is naturally present in breastmilk

Sphingomyelin: a structural building block of the brain

- 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

- Other phospholipids decline or show a modest increase during postnatal development

SM: a nutritional contributor to brain & cognitive development

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

SM & other polar lipids are vital nutrients for:

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

Brain function : synaptogenesis & synaptic transmission

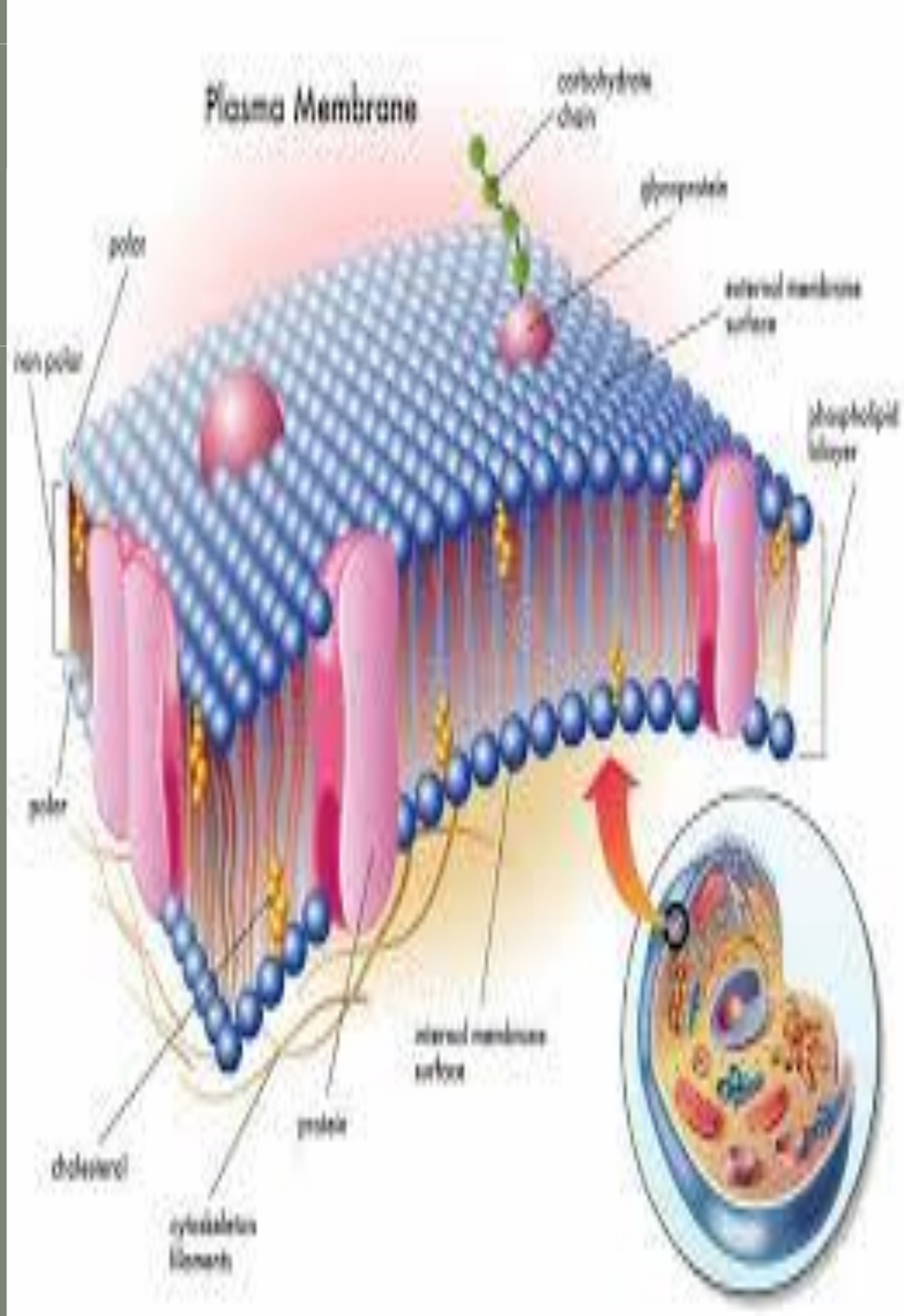
Brain metabolism

SM: a regulator of cellular events

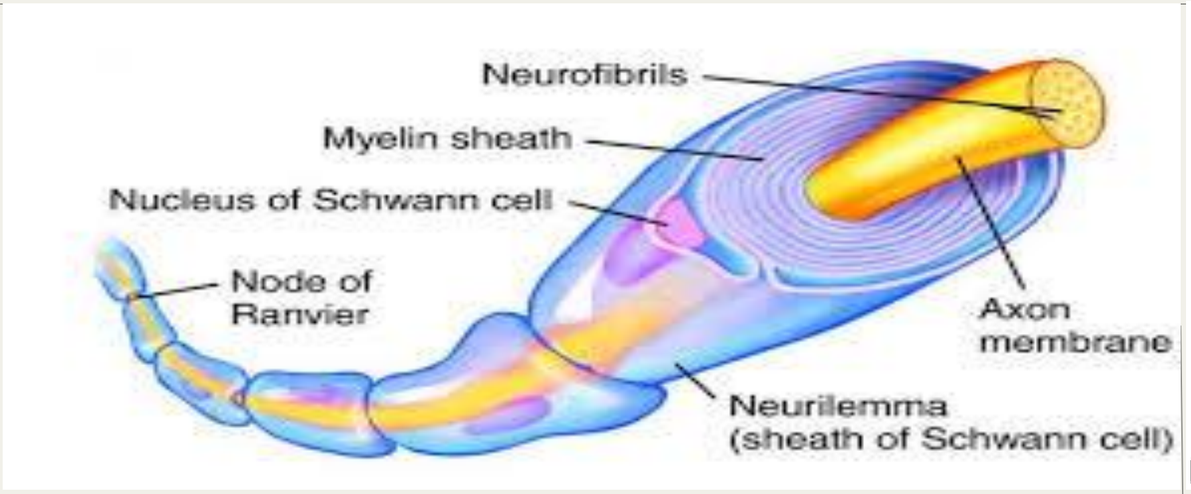
Not just a structural element

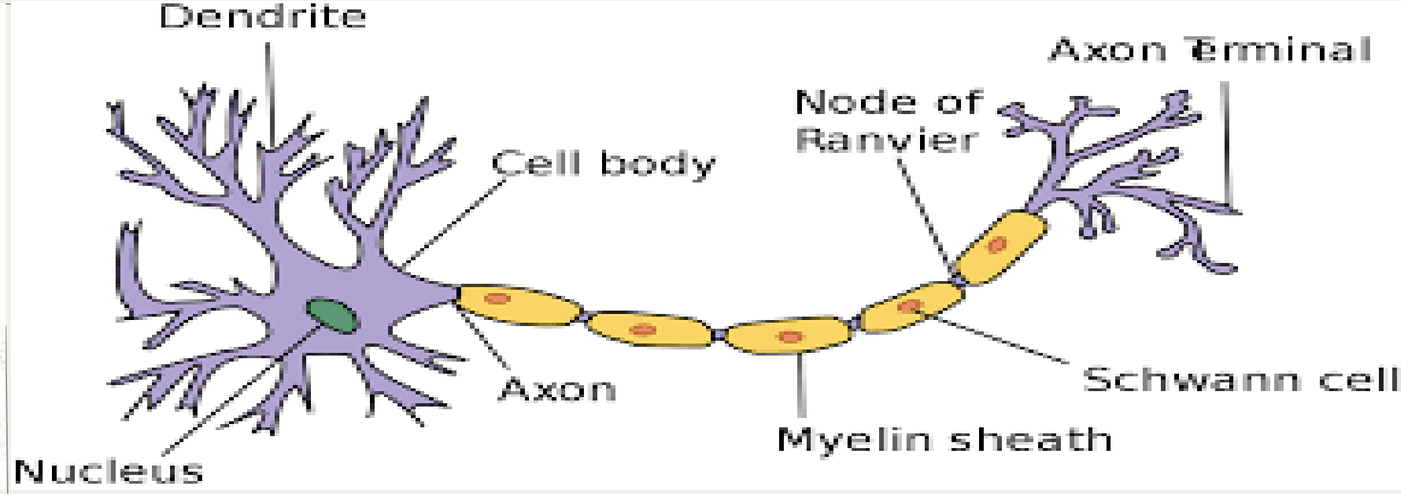
Recognised as a regulator of cellular events – microdomains in plasma membranes

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



SM: a key nutrient for myelination

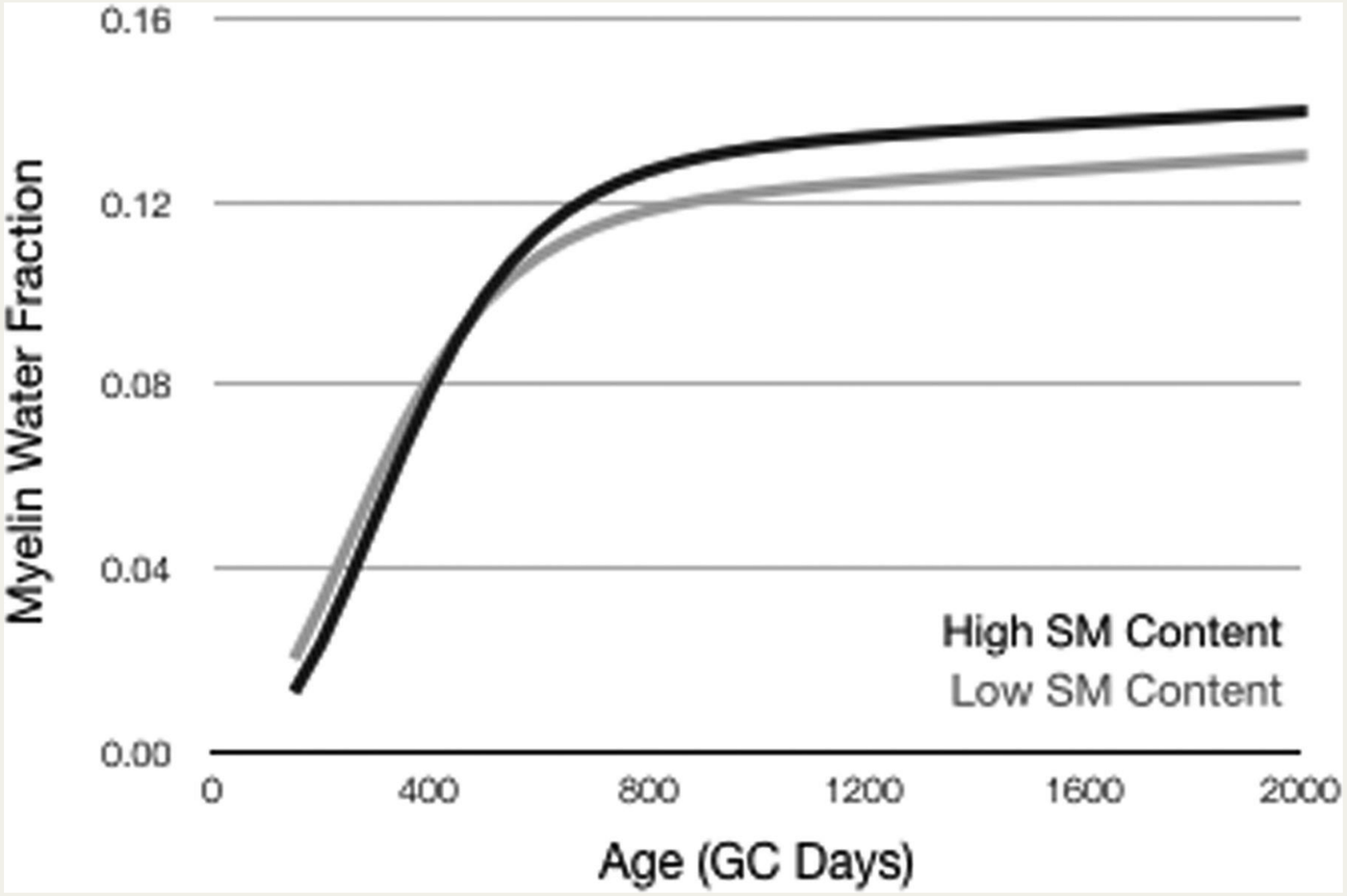




SM is a key component of the myelin sheath

- Myelin protects the neurones
- Helps to conduct signals more efficiently
- Prevents erratic activation of neighbouring axons

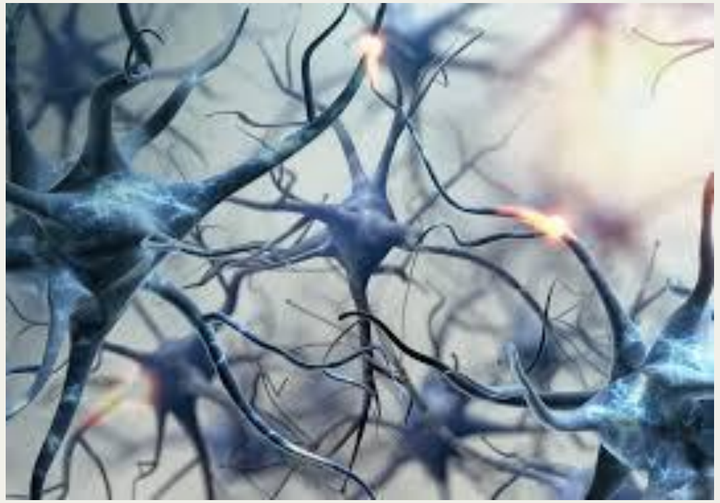
Positive correlation between dietary sphingomyelin & brain myelination



Benefits of brain myelination

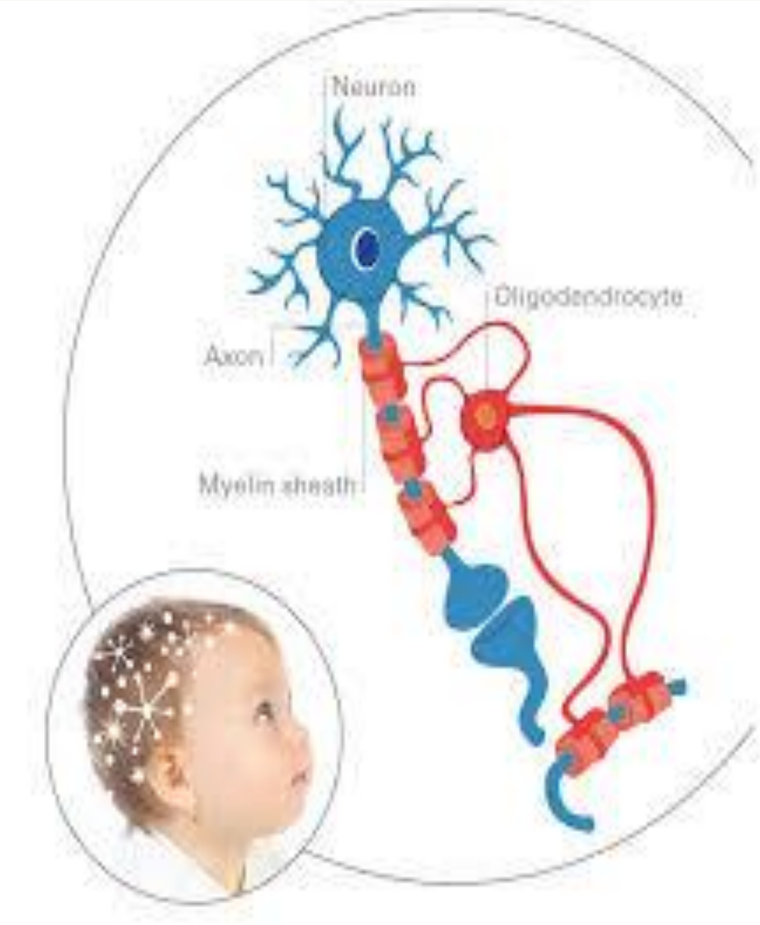
- Improves general cognitive ability
- Better language and reading ability
- Promotes working memory
- Higher processing speed
- Improved sensory reactivity

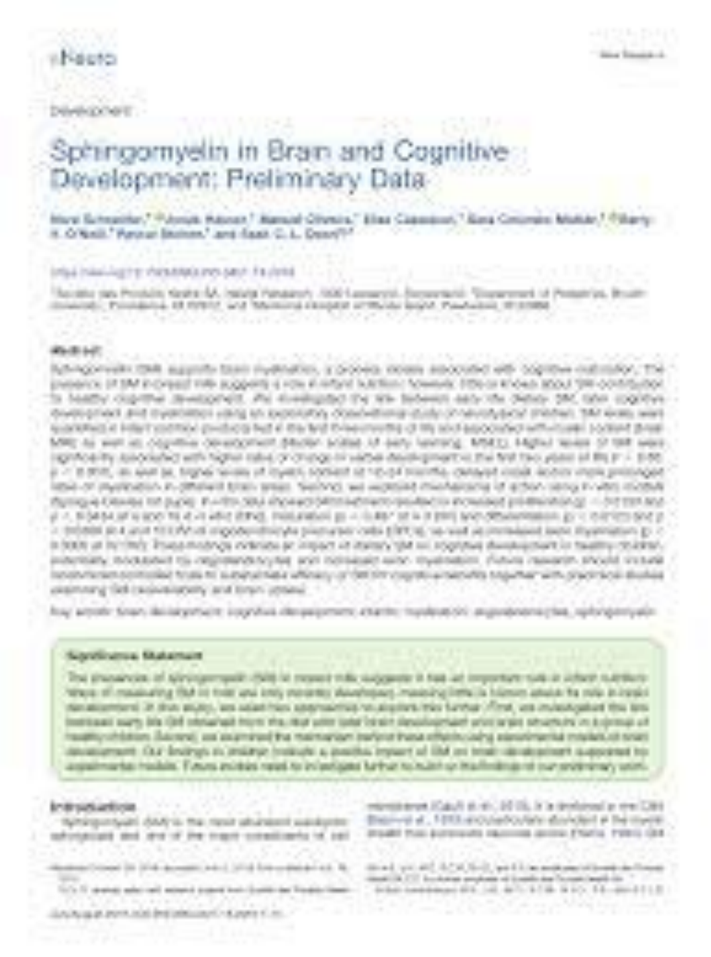
Brain myelination – the key to brain efficiency



- *The different parts of the brain have different functions.*
- *Efficient connectivity is mandatory for proper brain and cognitive functions*
- *It is the connections between the neurones that make the brain work*

SM-fortified milk has a positive association with neurobehavioural development of LBW infants - RCT





Neuro

Development

Sphingomyelin in Brain and Cognitive Development: Preliminary Data

- ***Improved behaviour rating scores on BSID-II***

Better novelty prerefence scores (Fagan test)

Increases sustained attention scores

Tanaka, et al. Brain Dev 2013

Key messages

The first 3 years of life represent a rapid and dynamic period of brain maturation

Most brain processes during the period are primarily focused on connecting the brain by myelination and formation of new brain connections

Early life nutrition is an important and modifiable factor that can shape myelination and subsequently cognitive outcomes

Key messages

CNS myelination is critical for maturation of brain networks!

- 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!***

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Thank
you!