Sphingomyelin and its role in Cognition

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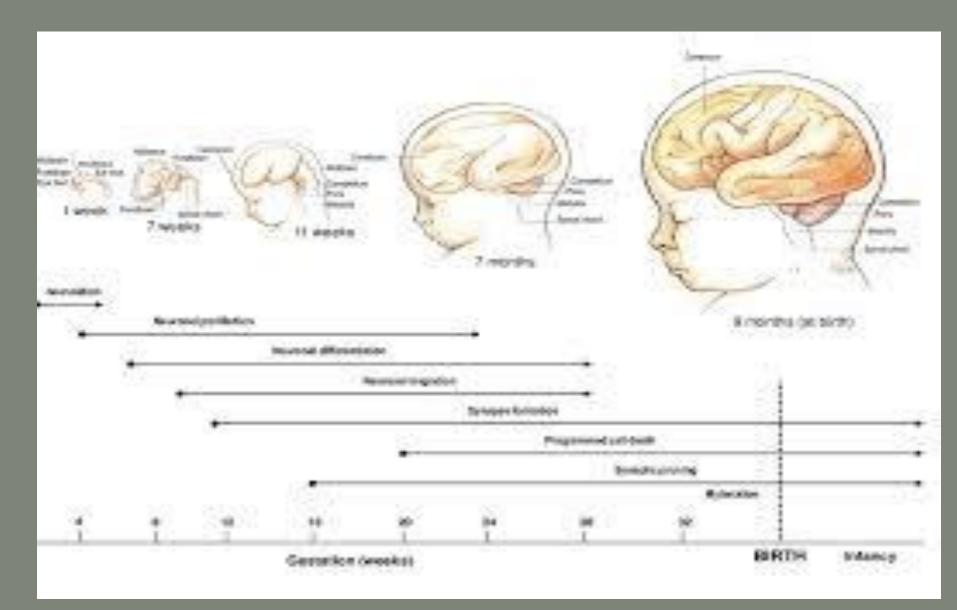
Main Goals

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

Sphingomyelin & Cognition

Development of is o The nervous system syst



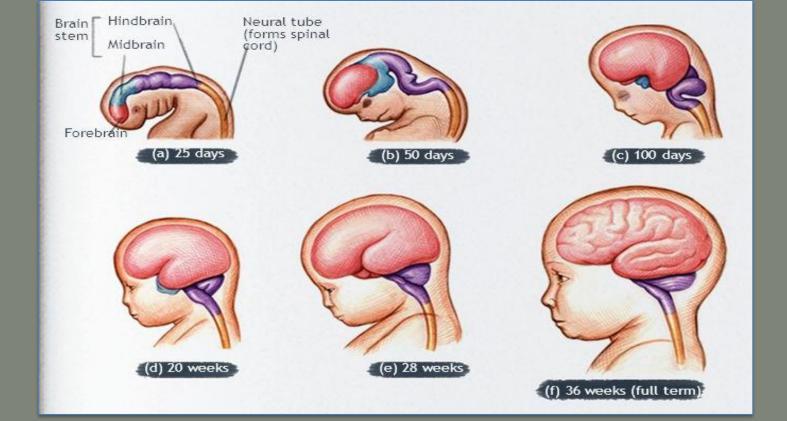
The foetal nervous system is one of the very first systems to develop and the last to be completed after birth

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

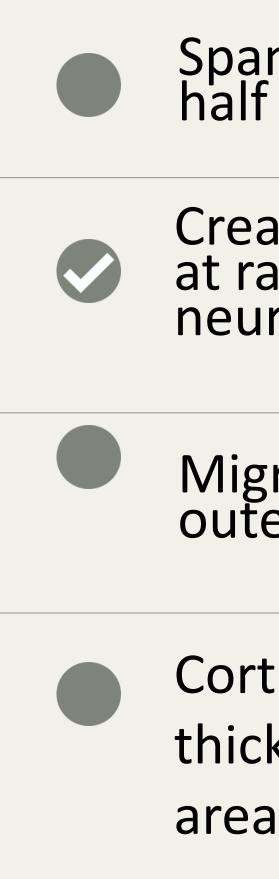
Conception to Mid-gestation

Mid-gestation to age 2 years



Phase 1

Key processes:



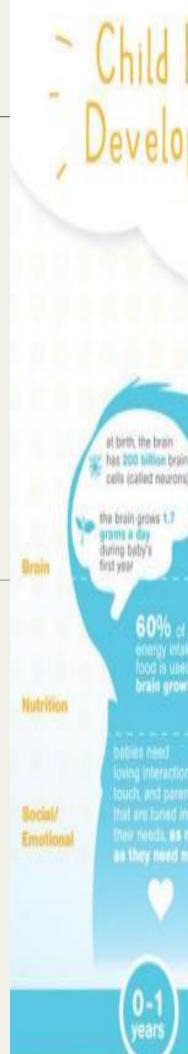
Spans through the first half of gestation

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

Phase 2

 Neuronal migration

 Neuronal connectivity





GOOD NUTRITION LEADS TO MORE STABLE MOODS INCREASES IN ABILITY TO PAY ATTENTION, AND IMPROVED MEMORY.

LOVING AND CONSISTENT CARE-GIVING

LEADS TO A BRAIN THAT HAS AN ABILITY TO LEARN TO DELAY GRATIFICATION. PROBLEM SOLVE, AND HAVE EMPATHY FOR OTHERS.

cells (called neurons)

brain growth

or roods as much a they need putritic

by age one, infants typically understand about 70 words, but speak only a handful of them

different regions of the developing brain occurs most rapidly during the first two years of life

ty age two, the brain reaches about 75% of adult weight

DHA, an omega-3 fatty ind choline, an essen nt, are critical build eveloping brain

t this age, loddlers

at 18 months; a toddler's spoken vocabulary starts to exipode, they add one new word every two waking hours.

loddlers have more than 00 trillion cell connections illed synapses) at age two the most they'll ever have in

by age two, the brain fructure has the overall appearance of an

ip strangthen bone

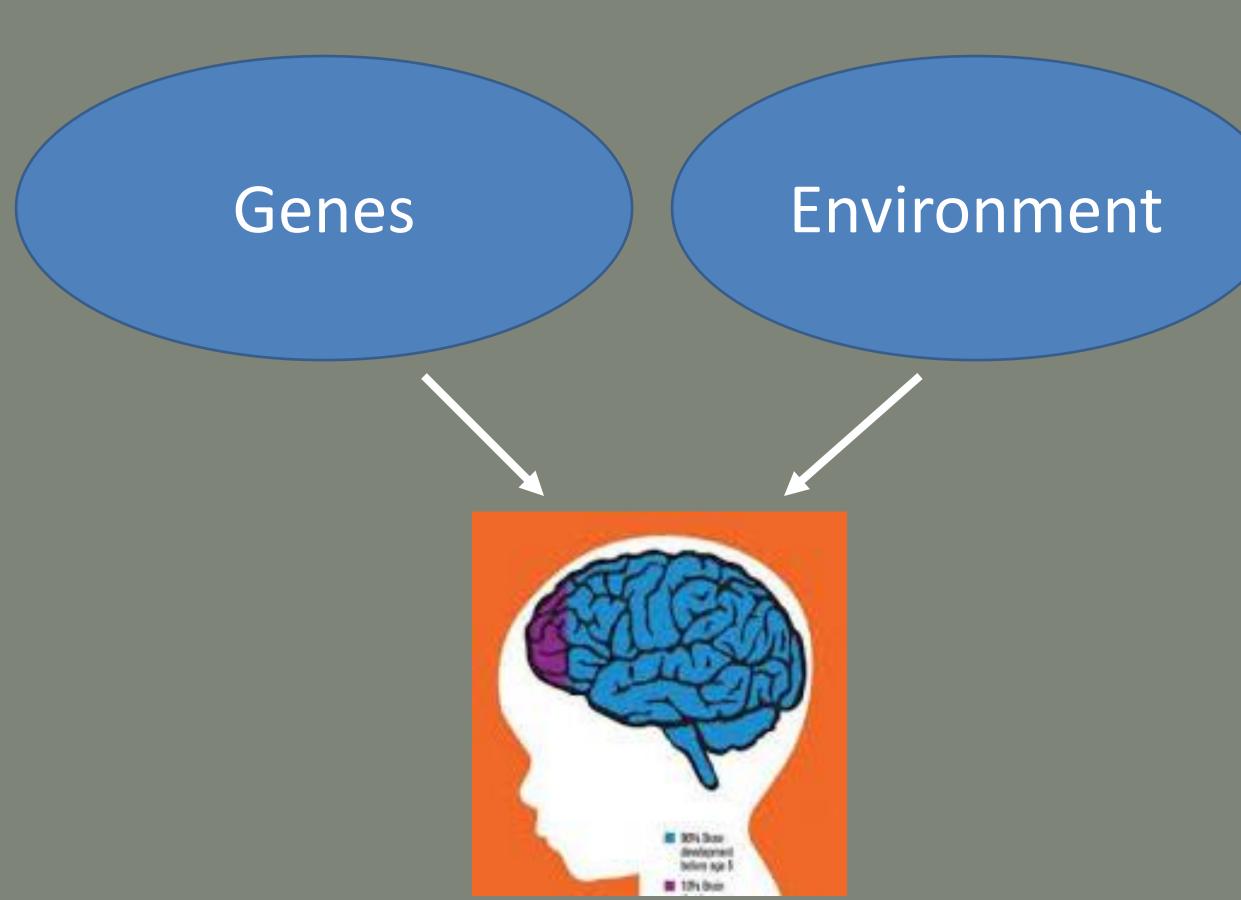
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by two years most toddlers have a 100-wari and are putting

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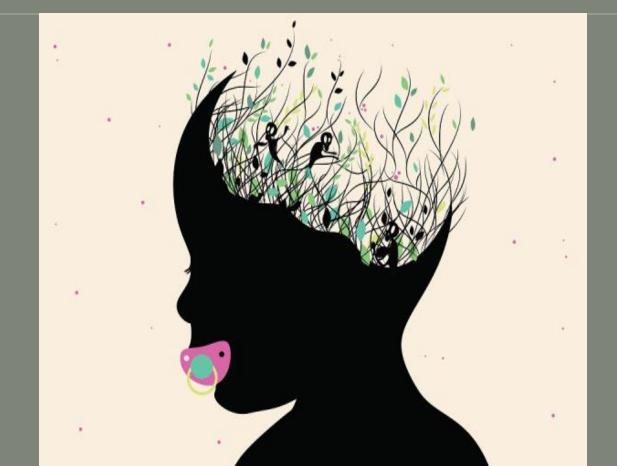
ABC

Key factors in brain development



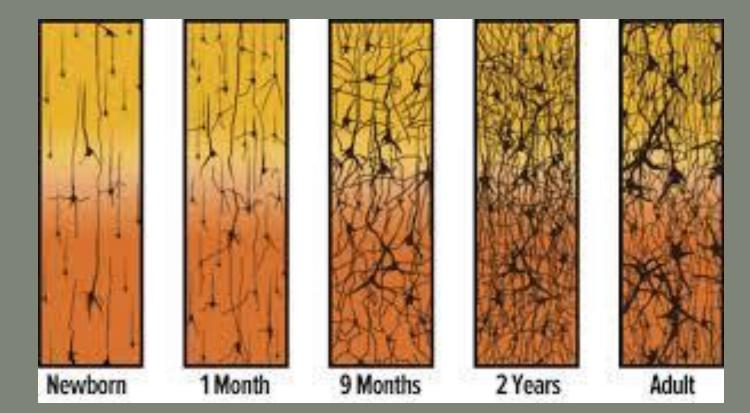
Early life: Key period for brain development

 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

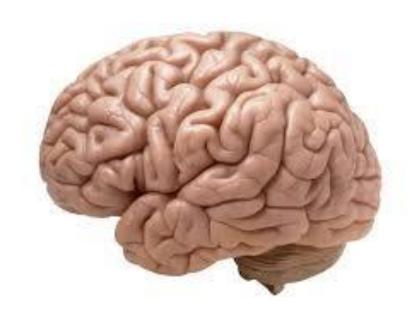
The nervous system is among the tissues of the mammalian body with the highest lipid content as well as the highest lipid complexity!

There are 5 major phospholipids in the brain

PHOSPHATIDYL-ETHANOLAMINE

PHOSPHATIDYL-INOSITOL

SPHINGOMYELIN

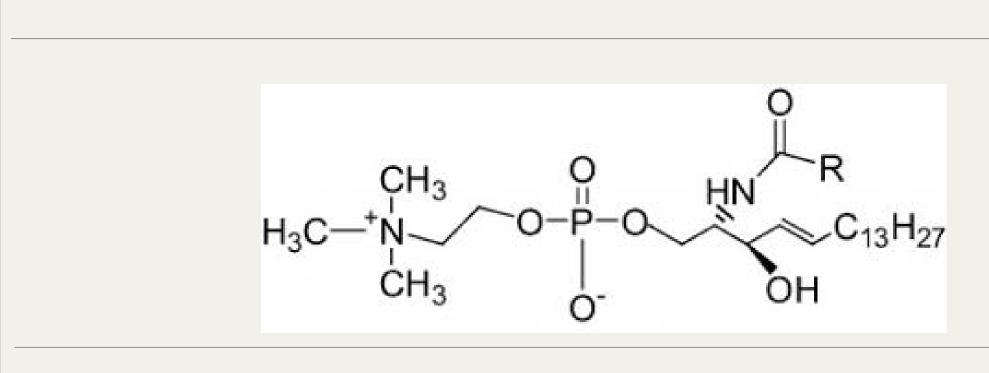


PHOSPHATIDYL-CHOLINE

PHOSPHATIDYL-SERINE

Sphingomyelin **(SM)**: a structural building block of the brain

The most abundant phospholipid in human milk



SM is naturally present in breastmilk

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



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 SM & other polar lipids are vital nutrients

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

for:

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

Brain function : synaptogenesis & synaptic transmission

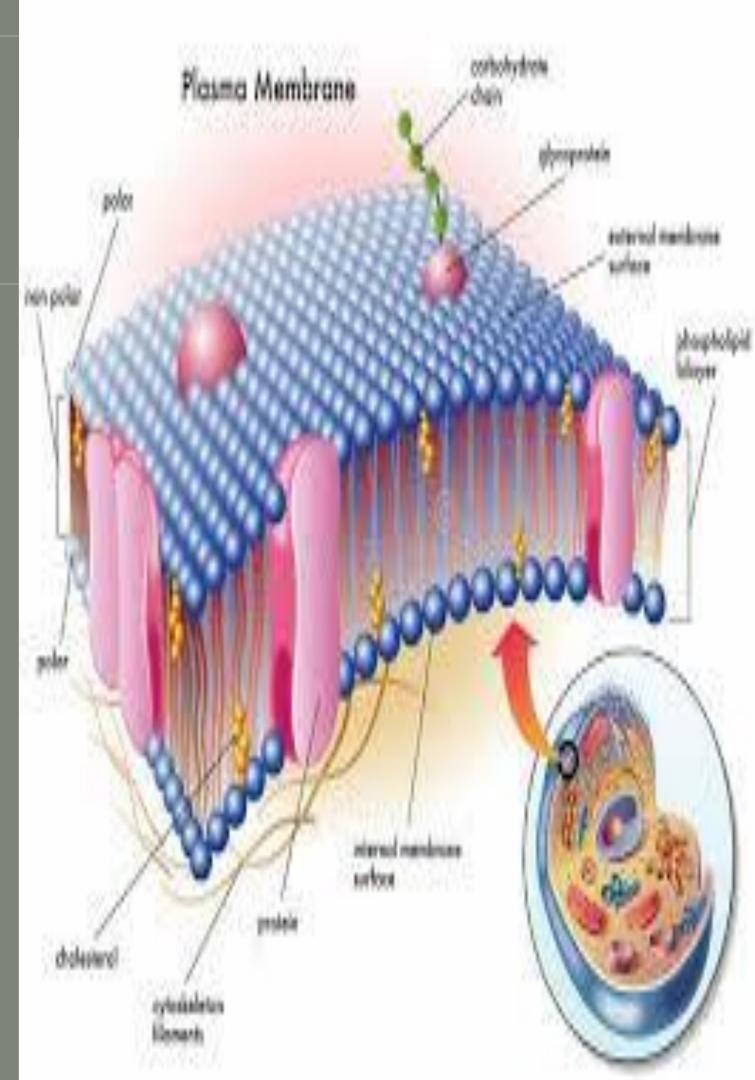
Brain metabolism

SM: a regulator of cellular events

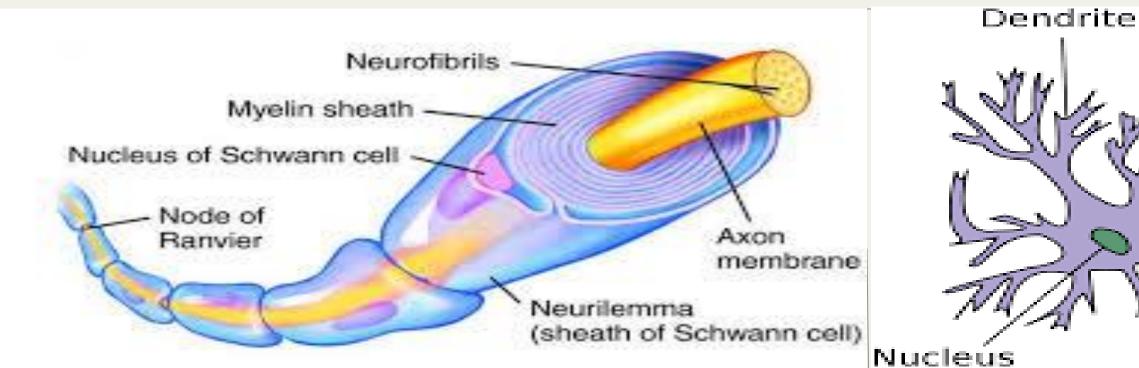
Not just a structural element

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

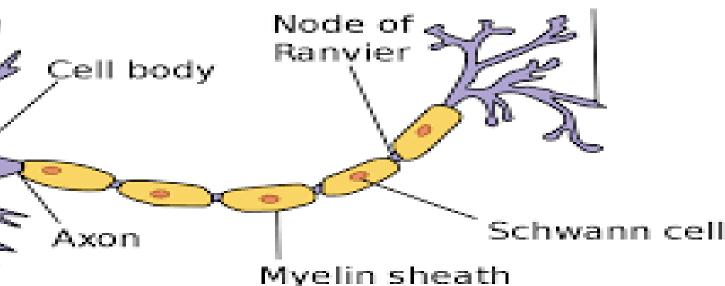


SM: a key nutrient for myelination



SM is a key component of the myelin sheath

Ο Ο efficiently Axon Terminal



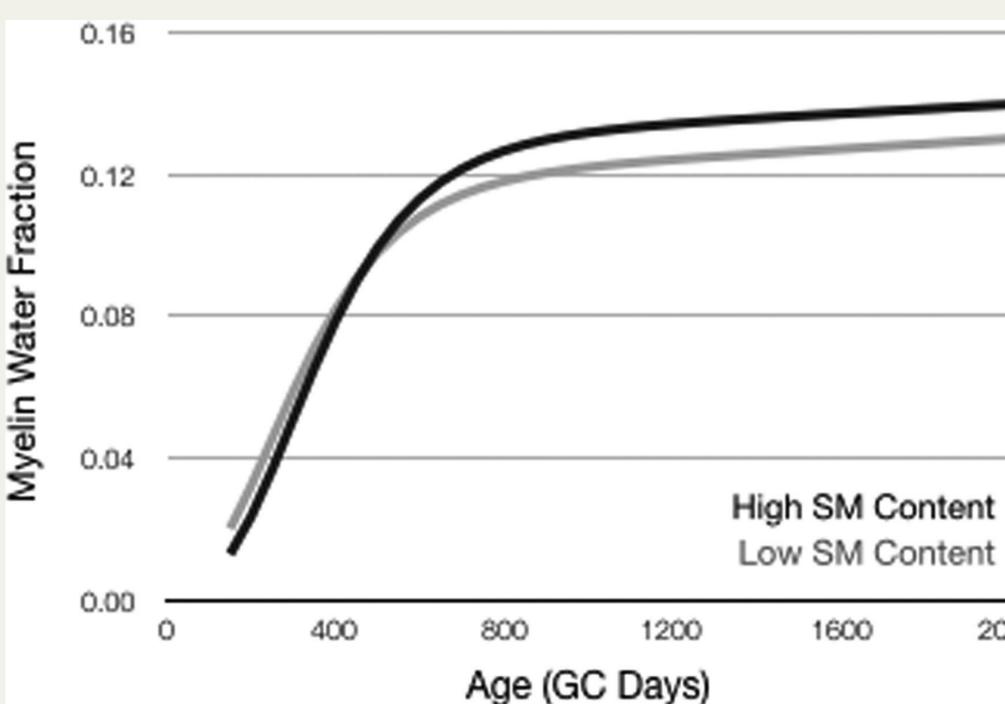
Myelin protects the neurones

Helps to conduct signals more

Prevents erratic activation of

neighbouring axons

Positive correlation between dietary sphingomyelin & brain myelination



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Benefits of brain myelination

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

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Brain myelination – the key to brain efficiency





Ο It is the connections between the

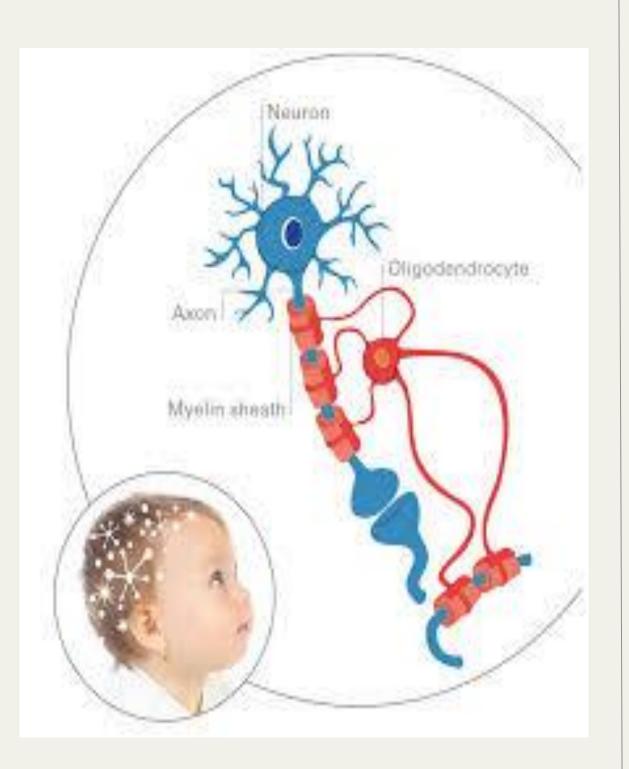
neurones that make the brain work



• The different parts of the brain have

Efficient connectivity is mandatory for proper brain and cognitive functions

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



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Sphingomyelin in Brain and Cognitive Development: Preliminary Data

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 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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