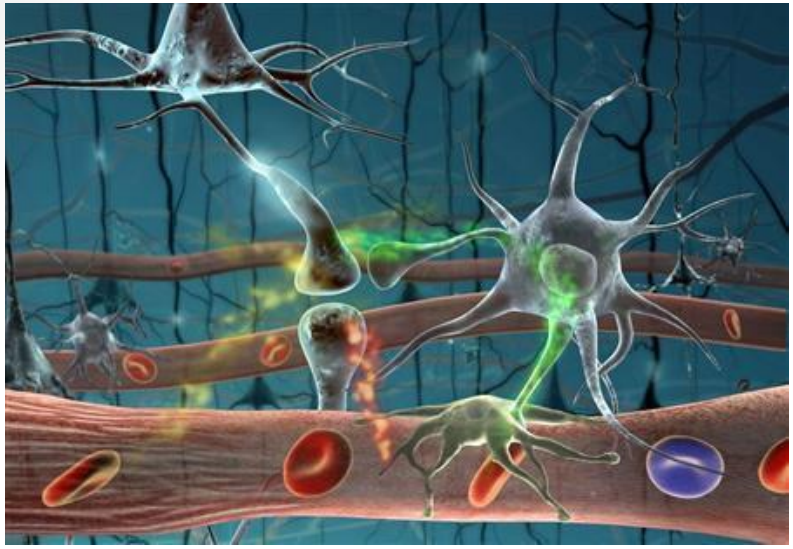
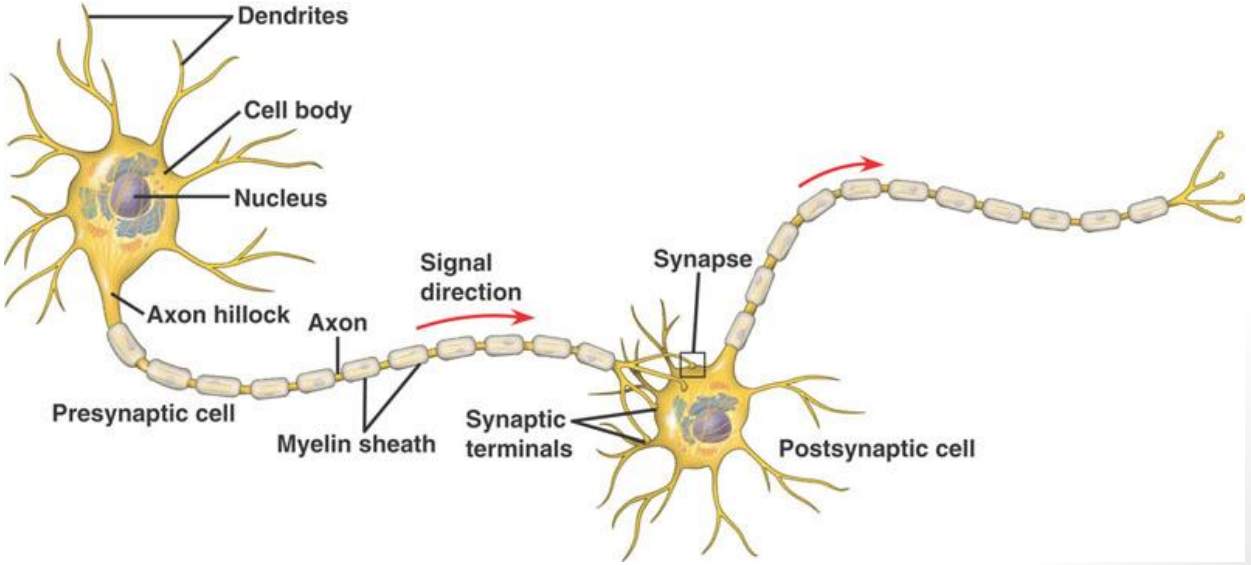
Fetal and Early Childhood Brain Development

- The human brain is an amazing work of art. It begins forming 16days post conception, with specialized brain cells called neurons present by 6 weeks.
- By the first 5 months of pregnancy, 100 billion neurons have been formed.
- Brain size however, is gradually increasing, a newborn's brain being ¼ that of the adult. It grows to 80% by 3years and 90% by 5years of its final adult size.

Basic Anatomy of the Neuron





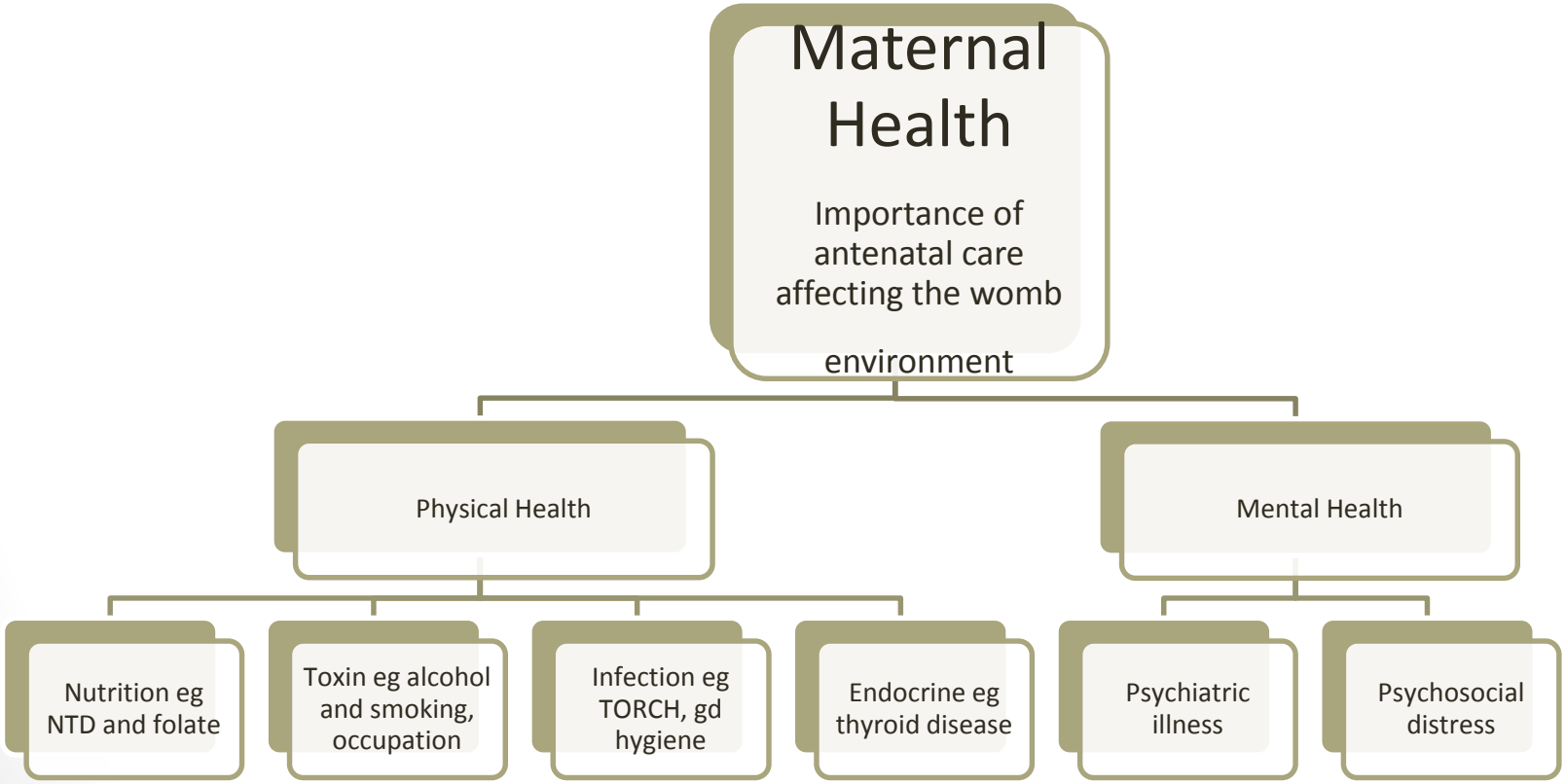
Basic Anatomy of the Neuron

- Dendrites are in charge of receiving information. This is processed in the cell and sent out via the axon.
- Synapses serve as the junctions where an axon meets a dendrite. The synapses peak in early childhood, then decline through to adolescence to about 1/3 of the peak numbers.
- Myelin serves as a plastic sheath insulating the axons. This increases the speed of the transmission and prevent unwanted connections between adjacent fibres. Myelination is most rapid from 0-2years old. Hence a newborn's brain is 16times less efficient than an adult, but this improves during childhood and peaks at 15 years old.
- Each neuron begins as a small cell that gradually develops and improves its connections. This is much like a small sapling that develops branches and hones its function. This explains the subsequent increase in brain size.

Chronology of fetal brain development

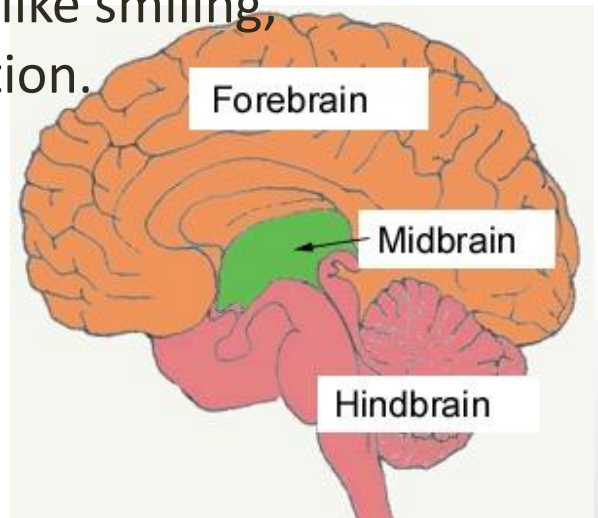
- 1st trimester:
- Week 5: synapses are formed in the brain and spinal cord
- Week 6: arching and curling of the body
- Week 8-10: movements of the arms, legs then fingers
- Week 12(end of 1st trimester): more complex movements like hiccupping, yawning and thumb sucking
- 2nd trimester: critical movements like breathing, sucking and swallowing become coordinated
- 3rd trimester: higher cerebral functions begin- touch, vision and hearing perception. Studies have shown that newborns can respond to familiar sounds like their mum's voice

Factors Influencing Fetal Brain Development



Brain Development After Birth

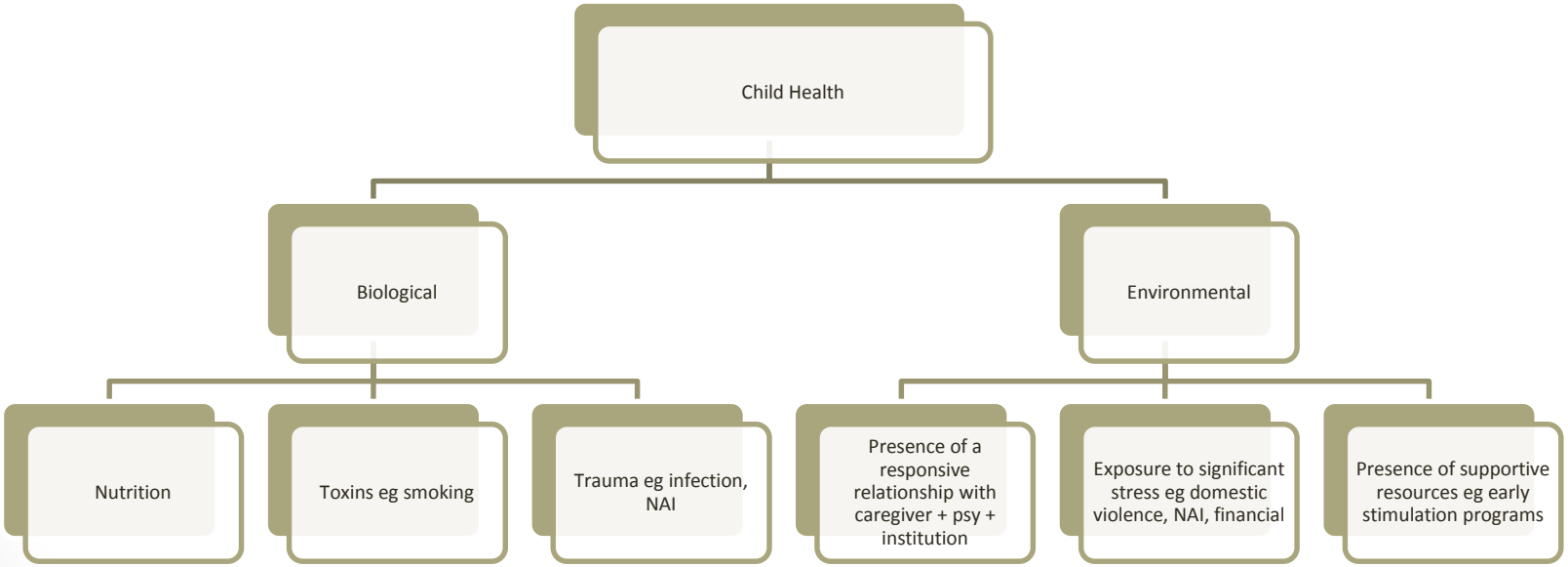
- By birth, the hindbrain which controls critical bodily functions like breathing and heart beat are well developed. However, the forebrain which is in charge of higher functions like cognition and motor function is still primitive.
- The brain forms its synaptic connections mostly after birth. At its peak, 2 million synapses are formed every second. By 2years old, there are 100 trillion synapses. They remain at its peak till 8 years then gradually decline to adult levels.
- With each sets of these come milestones like smiling, grasping, crawling and emotional connection.



Brain Development After Birth

- Myelination however continues in a prolonged fashion with most of the areas occurring by 2 years old. However some higher functions in the forebrain like emotional processing and memory continue through to adolescent and possibly early adulthood. Its sequence is predictable and the only known adverse environmental factor is severe malnutrition.

Factors Influencing Postnatal Brain Development



Nature or Nurture?

- Both! Genes and the environment are interacting constantly.
- Our DNA lay down the floor plan for the neurons and general connections. However it is experience that will fine tune it in response to the environment stimulus.

Understanding Brain Architecture

- The brain builds itself much like a complex skyscraper. It is built over time, foundation first. Genes and the environment constantly interact.
- For early childhood development, we are concerned with cognition, emotional stability and social functioning.
- Toxic stress can derail this process.

"Cells that fire together, wire together."- Carla Shatz

- Dr Carla Shatz, an American neurobiologist summarizes the Hebbian theory in this statement published in a scientific American article published in 1992.
- In the Hebbian theory, neural connections that are repeatedly stimulated are reinforced. Those that are not used will regress in a process called pruning. It is experience that shapes the brain making it efficient.

“Serve and Return”

- Serve and return is an important way a child interacts with his caregivers. It provides positive stimulation and if absent leads to “toxic stress”.
- Caregivers need to understand the importance of a responsive relationship with the child. However, these meaningful interactions cannot occur if the caregivers are overwhelmed with issues on a day to day basis. We need to address the needs of the caregivers to empower them to form strong relationships with the child.

The Concept of Toxic Stress

- Biological basis: In face of adversity, the body prepares for the “fight or flight” response by increasing stress hormones like adrenaline, increasing the heart rate and blood pressure.
- In the presence of a supportive relationship with an adult, the child learns to cope and the changes abate.
- In the absence of support, or when stress is prolonged or extreme, these physical changes persist, leading to damage to stress systems including the brain. This disruption to the brain architecture can affect the health, the learning ability and behaviour of the child.
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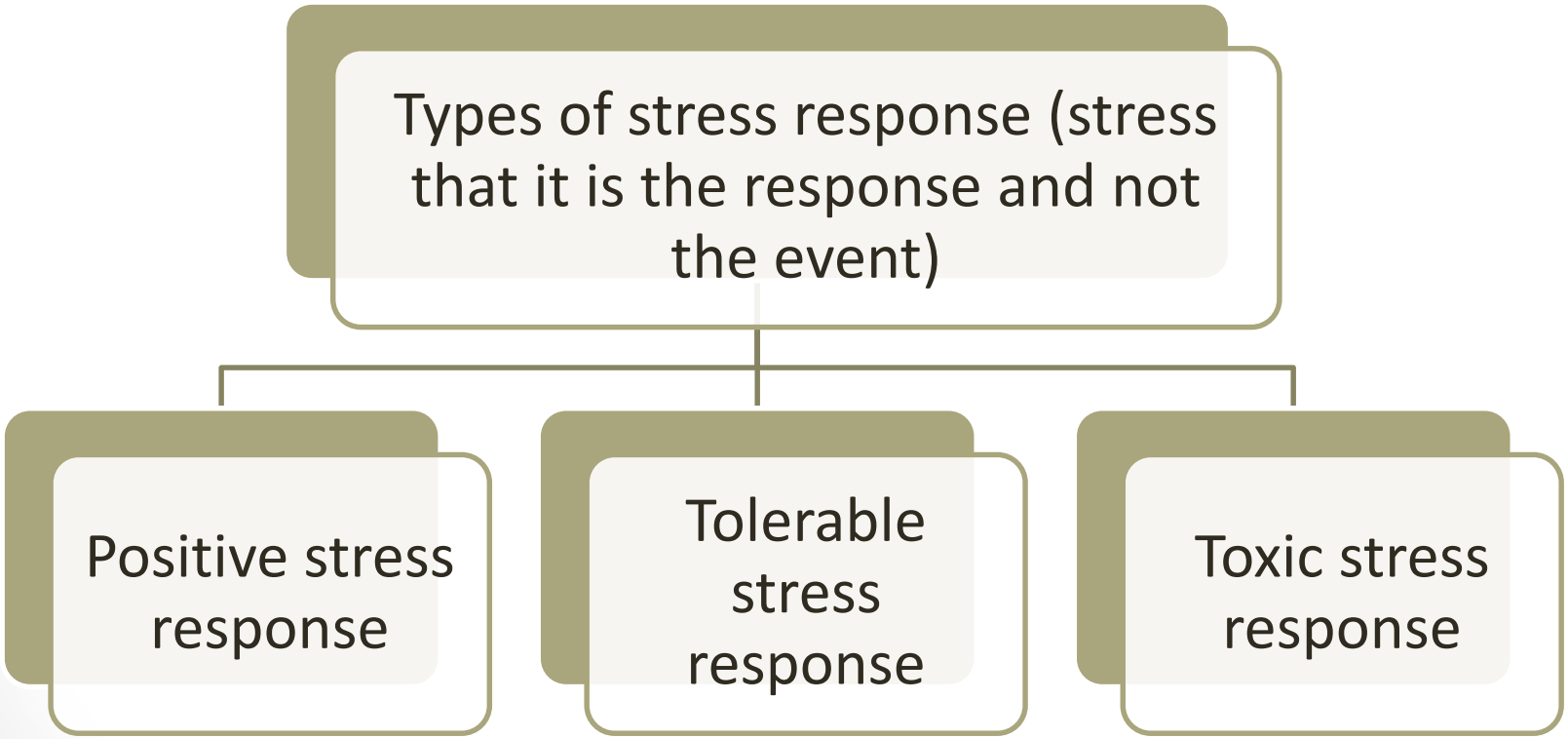
The Concept of Toxic Stress



Types of Stress Response

- Positive stress response: this is normal and essential where there is a brief increase in stress response but subsequently normalizes. For example, first day in school, or a new caregiver
- Tolerable stress response: there is a greater stress response but it is time limited and in the presence of a caring adult, to support the child through the adversity. Hence the brain recovers from the event. For example, the loss of a loved one, a natural disaster.
- Toxic stress response: the stress is severe, prolonged or frequent, and the child lacks a supportive adult figure. This disrupts the brain architecture and other systems, leading to increased risk of mental and physical illness that continues throughout his lifetime. For example, domestic violence, child neglect, caregiver mental illness

The Concept of Toxic Stress

- The outcomes are determined by
  - the child's genetic predisposition
  - the availability of a supportive, caring relationship with the caregiver
  - the intensity of the stressful experience
- Toxic stress damage is preventable and reversible.
  - remove the child from the experience if possible
  - provide or support the caregiver to build a stable, buffering relationship as early in life as possible