Section B

Neurodevelopment
Timeline of Brain Development


- Embryonic
  - Cell birth
  - Axonal/dendritic outgrowth
  - Synaptic production
  - Programmed cell death

- Postnatal
  - Synaptic elimination/pruning
  - Myelination

Majority of neurons
Fewer neurons, primarily in cortex
How Does the Infant Brain Become the Adult Brain?

- Overproduction
- Selective elimination
Neuronal Branching

Birth  Three months old  Two years old

Neuronal Branching as We Age

Synaptic Pruning and Myelination

- Dendrite
- Axon
- Myelin sheathing
- Synaptic knob

Unmyelinated axon

Myelinated axon
Synaptic Density and Age

Synaptic Density as a Function of Age in Two Cortical Regions

Visual cortex (Brodmann’s area 17)
Prefrontal cortex (middle frontal gyrus)
Synaptic Density and Age

Synaptic Density as a Function of Age in Two Cortical Regions

- **Visual cortex (Brodmann’s area 17)**
- **Prefrontal cortex (middle frontal gyrus)**
Brain Maturation

- Improved brain function
  - Increased efficiency of local computations
  - Increased speed of neuronal transmission
Frontal Lobe

- Executive function
- Planning
- Reasoning
- Impulse control
Dorsolateral and Ventromedial

- Thinking ahead and inhibition of impulsive responses
- Regulation of emotions; weighing risks and rewards; learning from experience
Brain Maturation and Behavioral Development

- Implications of brain maturation for behavioral development
  - Changes in pre-frontal cortex (PFC) should be reflected in improvements in executive functions
    - Future orientation (e.g., thinking ahead, consequences)
    - Response inhibition
    - Planning
    - Managing risk and reward
Brain development occurs within the context of the environment

Toxic environments impede normal brain development
The Process of Toxic Stress

- Hypothalamus
  - GRF- → Pituitary (ACTH)
  - +
  - Adrenal (cortisol +)
  - Adrenal (cortisol +)

Stress ➔ Pituitary (ACTH) ➔ + ➔ Adrenal (cortisol +) ➔ - ➔ Hypothalamus
Persistently Elevated Cortisol in Childhood

- Decreased synaptic and dendritic density early in life
- Decrease in pubertal hormones
- Diversion of brain resources away from learning to survival (e.g., fight or flight)
- Interruption of normal neurotransmitters (e.g., serotonin)
The Neurodevelopmental Impact of Chronic Abuse

- Diminished hippocampal volume
- Impaired development of frontal lobe (executive functioning)
- Diminished emotional control
- Problems with social relations and academic performance