Chapter highlights: The Developing Brain (Ch 2)

The purpose of “chapter highlights” is to offer a framework in which to think about the specific information discussed in each Brain Facts chapter. These highlights draw upon information in the chapter and on the new Brain Facts web site (http://www.brainfacts.org) and occasionally, on our own knowledge of neuroscience that may not be discussed in Brain Facts. Questions for Brain Bee will come from Brain Facts (new 2012 publication) and entries from the new Brain Facts web site that have “brainfacts.org” in the URL. Some but not all relevant entries are cited below.

Normal brain development involves both progressive and regressive cellular processes.

**Cell division (progressive):** occurs primarily in the inner cell layer lining the fluid filled space that will eventually become the ventricles of the brain and the central canal of the spinal cord

  - Neurogenesis is greatest in development but continues in some brain areas throughout life
  - Many more neurons will be produced than what ultimately survive into adulthood

**Cell migration (progressive):** chemical and physical cues in the environment play a critical role in guiding developing neurons to their adult destination.


  - Radial glia (that radiate out from the inner ventricular zone to the outer marginal zone of developing brain) form temporary scaffold on which neurons migrate

**Process extension (progressive):** primordial neurons extend axons and dendrites to form synaptic connections

  - Growth cones detect chemical cues in the environment to guide process growth (stop, turn, etc)

**Synaptogenesis (progressive):** neuronal processes arrive at targets to form specialized junctions called synapses.


  - Synapses connect neurons with target cells and is the site of chemical transmission

**Neural connections are pared back (regressive)**

**Programmed cell death** (aka apoptosis): about half the neurons initially produced die during development
Some adult onset neurodegenerative diseases may involve a re-activation of cell death pathways

Errant connections (such as sensory projections in motor pathways) are eliminated during the period of axonal regression/elimination

Many original projections are eliminated while cell bodies are spared.

**Extrinsic factors are key determinants of neuronal phenotype and/or fate**

Example: Most neurons are derived from the **ectoderm** but the decision to become a neuron depends on chemical cues from the **mesoderm** (primordial cell layer that gives rise to muscles, bones, etc)

Example: Cues in the ectoderm (but extrinsic to the cell) determine whether ectodermal cells will form the nervous system or skin

Example: Target-derived cues determine which neurotransmitter a neuron will use.

Example: Access to target-derived trophic factors determines whether a neuron will live or die during the period of developmental cell death.

**Early experiences can permanently alter brain wiring by changing the course of developmental processes**

Developmental cell death and axonal elimination represent critical periods during which environmental factors and experience can have lasting effects on the brain

Example: The “use it or lose it” principle is exemplified by permanent blindness in one eye when in development that eye is not used as opposed to no blindness when the adult eye is not used; this blindness is due to an abnormal loss of neural connections in the brain during the developmental period of axonal elimination.

**Induction is a basic principle determining cell identity in the nervous system.**

Sonic hedgehog is a key inducer of cell identity in the developing spinal cord

**Two major cell types in the nervous system that are derived from the ectoderm are neurons and glia.**

**Myelination of axons by specialized glia occurs last in the developmental sequelae and continues into young adulthood**

Inputs to the forebrain are last to be myelinated and may underlie the development of executive functions involving judgment and impulse control

**Changes in neural circuits occur in large part during critical periods**

The brain is able to modify itself throughout life

http://www.brainfacts.org/brain-basics/brain-development/articles/2012/plasticity/