• By 28 weeks after conception, brain has virtually all the neurons it will ever have.
• At birth, the brain weighs about .75lb (25% of adult weight)
• At 3 years of age, 80% of adult weight.
• At 5 years of age, 90% of adult weight.
• At 16 years of age, reaches adult weight.
• …then by 50 it starts getting smaller.

From Implantation to Neural Tube
• After implantation, cells start to differentiate.
• the inner cell mass becomes the embryo.

From Implantation to Neural Tube
• In the process known as gastrulation, the inner cell mass becomes the embryo.
• The single-layer embryo begins to fold itself into three layers.
• A U-shaped groove forms down the center of the top layer.
• The folds at the top of the groove fuse, creating the neural tube, which will develop into the brain and spinal cord.
The Neuron

- The neuron has three components.
  - **Cell body**: Basic biological material.
  - **Dendrites**: Fibers that receive input from other cells and conduct it toward the cell body.
  - **Axon**: Fiber that conducts electrical signals away from cell body to connections with other neurons.

- **Synapses** are junctions between axons and dendrites where communication takes place by means of electrical–chemical signals.

Glial Cells

- In addition to the neurons, the brain contains **glial cells**
  - Outnumber neurons 10 to 1.
  - Form myelin sheath around certain axons, insulating them and increasing the speed and efficiency of information transmission.

Brain Development

- **Neurogenesis** is the proliferation of neurons through cell division, mostly from conception to 20 weeks.
- **Migration** - between 8-15 weeks, neurons move to particular locations in the brain; innermost brain first, outermost brain last.
- **Differentiation** - Specialization.
- **Aborization** - is the increase in size and complexity of dendrites.

Brain Development

- **Myelination** begins in 4th month of prenatal development and continues into adulthood. Axons acquire insulating myelin (processing speed, attention span).
- **Synaptogenesis**: From 3 months before birth to 2 years of age, number of synapses increases.
- **Synapse elimination**: weeding out unnecessary connections. “Use it or lose it”
The Cerebral Cortex

- 80% of the brain
- The cortex is divided into two separate halves, the cerebral hemispheres.
- Left and right hemispheres are connected by a band of nerve fibers, the corpus callosum.

Cerebral Lateralization

- Cerebral Lateralization - Hemispheres have some specialized functions:
  - Right hemisphere processes information in a holistic manner, the “emotional” brain, simultaneous processing of information.
  - Left hemisphere processes information more linearly, the “thinking” brain, sequential processing.
- Evidence of lateralization at birth evident at birth, but continues and brain remains plastic.

Adolescence

- Myelination continues (integration of multiple sources, emotion & thought, scientific reasoning).
- Prefrontal cortex decreases in size and undergoes a reorganization of neuronal connections.
- Dopamine (neurotransmitter associated with novelty seeking) reaches peaks levels.

Aging

- Brain weight and volume decrease over adult years, especially after 50.
- Loss greater in areas that control sensory and motor activities.
- Slower processing speed (declining levels of neurotransmitters, “senile plaques”, reduced blood flow to the brain)
- Can still form new synapses and extend dendrites; still some plasticity.
The Brain and Experience

Plasticity - The capacity of the brain to be affected by experience.

- **Experience-expectant plasticity**
  - General experiences "expected" by the individual brain.
  - If such an experience does not occur, deficits may result and compensatory rewiring occur (e.g. kittens, cataracts, strabismus)

- **Experience-dependent plasticity**
  - Neural connections are created and reorganized throughout life as a function of individual experience.
  - Highly specialized effects can occur in individuals with unique skills (e.g. cellists and violinists)

Brain Damage and Recovery

- Worst time is in the **very early stages of prenatal development** and in the **first year after birth**, when neurogenesis and neuron migration are occurring.
- Brain damage in **early childhood**, when synapse generation and pruning are occurring, has the best prognosis for recovery.
- As developmental processes are complete and plasticity lessens, successful recovery from brain damage is less likely.

Synaptogenesis and Synapse Elimination

[Graphs showing vocabulary and block design scores over age]

Control versus Congenital lesion