Review for Exam

Monday  5-6:20 pm
York 2722
Initially, the embryo has 3 distinct layers of cells

- **Ectoderm** >> Nervous System & Skin
- **Mesoderm** >> Muscles, Bone
- **Endoderm** >> Organs
Embryonic Development

- **Neural Plate**
- **Neural Fold**
- **Neural Crest (PNS)**
- **Neural Tube (CNS)**

Folds seal together

- **21 Days**
- **22 Days**
- **28 Days**
Spina Bifida

Neural Folds fail to join
Neural Tube develops into
Forebrain, Midbrain & Hindbrain

Hollow center becomes
Ventricles and Central Canal
Proliferation of cells

First 7 weeks: SYMMETRICAL DIVISION

Then switch to ASSYMMETRICAL DIVISION
Radial Glia
One of the first types of Glia cells to develop

Migration

Ventricular Zone
As new cells accumulate in the Ventricular Zone, the Neurons start to migrate.

Radial Glia
One of the first types of Glia cells to develop

Newborn Neurons "crawl" along Radial Glia
Once in place, Neurons begin to differentiate into a wide variety of cell types. Influenced by **Cell Autonomous** (genetic) and **Induction** (environmental) factors.
Synaptogenesis

Forming the critical **CONNECTIONS** between neurons
Synaptogenesis

At this stage, the terminal of the axon is a ciliated **Growth Cone**

Its cilia are called **Filopodia**

*Figure 3.10 The growth cone. This micrograph, a photograph taken by an electron microscope at extremely high magnification, shows the growth cone of a developing neuron with its many filopodia.*
Synaptogenesis

Glia cells, called "Guidepost Cells", ooze neurotrophins that attract/repel axon Growth Cones
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Time 1

Time 2

Time 3
Synaptogenesis

A competitive process
Synaptogenesis

Apoptosis
Cell Suicide

Neurons are massively OVER-produced (50% more than present at birth!) and then selectively die off.

The less fit, less well-connected cells are culled, so only the most fit, best-connected persist.
Cells that **Fire Together, Wire Together**
Cells that Fire Together, Wire Together

Waves of spontaneous activity

Wrist  Forearm  Elbow

Even after synaptic connections have been formed, fetal circuits continue to be modified
Cells that **Fire Together, Wire Together**

Waves of spontaneous activity

Fetal Post-Synaptic Cells - The more **NTs** they receive, the more **Neurotrophins** they release
Cells that Fire Together, Wire Together

Waves of spontaneous activity

Wrist  Forearm  Elbow

Fetal Post-Synaptic Cells - the more NTs they receive, the more Neurotrophins they release
Cells that **Fire Together, Wire Together**

Fetal **Post-Synaptic Cells** - the more **NTs** they receive, the more **Neurotrophins** they release.
Cells that **Fire Together, Wire Together**

Waves of spontaneous activity

Wrist  Forearm  Elbow

Fetal **Pre-Synaptic Cells** that do not get strong feedback **weaken**
Cells that Fire Together, Wire Together

Waves of spontaneous activity

Wrist

Forearm

Elbow

Fetal Pre-Synaptic Cells that do not get strong feedback weaken
Cells that **Fire** Together, **Wire** Together

Waves of spontaneous activity

**Wrist**

**Forearm**

**Elbow**

Fetal Pre-Synaptic Cells that do not get strong feedback **weaken**
Cells that Fire Together, Wire Together

Wrist | Forearm | Elbow

Waves of spontaneous activity

Finally, the Pre-Synaptic Cells w/out strong feedback commit Apoptosis
Cells that **Fire Together, Wire Together**

Wrist  Forearm  Elbow

Waves of spontaneous activity

The remaining connections preserve **Topological** maps.
Topological Maps

The Penfield Map in Somatosensory Cortex

A "Topological" Map preserves the spatial relationships of the (in this case Sensory) surface that it represents
Further Developments After Birth
At birth, ~350 g

At 1 year, 800-1000 g

Adult, 1200-1400 g
Most "brain growth" after birth = **Dendritization**
Effects of Experience

Maps in V1 include columns of cells that preferentially respond to Horizontal, Vertical or Diagonal lines.

While these maps are largely laid down during Fetal development, they are also shaped by experience.
Effects of Experience

Kittens, exposed to ONLY Vertical lines, during critical period for post-natal Synaptogenesis in area V1

Cells, which would otherwise respond to Horizontal lines, are taken over by connections activated by Vertical lines

Afterward, these cats will NEVER be able to detect Horizontal lines in environment
Effects of Experience

But NOTE:
Other areas of visual cortex continue to be modified throughout life

e.g. **Fusiforme Gyrus** of the Inferior Temporal (IT) area, end of "Ventral Pathway"

Circuitry changes every time you learn to recognize a new face...
Myelinization of axons continues into adulthood (until ~20 years old)
The brain is VERY plastic!
Continues to change
- make new connections – throughout life!

More on this to come...!
LINKS

http://www.youtube.com/watch?v=JD8DNuAMEDM&feature=related
Google “tutortom10 neural growth and regulation”

Short Free Tutorials: www.khanacademy.org/