COGS 17

Week 4

Development!

Reminders!

Homework Problem Sets

- Homework #3 is due TODAY @ 11:59 PM!
- No late homeworks accepted

Midterm

- Midterm 1 is TOMORROW from 3-30:4:50 PM!
- Can be taken online or in class
- Will be proctored in class

Extra Credit

- SONA
- Mnemonics
- Do all HWs → 4 extra credit points

Midterm 1 Format

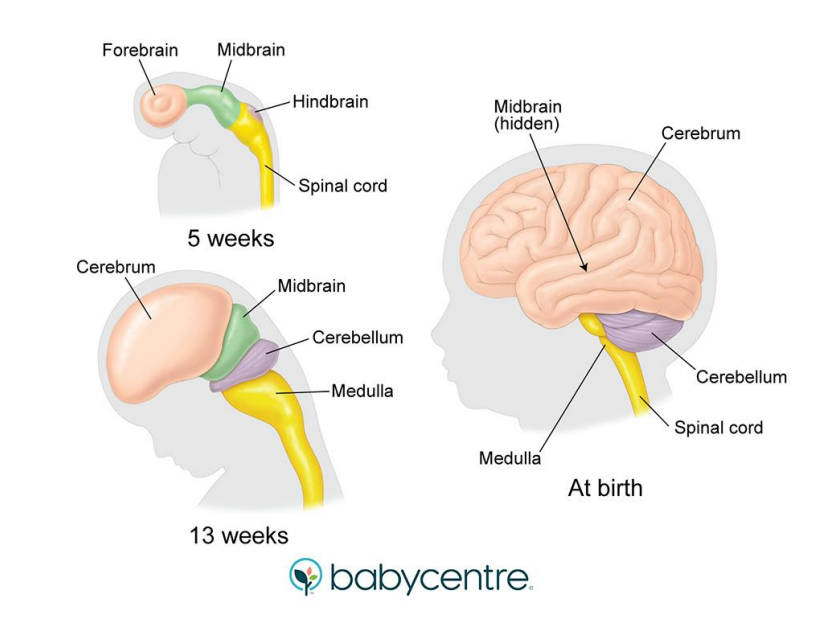
- 23 questions w/ a total of 125 points
- VERY similar to homework
    - TRUE or FALSE
    - Fill in the blank
    - Matching
- Most questions focus on Neuroanatomy (50%!)
- When taking the test, refer to:
    1. Notes
    2. Slides

For Slides + Problem Sets

Link:

https://drive.google.com/drive/folders/1DlvXFvEKxhF3ykEaK2_jBsNUgGOb8fS3?usp=drive_link

Embryonic Development



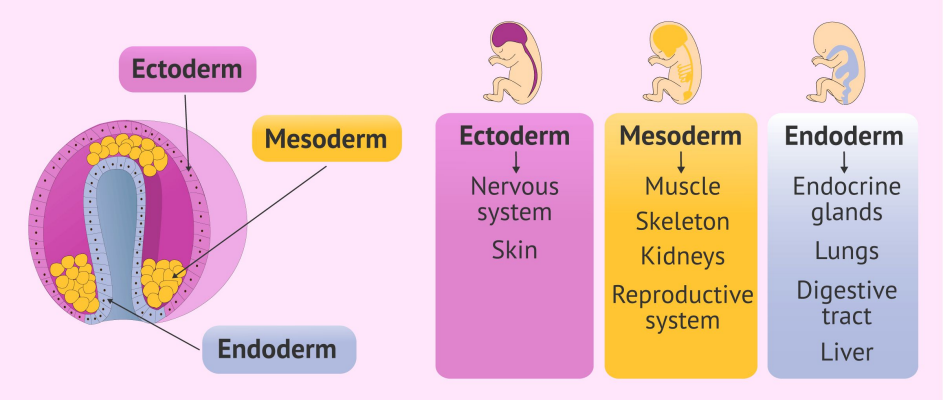
Embryonic Development

Initially there are 3 layers of cells

Outer Layer **(Ectoderm)**
- Nervous system and skin

Middle Layer **(Mesoderm)**
- Bones, muscles, and blood vessels

Inner Layer **(Endotherm)**
- Internal organs and glands



Embryonic Development

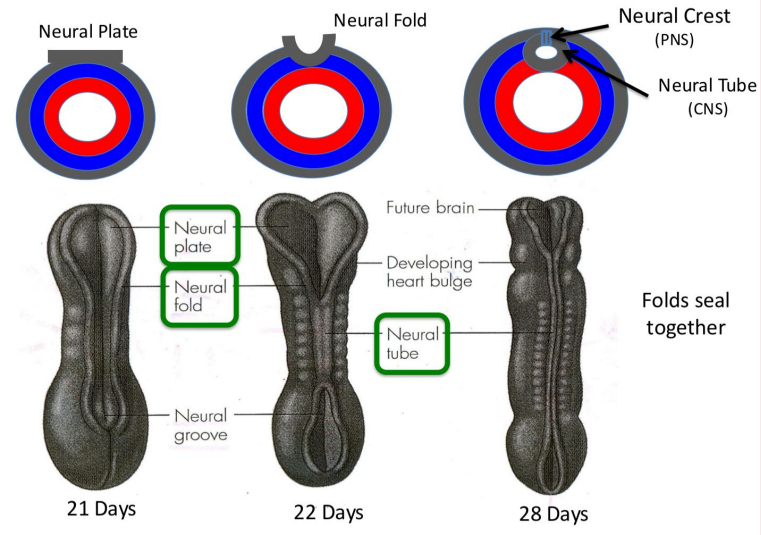
Dorsal ectoderm thickens and hardens to form the **Neural Plate**

- The edges of the plate forms ridges called **Neural Fold,** which curl up towards each other along the longitudinal axis until they touch and fuse

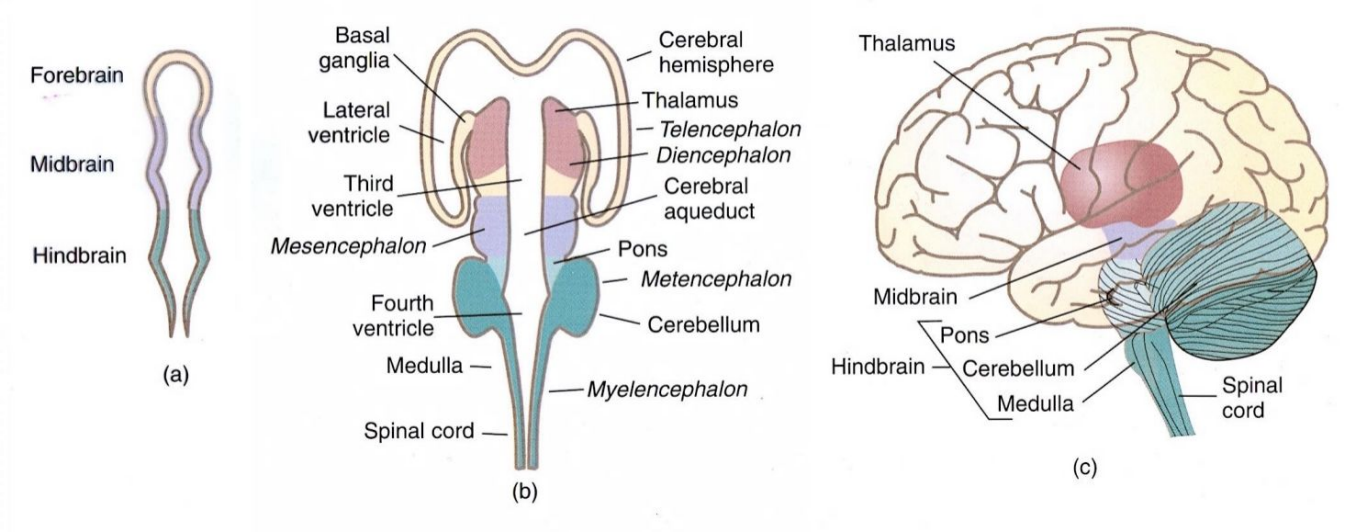
By Week 4, the curling-fusing process is completed to form the **Neural Tube**

- Become CNS
- Anterior end > Brain
- Posterior end > Spinal Cord

Dorsal surface of the Neural Tube forms the **Neural Crest**



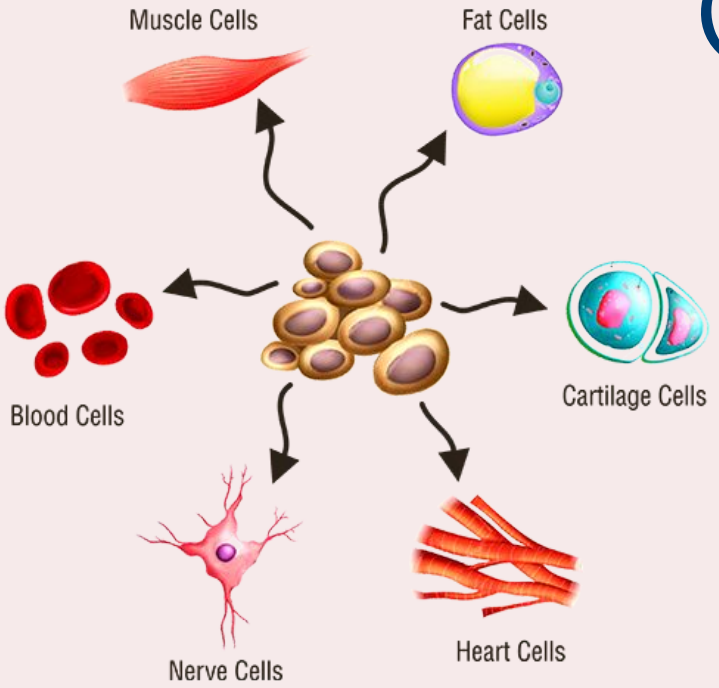
Embryonic Development



Proliferation of Cells

Stem Cells

- Special cells that can turn into different types of cells
- In a developing embryo, they can develop into any type of cell

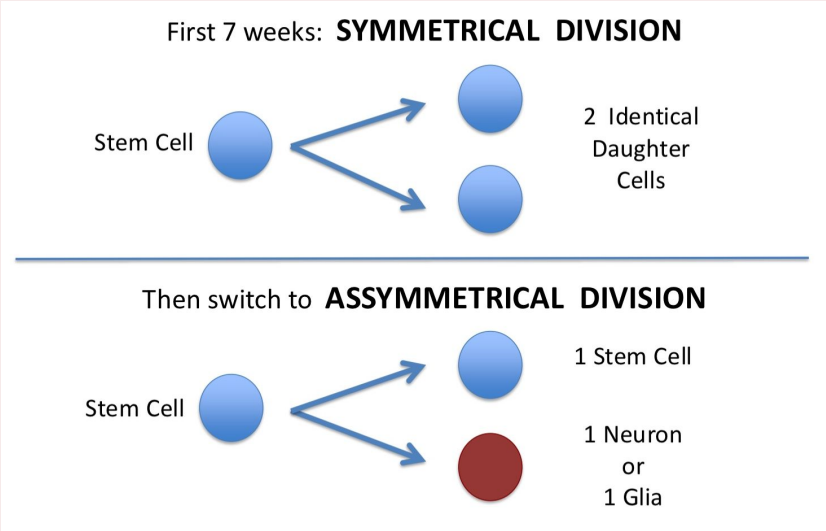


Proliferation of Cells

Ectoderm Stem Cells

- During the first 7 weeks: Undergoes **Symmetrical Division** (produces two identical daughter cells) increasing the size of the **Ventricular Zone**
- After Week 7: Shifts to **Asymmetrical Division** (produces one stem cell, one neuron or glia) lasts for ~3 months to produce over 100 billion neurons in cortex

Generally, Stem cells remain in place while neurons migrate to their final destinations



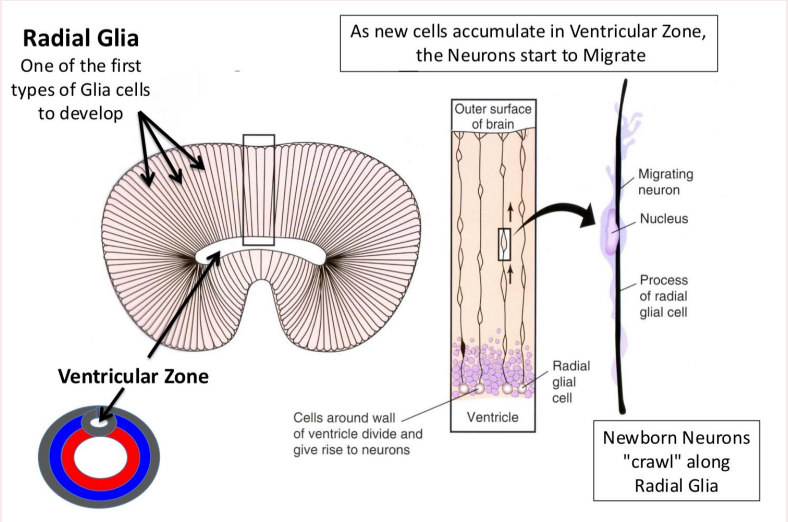
Migration and Differentiation

Some neurons migrate by “crawling” along **Radial Glia** that extends fibers outwards from the **Ventricular Zone**

Other neurons may migrate by following chemical trails (= **Neurotrophins**) laid down by Glia cells or by other neurons

Differentiation: Once in place, neurons differentiate into a wide variety of cell types

- Autonomous (genetic) & induction (local environmental) factors affect the cell’s “fate”

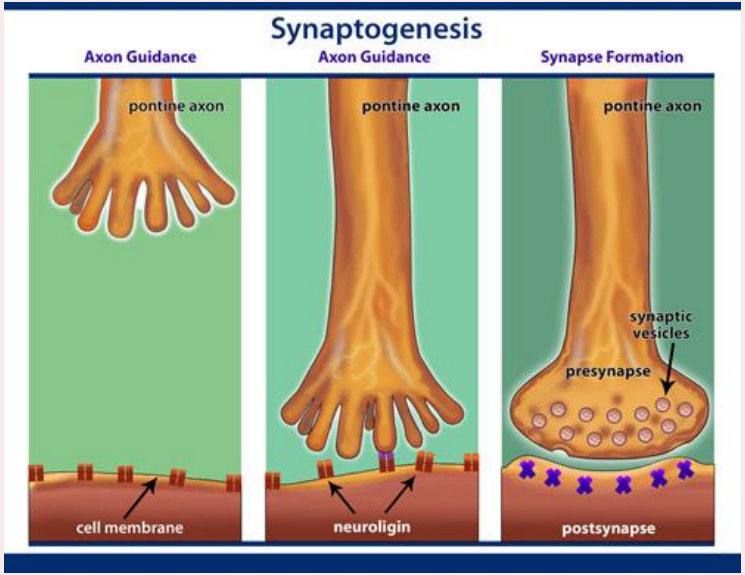


Synaptogenesis

Chemical trails - Neurotrophins

= chemicals that attract/repel and promote survival and activity of neurons

- Muscles produce NGF (Nerve Growth Factor) that attract and promote survival of Sympathetic Nervous System Axons
- CNS can produce BDNF (Brain-Derived Neurotrophic Factor) which promotes the axon survival

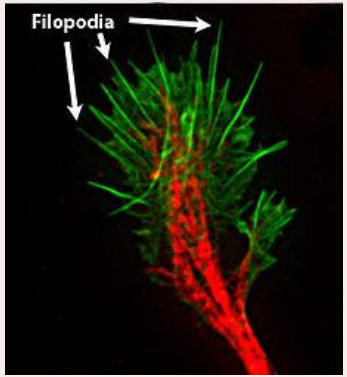


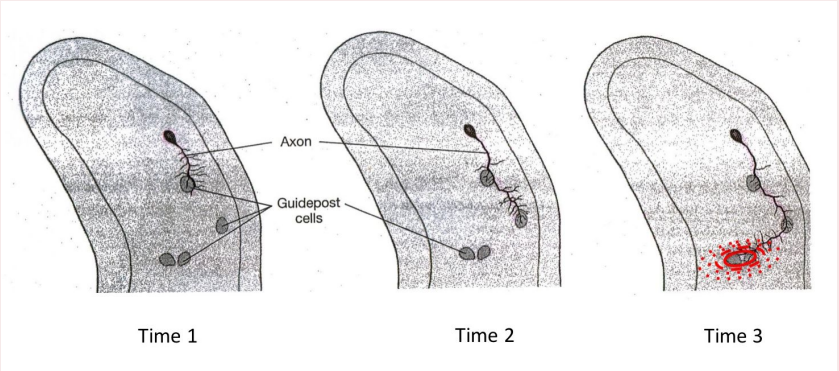
Synaptogenesis

Neurons grow Axons and Dendrites once they've settled down after migration and form the critical connection between neurons

Axons must seek out appropriate target postsynaptic cells ("who do I communicate with?")

1. **Filopodia** (= cilia) on the growth cone at the end of the axon can detect local chemical gradients
2. **Guidepost cells** (type of Glia cell) attracts the growth cone, allowing stepwise guidance of axon

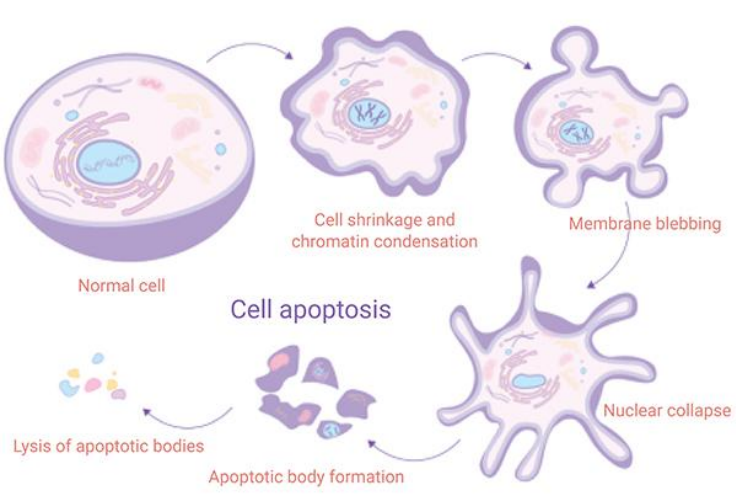




Apoptosis

Suicide Gene programs **cellular death**

- Activated when certain conditions are met (abnormal cellular growth or failed connections)
- During development, the NS massively overproduces cells (50% more than present at birth) and then “losers” in the race selectively die off (only the most fit, best-connected persist)



Patterns of Co-Activity

"Cells that Fire Together, Wire Together"

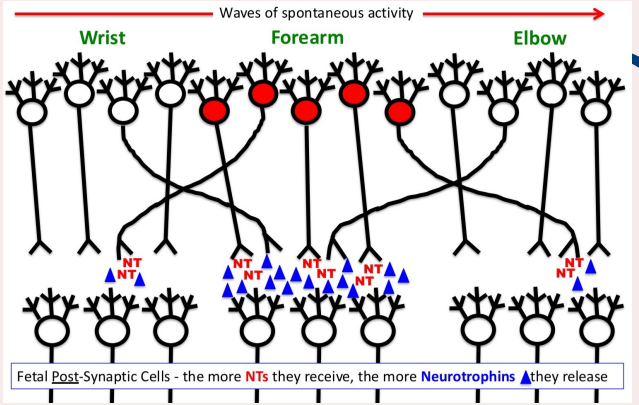
NT release by developing presynaptic cell. In response, postsynaptic cell releases **neurotrophins** (chemical feedback) to promote the presynaptic cell survival

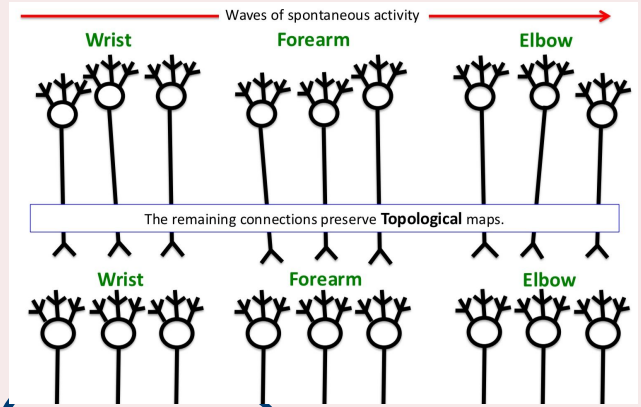
Cells that do not receive strong feedback are targeted for apoptosis

When out-competed die, remaining connections will produce **Collateral Sprouts** that will take over synapses

Adjacent presynaptic cells tend to correlate their bursts of activity

This makes connections to adjacent target, forming a **topographic map** (e.g., Penfield map) where spatial relationships are preserved





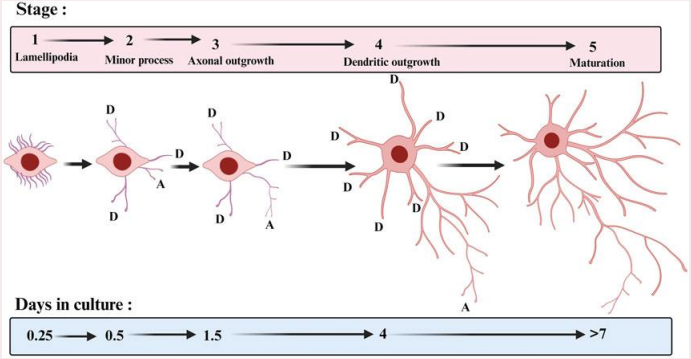
Further Development

Brain growth continues after birth, mainly due to increase in cell size and branching (**dendridization**, x new cells!)

- Newborn: 350g
- 1 y/o: 800-1000g
- Adult: 1200-1400g

New neurons are rare, but they do occur in some places (e.g., Olfactory Bulb, Hippocampus, Cerebellum)

Maps initially formed during fetal development continues to be shaped by experience



Effects of Experience

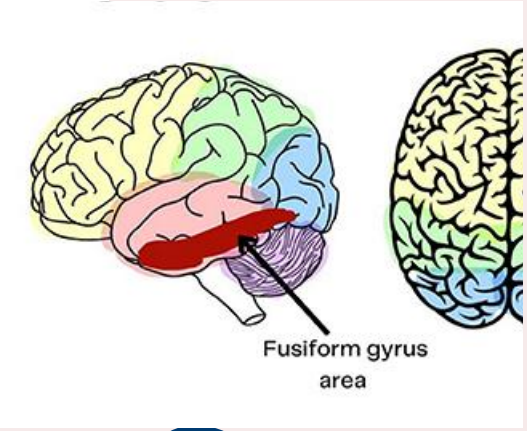
Post-natal experience continues to shape **Synaptogenesis,** especially in infancy

e.g., Kittens, exposed to only vertical lines during their critical period, could NOT detect horizontal lines

BUT…

Other areas of visual cortex continue to be modified throughout life

e.g., **Fusiform gyrus**: circuitry changes every time you learn to recognize a new face



Myelination continues through adulthood (~20 y/o)