Lecture 6: Cells and Tissue

Midterm: everything up to lecture 7

The Synapse

- Nervous system works because info flows from neuron to neuron
- Neurons functionally connected by **synapses**, junctions that mediate information transfer → from 1 neuron to another
- **Presynaptic neuron** neuron conduction impulses toward synapse
- **Postsynaptic neuron:** neuron transmitting electrical signal away from synapse (receives info)

Chemical Synapses

- Most common - specialized for release and reception of **chemical neurotransmitters**
- Typically composed of 2 parts
  → axon terminal of presynaptic neuron: contains **synaptic vesicles** filled with neurotransmitter
  → receptor region on postsynaptic neuron's membrane: receives neurotransmitter
- 2 parts separated by fluid-filled synaptic cleft

Neurotransmitters released into the synapse through exocytosis

1. **Action potential arrives at presynaptic terminal**
2. **Voltage- gated CA^{+2} open in response to depolarization**
3. **Ca^{+2} influx causes synaptic vesicles to fuse with pMb and release NT by exocytosis**
4. **NT diffuses across the synaptic cleft and binds to its specific postsynaptic receptors**
5. **Neurotransmitter binding opens ion channels resulting in a graded potential**
6. **NT effects are terminated by several mechanisms**
   - **Reuptake by transportes**
   - **Diffusion away from synapse**
   - **Enzymatic degradation**

Synaptic delay → time needed for neurotransmitter to be released diffuse across synapse, and bind to receptors

Electrical Synapses

- Less common than chemical synapses
- Neurons are electrically coupled
  → joined by gap junctions that connect cytoplasm of adjacent neurons

Postsynaptic Potentials

- Neurotransmitter receptors cause graded potentials that vary in strength based on:
    1. Amount of neurotransmitter released
    2. Time neurotransmitter stays bound to its receptor
- Depending on the type of chemical synapses there are 2 types of postsynaptic potential

EPSP

Excitatory postsynaptic potentials

IPSPS

Inhibitory postsynaptic potential

- Cell less likely to fire

Integration and Modification of Synaptic Events

Postsynaptic

Often a single EPSP cant induce an AP but the SPs can summate

- 2 types of summation
    1. Temporal
    2. Spatial

Temporal Summation

A rapidly firing presynaptic neuron causes ESPSs that are close in time

- One goes and isn't enough so another is sent supper quick and so it passes threshold

“timing”

Spatial Summation

More than one neuron fires at once EPSPs are generated at different locations on the neuron

- Both go and basically influence each other and there

“spatial = location”

Activity Dependent Synaptic Potentiation

Presynaptic Changes

- Ca^{+2} concentration increases in presynaptic terminal → release of more neurotransmitter → more EPSPs in postsynaptic neuron

Postsynaptic Changes

- Potentiation can cause Ca^{+2} voltage channels to open
- Ca^{+2} activates **kinases**
- **NMDA** receptors (Mg^{+2} block removed by strong depolarization

- **Long-term potentiation** involved in learning and memory

Changes in strength in a synapse

Graded vs Action Potentials

Developmental Aspects of Neurons

- Nervous system originates from the **neural tube and crest (ectoderm)**
- **Neuroepithelial** cells of the neural tube proliferate into number of cells needed for development
- **Neuroblasts**
  → become amitotic
- **Growth cone**
  → structure at the tip of the axon that allows it to interact with its environment
    - Neurotrophins → that attract and repel the growth cone
    - Nerve Growth factor (NGF) → which keeps neuroblast alive
    - Filopodia growth cone processes that follow signals toward target

Roger Sperry - Chemoaffinity Hypothesis

About ⅔ of neurons die before birth

- If axons dont form a synapse with their targe → apoptosis (programmed cell death)
- Not unique to neurons all cells do this

During postnatal development learining reinforces certain synapses and prunes