

Week 4

- KW Chapter 4 : Neurons
- KW Chapter 5 : Neurotransmitters

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Chapter 4 : Neurons

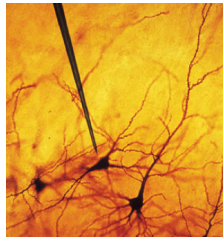
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Case Report : Single Cell Recording

- History:
 - Subject with epilepsy volunteered for research study
 - Goal: find location where seizure originates and remove it
 - Recordings of electrical potential on surface of skull failed to find location
 - Single Cell recordings were used



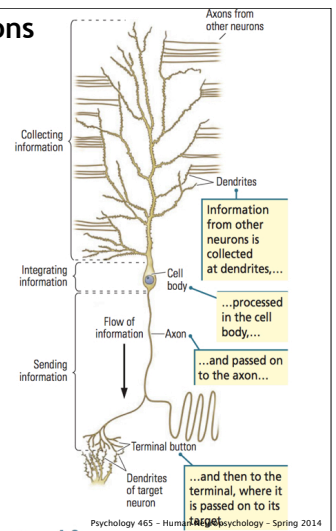
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Neurons

- Function
 - information processing
- Structure
 - Dendrite
 - inputs
 - Cell Body
 - calculation
 - Axon
 - output



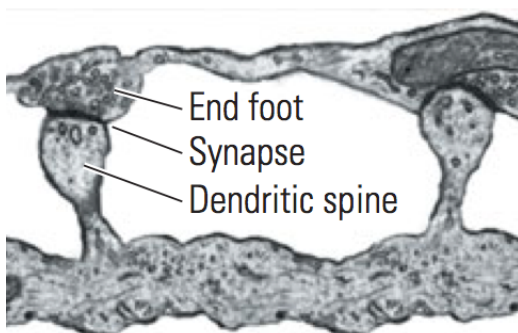
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Synapse

- Gap between dendrite and axon



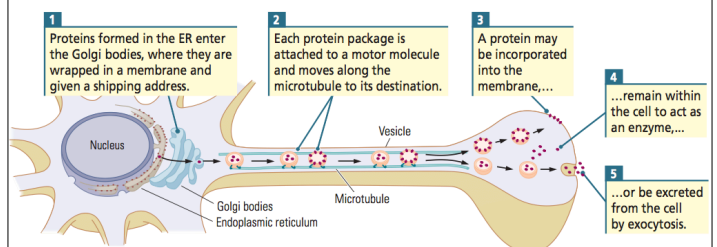
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Vessicles and Neurotransmitters

- Neurotransmitters bridge the synapse between axon and dendrite
- Vessicles are created in cell body and hold neurotransmitters



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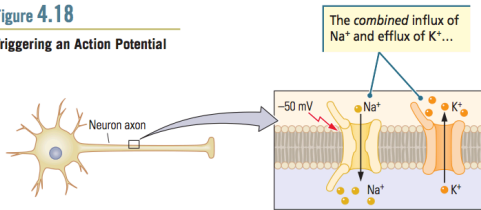
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The Action Potential

- Sodium (Na) ions enter cell, Potassium (K) ions exit
- Cell voltage changes

Figure 4.18

Triggering an Action Potential



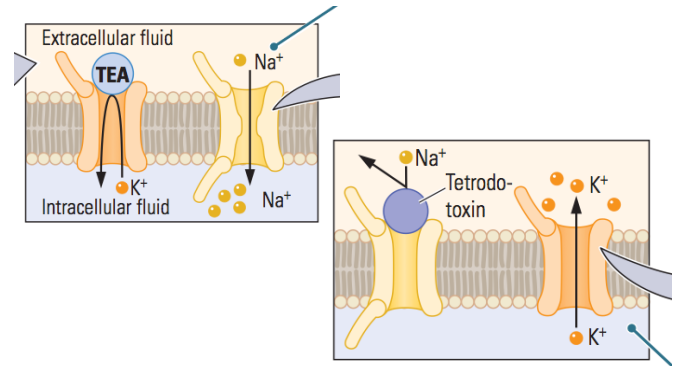
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Research methods

- TEA (tetra-ethyl-ammonium) blocks K channels
- Tetrodotoxin blocks Na channels



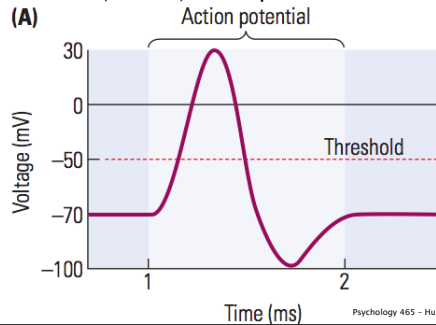
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Axons are Electro-Chemical computers

- Electrical potential (Voltage)
- Resting voltage (-70mV)
- Stimulation from dendrites -> increases voltage
- Threshold (-50mV)
- Action Potential (+30mV) aka "spike"



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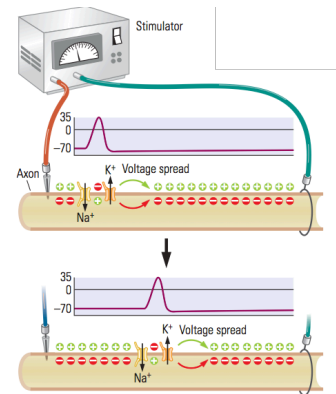
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The Nerve Impulse

- Action Potentials travel along the axon
- aka "propagation"

- Domino Analogy



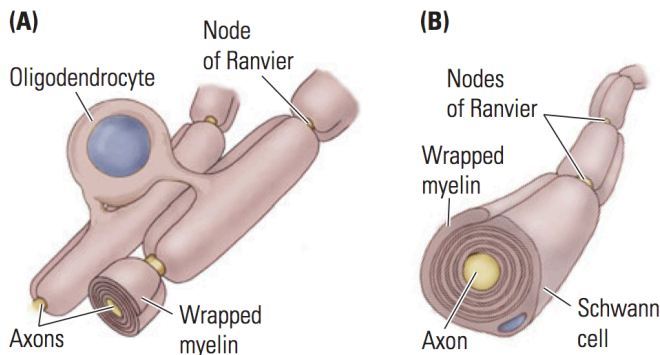
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Going Faster

- Nerve impulse speed related to axon size (bigger -> faster)
- Problem: too big = too crowded. Solution: Myelination
 - "saltatory conduction" (to leap)



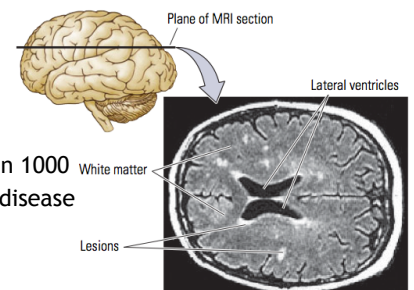
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Disease: Multiple Sclerosis

- Sclerosis = *hardness*
- MS : myelin is attacked, causing inflammation and damage / destruction of myelin
- Unpredictable / Disabling
- Remissions & Relapses
- often mis-diagnosed
- Epidemiology
 - typically age 15-40
 - 2x more F than M
 - prevalence about 1 in 1000
- Possibly auto-immune disease
- Lesions visible on MRI



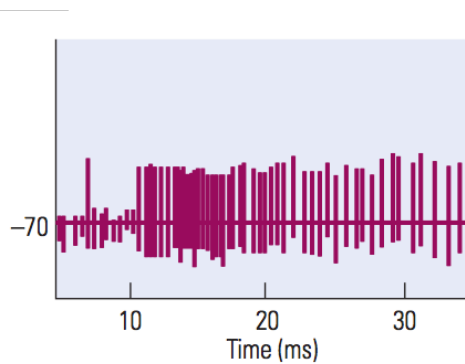
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Information is coded in Spike Trains

- Neurons can have multiple action potentials
- Information is coded in timing & pattern of spikes



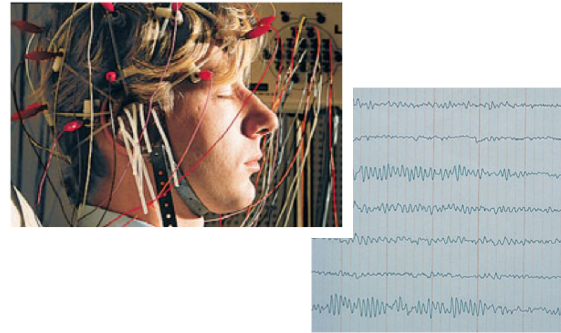
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Multiple neurons are synchronized

- Waves and patterns of thousands of neurons firing together
- Strong enough that voltage can be detected on scalp
- Electro Encephalograph (EEG)



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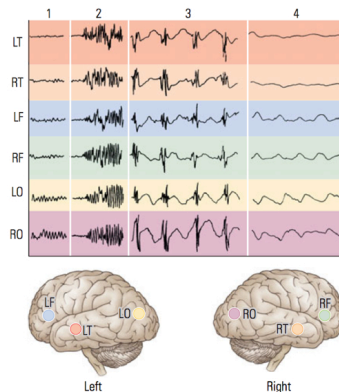
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Epilepsy

- Seizure
 - large groups of neurons firing all at once
 - out of control
 - pattern spreads
 - can involve entire brain

- Key
 - 1=pre
 - 2=onset
 - 3=clonic
 - 4=coma



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Chapter 5 : Neurotransmitters

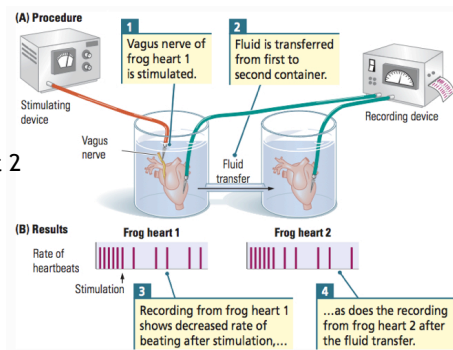
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Otto Loewi's Experiment

- Frog hearts in bottles
- Stimulate vagus nerve of heart 1
 - heart 1 slows down
- Pass fluid to heart 2
 - heart 2 slows down
- Conclusion : must be chemical
- Acetylcholine



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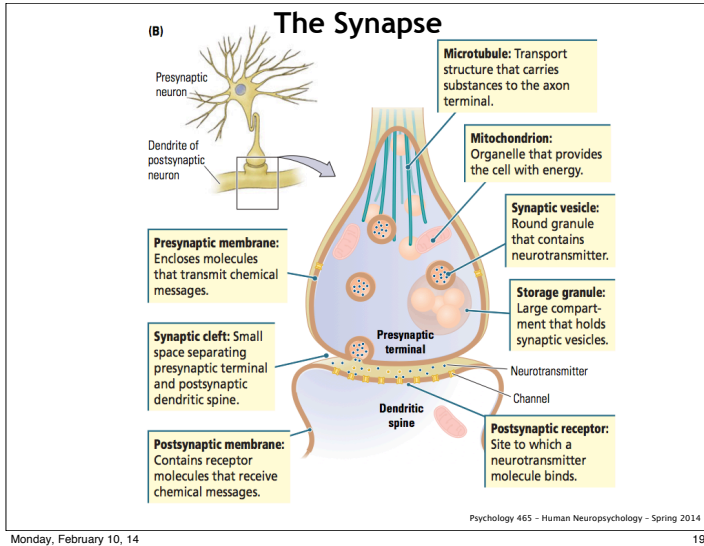
Neurons and neurotransmitters

- Neurons generally release only 1 specific NT
- Neurons are named for the NT they release
 - Neurons that release Acetylcholine
 - "cholinergic"
- Some NTs function in both CNS and PNS
- Some don't
 - epinephrine : PNS
 - nor-epinephrine : CNS
- Hundreds of NTs
- NTs can be excitatory OR inhibitory depending on specific neuron
 - but typically are + or -

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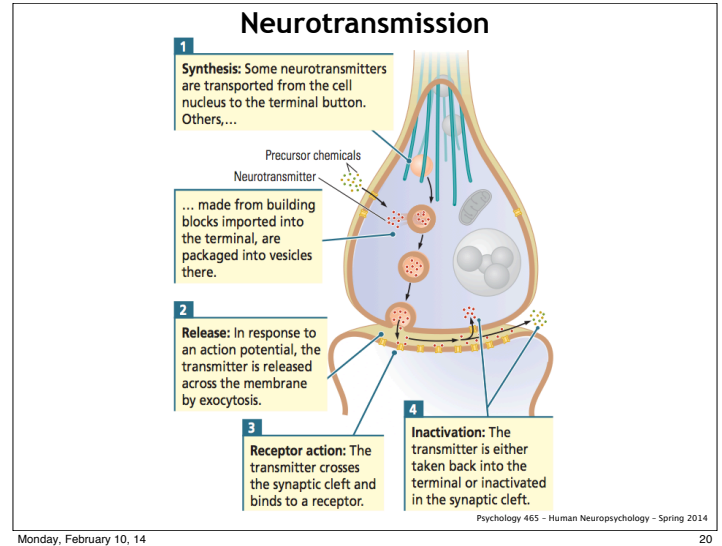
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Neurotransmission

- Synthesis
- Release
- Receptor Action
 - depolarize (excitation)
 - hyper-polarize (inhibition)
 - creates new synapses
 - other cascaded processes
- Inactivation
 - Reuptake
 - Degredation
- Autoreceptors
 - pre-synaptic cell may also be affected

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Categories of Neurotransmitters

- More than 100
- More than one NT may be in single vessicle
- Small-molecules
 - organic chemicals
- Neuropeptides
 - short amino acid chains
- Transmitter gasses
 - tiny water-soluble gas molecules such as NO and CO

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Small Molecule Neurotransmitters

- Acetylcholine
- Amines
 - Dopamine (DA)
 - Norepinephrine (NE)
 - Epinephrine (EP)
 - Serotonin (5HT)
- Amino Acids
 - Glutamate (Glu)
 - Gama-aminobutyric acid (GABA)
 - Glycine (Gly)
 - Histamine (H)

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NTs and Behavior in PNS

- PNS
 - SNS
 - motor neurons: cholinergic (ACh), excitatory, produce muscle contractions
 - ANS
 - Sympathetic: Fight or Flight
 - epinephrine (EP) aka Adrenaline
 - Parasympathetic : Rest and Digest
 - acetylcholine (ACh)

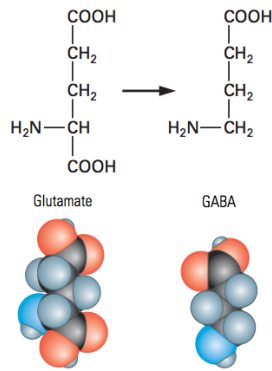
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NTs and Behavior in CNS

- Glutamate (Glu)
 - major excitatory NT
- Gama-aminobutyric acid (GABA)
 - major inhibitory NT



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CNS Activating Systems

- In brain, NT systems have large-scale effects
- Major Ones:
 - Cholinergic
 - Dopaminergic
 - Noradrenergic
 - Serotonergic
- Functions are complex, interlinked
- Generally not possible to have 1:1 relationship between system and disease/disorder

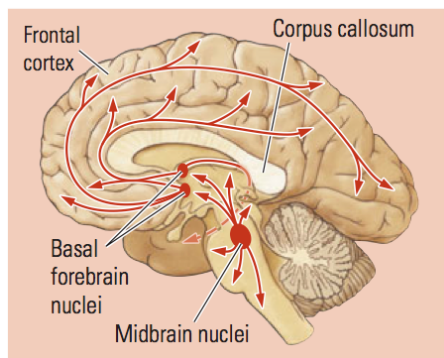
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Cholinergic Activating System

- Functions:
 - Waking EEG
 - Memory
- Damage/Disease:
 - Alzheimer's Disease



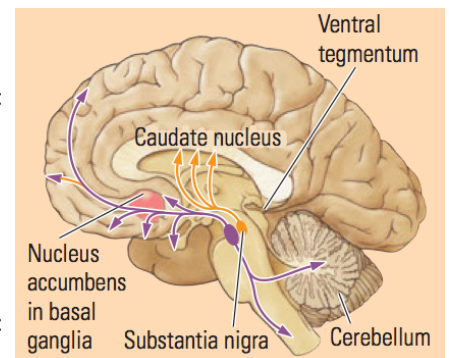
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Dopaminergic Activating System

- Nigrostriatal
 - Functions:
 - normal motor behavior
 - Damage/Disease:
 - Parkinson's
- Mesolimbic
 - Functions:
 - reward & pleasure
 - Damage/Disease:
 - addiction
 - schizophrenia



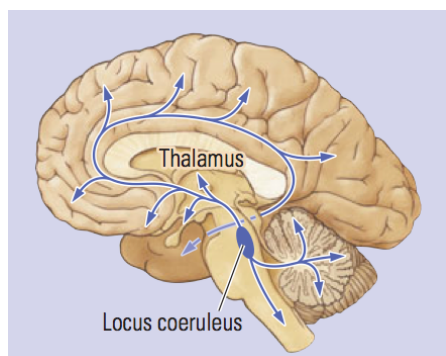
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Noradrenergic Activating System

- Functions:
 - emotional tone
 - cognitive functioning
- Damage/Disease:
 - impaired thinking
 - depression



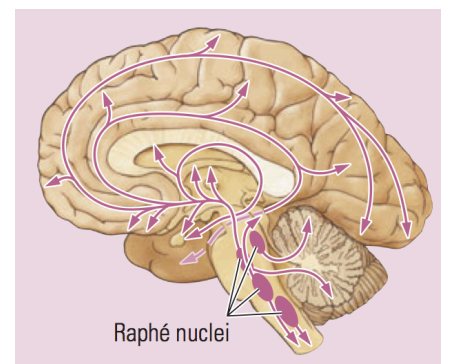
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Serotonergic Activating System

- Functions:
 - waking EEG
 - resistance to stress
- Damage/Disease:
 - depression
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 - OCD
 - tics
 - schizophrenia



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