Thought for the day:

"If you think you can or you can't, you're always right."

Henry Ford

“Do or do not, there is no try” - Yoda
Neurology – Plan for today….

- Excitatory Post Synaptic Potentials (& IPSP)
- Memory
  - Short Term
  - Long Term
- Neurotransmitters
- Addiction
- Neurotransmitter Hall of Fame
- Applications
Excitatory & Inhibitory Post synaptic Potentials

- See Page 408 – 411
- Remember Resting Membrane Potential?
EPSP & IPSP

- May be dozens, 100s, or even a 1000 synapses on a single neuron.
- create graded (local) potentials, not action potentials
- strength proportional to amount of stimulus
Depolarization = excitatory = EPSP

- depolarization which brings membrane potential closer to threshold... therefore is considered excitatory
Hyperpolarization = Inhibitory = IPSP

- a more negative potential, away from threshold = hyperpolarization
- therefore considered inhibitory
Summation

- The combination of these graded, local potentials at the axon hillock.

- Benefit: unnecessary or unintentional impulses can be intercepted providing a greater degree of control.
Conclusion:

- Voluntary movements, reflexes, memory, emotions, moods, etc. can all be explained by understanding the activities at chemical synapses.
Memory

- Memory is the storage and retrieval of information.

- The three principles of memory are:
  - Storage – occurs in stages and is continually changing.
  - Processing – accomplished by the hippocampus and surrounding structures.
  - Memory traces – chemical or structural changes that encode memory.
I brought something with me from the past — a strange thing called “memory.”

Ashleigh Brilliant
Memory Processing

Figure 12.22
Stages of Memory

- The two stages of memory are short-term memory and long-term memory
- Short-term memory (STM, or working memory) – a fleeting memory of the events that continually happen
- STM lasts seconds to hours and is limited to 7 or 8 pieces of information
- Long-term memory (LTM) has limitless capacity
Transfer from STM to LTM

Factors that effect transfer of memory from STM to LTM include:

- Emotional state – we learn best when we are alert, motivated, and aroused (Trains)
- Rehearsal – repeating or rehearsing material enhances memory
- Association – associating new information with old memories in LTM enhances memory
- Automatic memory – subconscious information stored in LTM
MY MIND CONTAINS MANY GOOD IDEAS,

BUT IT'S NOT ALWAYS EASY TO SQUEEZE ONE OUT.

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Brain Video

- Shows role of hippocampus in short-term and long-term memory
- Shows physiology of chemical synapse
Categories of Memory

- The two categories of memory are fact memory and skill memory

- Fact (declarative) memory:
  - Entails learning explicit information
  - Is related to our conscious thoughts and our language ability
  - Is stored with the context in which it was learned
Skill Memory

- Skill memory is less conscious than fact memory and involves motor activity
- It is acquired through practice
- Skill memories do not retain the context in which they were learned

(VIDEO CLIP - Pool)
Structures Involved in Fact Memory

- Fact memory involves the following brain areas:
  - Hippocampus and the amygdala, both limbic system structures
  - Specific areas of the thalamus and hypothalamus of the diencephalon
  - Ventromedial prefrontal cortex and the basal forebrain
Structures Involved in Skill Memory

- Skill memory involves:
  - Corpus striatum – mediates the automatic connections between a stimulus and a motor response
  - Portion of the brain receiving the stimulus
  - Premotor and motor cortex
Mechanisms of Memory

- Neuronal RNA content is altered
- Dendritic spines change shape
- Extracellular proteins are deposited at synapses involved in LTM
- Number and size of presynaptic terminals may increase
- More neurotransmitter is released by presynaptic neurons
- New hippocampal neurons appear
Memory Formation

- A User friendly sequence:
- Awareness of new information starts in the cerebral cortex.
- New information is sent to the hippocampus (and amygdala) to be stored as STM.
- Each time you recall it, say it, write, etc. you’re bringing that info back to the cortex and making that memory more durable. What you’re really doing is facilitating the synapses of that particular pathway.
- Eventually it is relayed to Long-term, permanent memory in the cerebral cortex.
Memory – Practical Applications

- Most neurons are amitotic but new synapses form all the time and existing synapses can be trained to work better. This is the basis for memory and stroke recovery.
- Repeated EPSPs at the synapses of the same neuronal pathway causes physical changes called long term potentiation.
The receptor proteins are altered to respond more quickly or dramatically... therefore easier to reach threshold and AP.

This is why reading is not really studying. Reading is not recalling.

Reading is information IN not OUT. ... uses different pathways, different synapses.
Memory – Practical Applications

- Real studying requires that you say it, write it, draw it, explain it, etc. from memory.
- The more times you recall it, say it, write it, etc. The more you change the receptor proteins at the synapses and therefore the more likely you can recall a piece of information when you need to.
- Use of Mnemonic & Memory Devices
Memory - (Opinion & Observations)

- We remember what is interesting to us, and what we perceive will be useful.
- “Francis” (a.k.a. Forrest Gump)
- Photographic memory
- Could remember every baseball player and statistic in the paper.
Memory - (Opinion & Observations)

- We remember what is interesting to us, and what we perceive will be useful.
- “Francis” (a.k.a. Forrest Gump)
- but every day was day 1 in his job.
Proposed Memory Circuits

(a) 
- Thalamus
- Prefrontal cortex
- Basal forebrain
- Medial temporal lobe (hippocampus, etc.)
- Sensory input
- ACh

(b) 
- Thalamus
- Premotor cortex
- Basal nuclei
- Substantia nigra
- Sensory and motor inputs
- Dopamine

Legend:
- ACh: Acetylcholine
Place holder slide

- End of Memory – Start Addiction section
Neurotransmitters

- Review three handouts (in order):
  - Neurotransmitters
  - Generic Effects of Drugs
  - Neurotransmitter “Hall of Fame”
EVERYTHING CAN BE HIGHLY MEANINGFUL OR TOTALLY ABSURD, DEPENDING ON THE CHEMICALS CURRENTLY INFLUENCING YOUR BRAIN.
Physiology of Addiction

- Addiction is defined as “a state of dependency upon a drug.”
- This dependency may have both psychological and/or physiological components. In other words, you may just think you need the drug or you may actually need the drug.
Example: Nicotine – The endless cycle

- Nicotine is absorbed into the blood at the lungs and carried to the brain where it mimics ACh and binds to nicotinic receptors.

- This triggers the release of excitatory hormones epinephrine and norepinephrine more commonly known as adrenaline and noradrenaline. The user feels energized and more alert.
Example: Nicotine – The endless cycle

- Within 30 minutes your nicotine levels drops and your energy level drops. By now you’re probably facing a bit of “stress” in your day. So you light up again to “relax.”
Example: Nicotine – The endless cycle

- This time the nicotine triggers the release of a stress-reducing hormone cortisol and the brain’s own pleasure producing NTs – dopamine and probably glutamate.
- The user feels calmer and more relaxed but only for about 30 minutes and the craving is back.
Example: Nicotine – The endless cycle

The craving is back because the presence of nicotine has prompted the brain to $\uparrow$ the # of nicotinic receptors for ACh and $\downarrow$ production of your own ACh.
Example: Nicotine – The endless cycle

- Therefore, you actually do “need” the nicotine. When these receptors don’t get “their fair share” of the drug nicotine the brain experiences “withdrawal symptoms” and you experience impaired function.
Example: Nicotine – The endless cycle

- The user (addict) actually needs the nicotine just to feel normal.
- Nicotine is 2X as addictive as heroin.
Nicotine

- Does it enhance mental capacity?
Does it enhance mental capacity?

- As the complexity of mental tasks increases nonsmokers outperform smokers by wider and wider margins... even though the smoker *feels* like he is performing quite well.

- As a “bonus” - More than half of those who smoke cigarettes will die from a preventable smoking related illness.