Chapter 12

Neural Coding
Neural Circuits

Figure 12.30
Memory and Synaptic Plasticity

• physical basis of memory is a pathway through the brain called a **memory trace** or **engram**
  
  – along this pathway, new synapses were created or existing synapses modified to make transmission easier
  
  – **synaptic plasticity** – the ability of synapses to change
  
  – **synaptic potentiation** - the process of making transmission easier

• kinds of memory
  
  – **immediate**, **short-** and **long-term** memory
  
  – correlate with different modes of synaptic potentiation
Immediate Memory

- **immediate memory** – the ability to hold something in your thoughts for just a few seconds
  - essential for reading ability

- feel for the flow of events (sense of the present)

- our memory of what just happened “echoes” in our minds for a few seconds
  - reverberating circuits
Short-Term or Working Memory

• **short-term memory (STM)** - lasts from a few seconds to several hours
  – quickly forgotten if distracted
  – calling a phone number we just looked up
  – reverberating circuits

• facilitation causes memory to last longer
  – **tetanic stimulation** – rapid arrival of repetitive signals at a synapse // causes Ca$^{2+}$ accumulation and postsynaptic cell more likely to fire
  – **post-tetanic potentiation** - to jog a memory
    • Ca$^{2+}$ level in synaptic knob stays elevated
    • little stimulation needed to recover memory
Long-Term Memory

• types of long-term memory
  – **declarative** - retention of events that you can put into words
  – **procedural** - retention of motor skills

• physical remodeling of synapses // new branching of axons or dendrites

• molecular changes - **long-term potentiation**
  – changes in receptors and other features increases transmission across “experienced” synapses
  – effect is longer-lasting
Molecular Changes and Long-Term Memory

• molecular changes are called **long-term potentiation**

• method described
  
  – receptors on synaptic knobs are usually blocked by Mg$^{+2}$ ions
  
  – when bind glutamate and receive tetanic stimuli, they repel Mg$^{+2}$ and admit Ca$^{+2}$ into the dendrite – Ca$^{+2}$ acts as second messenger

• more synaptic knob receptors are produced
• synthesizes proteins involved in synapse remodeling
• releases nitric oxide that triggers more neurotransmitter release at presynaptic neuron