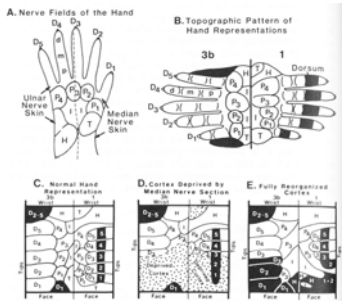
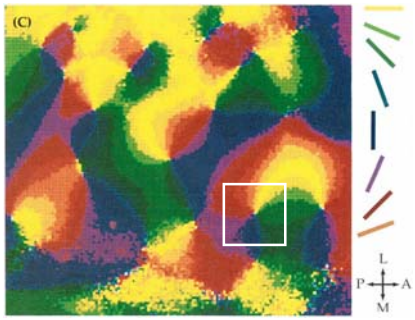
Reorganization of Cortex



- Median nerve sectioned to show fluidity of cortical organization
- (C) before
- (D) immediately after
- (E) several months later

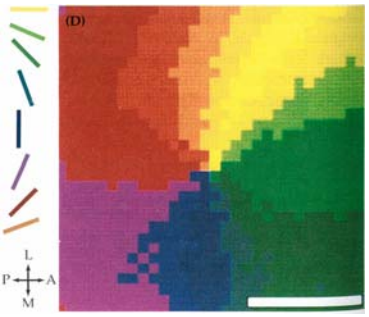
(fig. < McClelland & al, *Par. Distr. Proc.* II)

Orientation Columns



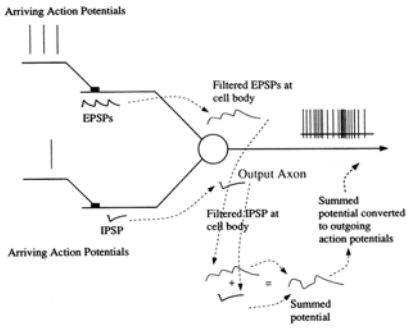
(fig. < Nicholls & al., *Neur. to Brain*)

Orientation Columns



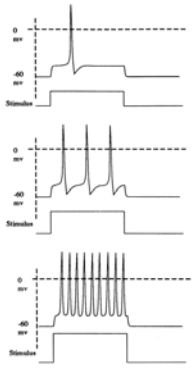
(fig. < Nicholls & al., *Neur. to Brain*)

Slow Potential Neuron



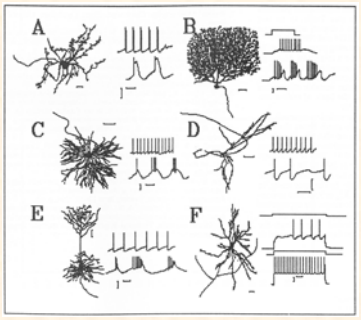
(fig. < Anderson, *Intr. Neur. Nets*)

Frequency Coding



11/3/04 (fig. from Anderson, *Intr. Neur. Nets*) 5

Variations in Spiking Behavior



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Synapses

video by Hybrid Medical Animation

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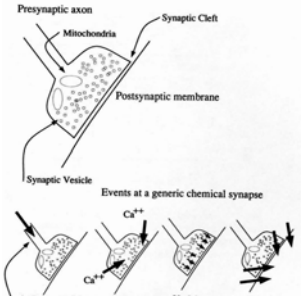
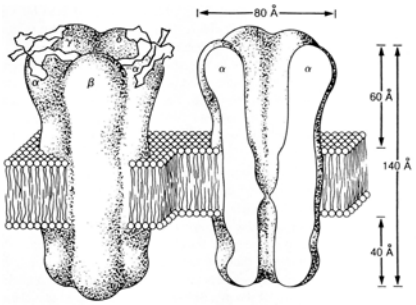
Chemical Synapse



1. Action potential arrives at synapse
2. Ca ions enter cell
3. Vesicles move to membrane, release neurotransmitter
4. Transmitter crosses cleft, causes postsynaptic voltage change

11/3/04 (fig. from Anderson, *Intr. Neur. Nets*) 8

Typical Receptor

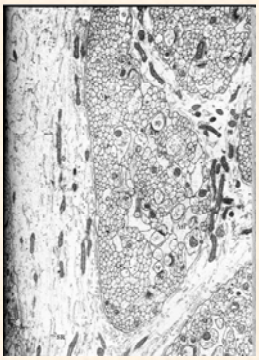


11/3/04 (fig. from Anderson, *Intr. Neur. Nets*) 9

Axon Hillock

11/3/04 (fig. from Peters, Palay & Webster) 10

Dendrite & Dendritic Branches



11/3/04 (fig. from Peters, Palay & Webster) 11

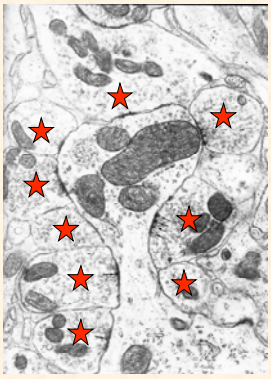
Dendrite & Dendritic Spine

11/3/04 (fig. from Peters, Palay & Webster) 12

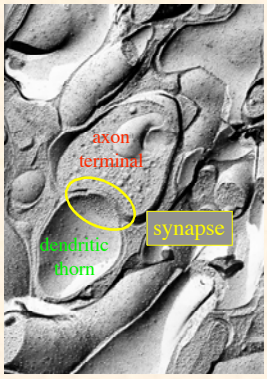
Neuropil

Myelinated Axon Making Synapse on Dendrite

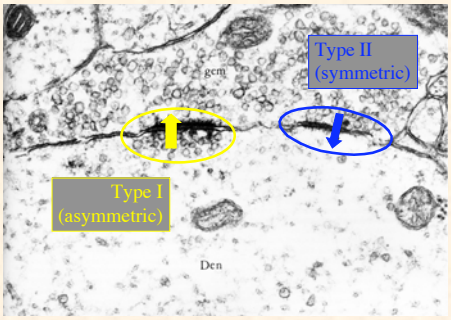
Various Synapses



Excitatory Synapse Between Axon Terminal and Dendritic Thorn



Dendro-dendritic Synapses



11/3/04 (fig. from Peters, Palay & Webster) 17

Electrotonic Synapse

11/3/04 (fig. from Peters, Palay & Webster) 18 5B

Artificial Neural Networks

(in particular, the Hopfield Network)

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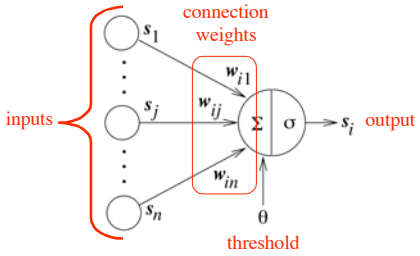
Typical Artificial Neuron



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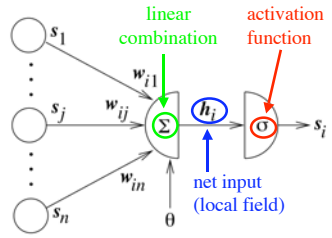
Typical Artificial Neuron



Equations

Net input: $h_i = \left(\sum_{j=1}^{n} w_{ij} s_j \right) - \theta$

$\mathbf{h} = \mathbf{W}\mathbf{s} - \theta$

New neural state: $s_i' = \sigma(h_i)$

$\mathbf{s}' = \sigma(\mathbf{h})$

Hopfield Network

- Symmetric weights: $w_{ij} = w_{ji}$
- No self-action: $w_{ii} = 0$
- Zero threshold: $\theta = 0$
- Bipolar states: $s_i \in \{-1, +1\}$
- Discontinuous bipolar activation function:

$$\sigma(h) = \operatorname{sgn}(h) = \begin{cases} -1, & h < 0 \\ +1, & h > 0 \end{cases}$$

What to do about $h = 0$?

- There are several options:
  - $\sigma(0) = +1$
  - $\sigma(0) = -1$
  - $\sigma(0) = -1$ or $+1$ with equal probability
  - $h_i = 0 \Rightarrow$ no state change ($s_i' = s_i$)
- Not much difference, but be consistent
- Last option is slightly preferable, since symmetric