Lecture 33 – Cortical Neurons, the EEG, and the Mechanisms of Epilepsy – Kriegstein

I. EEG
- A. Structural correlates
  - 1. cortex contains pyramidal and non-pyramidal neurons
    - a. pyramidal neurons
      - i. radially oriented apical dendrites
      - ii. contribute to EEG
    - b. non-pyramidal neurons
      - i. largely non-radial
      - ii. do not contribute to EEG
  - 2. sinks and sources underlie EEG polarity
    - a. cortico-cortical synapses in layers 2 and 3 (superficial)
    - b. thalamo-cortical synapses in layer 4 (deep)
- B. Spectral analysis of EEG
  - 1. background gradients
    - a. amplitude
    - b. frequency
    - c. alpha rhythm
  - 2. localization
  - 3. far field potentials
    - a. visually evoked potential waveform
    - b. latency measure

II. Canonical Cortical Circuit
- A. Glutamatergic pyramidal cells
  - 1. reciprocal excitatory connections
  - 2. provide excitation for recurrent inhibition
- B. GABAergic interneurons
  - 1. provide recurrent and feed-forward inhibition
  - 2. responsible for surround inhibition
- C. Neuronal membrane properties
  - 1. single firing
  - 2. burst firing
    - a. CA3 hippocampal neurons
    - b. deep layer cortical pyramidal neurons

III. Seizure Focus
- A. Interictal spike
  - 1. paroxysmal depolarization shift
  - 2. transition to ictal discharge

IV. Classification of Seizures
- A. Primary generalized
  - 1. major motor (grand mal)
  - 2. absence (petit mal)
- B. Partial
  - 1. simple
  - 2. complex
  - 3. secondary generalized
    - a. localization
    - b. MRI
    - c. PET

V. Hippocampal pathology
- A. Mesial temporal sclerosis
  - 1. appearance on MRI
  - 2. selective neuronal injury
  - 3. sprouting of dentate granule cells
    - a. Timm's stain
    - b. effect on excitability
- B. Neurogenesis of granule cells
- C. Gene expression changes induced by status

VI. Treatment
- A. Modern pharmacological approaches
  - 1. sodium channel antagonists
    - a. phenytoin
    - b. carbamazepine
  - 2. GABA enhancers
    - a. barbiturates
    - b. benzodiazepines
    - c. valproate
  - 3. glutamate antagonists
  - 4. GABA uptake blockers

Relevant reading: chapter 46 in "Principles"