Lecture 29 – 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”