NEURAL REGULATION OF BREATHING
Section 4, Part B

NEURAL REGULATION OF PULMONARY VENTILATION

I. Gamma Efferent System
   A. Components of the gamma system
      1. spindles appear to sense position of the muscle
         a. intercostal muscles -
         b. diaphragm -
      2. alpha fibers -
      3. neurons -
         a. alpha neuron -
         b. gamma efferent neurons -
         c. gamma afferent neurons -
   B. Method of servo control
      1. gamma system adjusts breathing pattern -
      2. if all systems contract together, spindle fibers do not become excited
      3. if compliance decreases, muscles may meet resistance in contracting
         a. gamma afferent becomes excited -
      4. if effort is too great, upper center may be affected -
   C. Altering breathing patterns
      1. normal respiration -
      2. obstructive disease pattern -
      3. restrictive disease pattern -
      4. diseases with low compliance -

II. Proprioceptive Reflexes
   A. Hering-Breur inspiratory reflex -
      1. inflated lungs stimulate pulmonary stretch receptors -
      2. impulses travel through vagus to NTS (dorsal resp. group)
         a. impulses are thought to continue on to pons
      3. effect is to terminate inspiration
      4. 1868, Hering and Breur demonstrated mechanisms for halting inspiration
         a. increased intra tracheal pressure
         b. occluded trachea at end of normal inspiration -
         c. bilateral vagotomy destroys effect
      5. transection of apneustic center -
      6. transection between NPBM and apneustic center -
   B. Paradoxic reflex of Head
      1. Hering-Breur reflex is blocked by cooling vagus to 8° C -
      2. hyperinflation causes more inspiratory effort -
      3. receptors are in lung parenchyma -
      4. may support VT during exercise -
5. sectioning abolishes reflex

C. Deflation reflex
   1. deflation of lung initiates inspiratory effort -
   2. vagotomy destroys reflex
   3. reflex probably helps to reinforce hyperpnea -

D. Other vagal reflexes
   1. pulmonary embolism -
   2. stimulation of the juxtapulmonary capillary receptors -
   3. chemical stimulation -
      a. chemical irritants -
      b. mechanical irritants, upper airway -
   4. pulmonary blood pressure changes -
   5. Inc. FICO₂ -

III. Factors Affecting Ventilation and Breathing Patterns
A. Factors affecting ventilation
   1. blood pressure -
      a. reflex originates in the aorta and carotid sinus
      b. normal arterial pressure
      c. baroreceptors are located in the walls of atria and great vein -
   2. hormones -
      a. pregnancy -
      b. chronic hyperventilation during pregnancy produces resp. alkalosis
      c. PaCO₂ decreases during ovulation (luteal phase) -

B. Emotions and respiration
   1. breathing reflects man's emotional and mental state -
   2. anticipation of physical or sexual activity -
   3. breath holding
   4. cough -
   5. panic -
   6. depression -
   7. emotions can trigger breathing problems -

C. Abnormal breathing patterns
   1. vagal breathing -
      a. neural interference of the Hering-Breur reflex
   2. apneustic breathing -
      a. loss of inhibition of pontine apneustic center
      b. causes inspiratory apnea
   3. Biot's breathing -
      a. observed with inc. in intracranial pressure
   4. coupled breathing or grouped breathing -
      a. seen at high altitudes
      b. O₂ abolishes pattern
   5. Cheyne-Stokes breathing -
      a. seen in patients with brain damage and those terminally ill
      b. also seen in infants and healthy people at high altitudes
      c. occurs due to a lag in circulation time -
      d. seen in peripheral chemoreceptor denervation and some midbrain lesions

D. Hyperventilation of neural origin
   1. decreased lung compliance -
   2. cerebrovascular diseases around breathing centers -
E. Hypoventilation of neural origin
   1. lesions in the brain can also cause hypoventilation
   2. narcotics -
   3. Ondine's curse -
   4. seizure activity can produce hypoventilation in infants