Regulation of breathing

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Goals

- adequate PaO_2 & $PaCO_2$
- minimize work of breathing
- role in A-B balance

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Respiratory control center

- in medulla oblongata
- 2 parts:
  - ventilatory pattern generator
  - integrator
    - takes input from
      - higher brain centers (cortex, hypothalamus, limbic system,...)
      - chemoreceptors (central & peripheral)
      - sensory nerves from AW, lungs & muscles of breathing
    - controls rate & amplitude of ventilation (by controlling the pattern generator)

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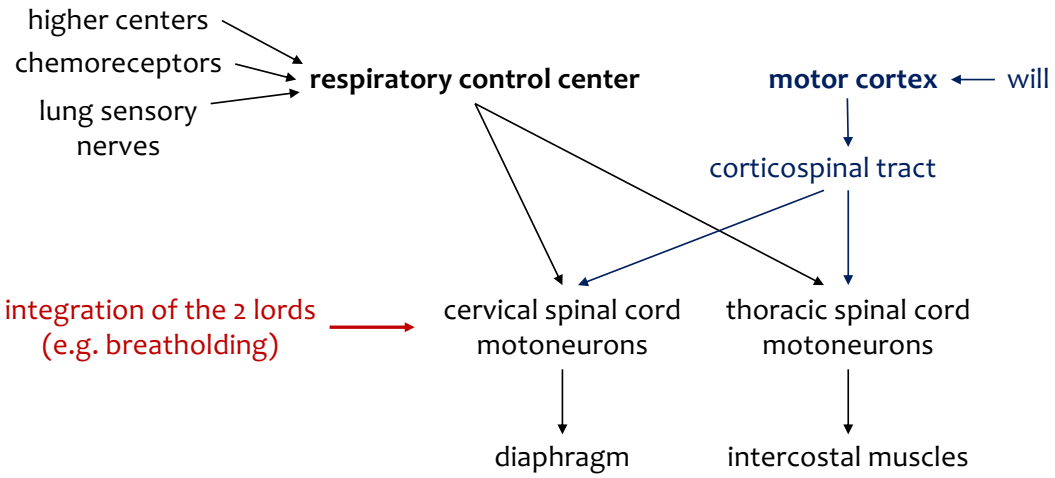
Voluntary & automatic breathing



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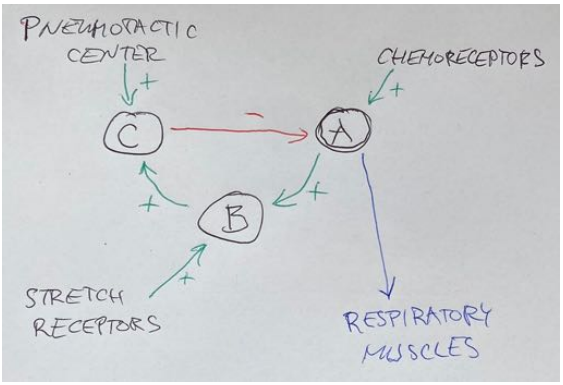
Respiratory control center

- no typical pacemaker
- dorsal respiratory group (*nucleus tractus solitarii*)
- ventral respiratory group (rostral *nucleus retrofacialis*, caudal *nucleus retroambiguus*, *nucleus paraambiguus*)
- tonic inspiratory drive from DRG + phasic inhibitory activity



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Chemoreceptors

- central
  - close to control center
  - detect:
    - brainstem interstitial fluid pH
    - changes in $PaCO_2$ (CO_2 diffuses through BBB, H^+ &HCO_3^- slowly)
- peripheral
  - carotid & aortic bodies → n. glossopharengeus, n. vagus
  - detect:
    - mainly PaO_2
    - $PaCO_2$, pH

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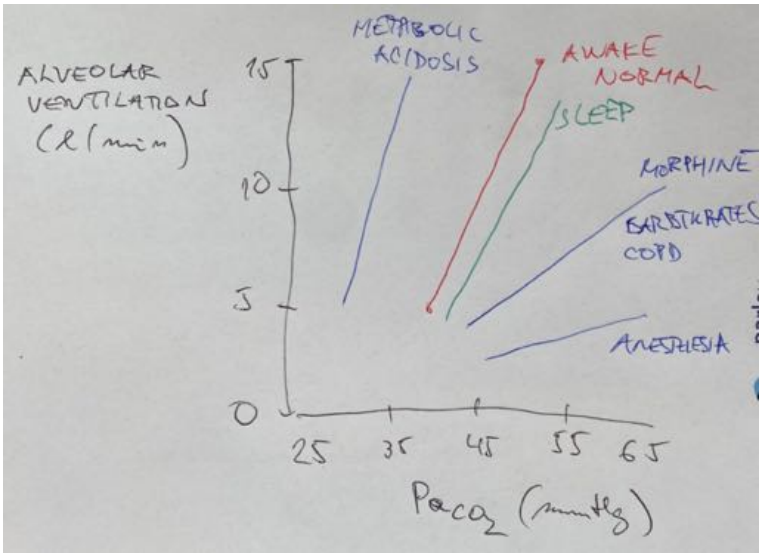
Ventilatory response to CO_2



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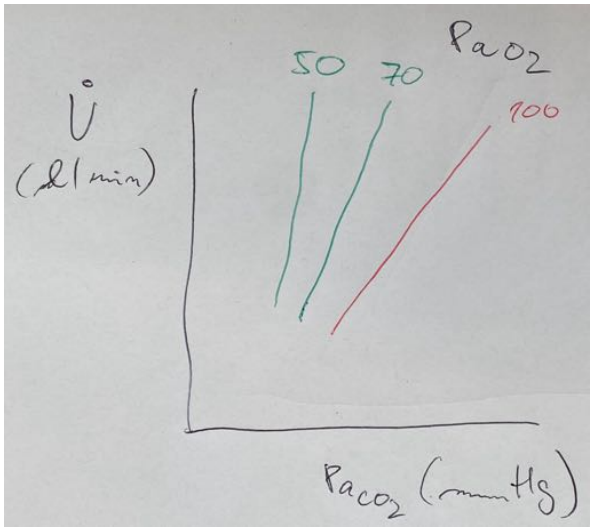
Hypoxia increases ventilatory response to CO_2



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Carotid & aortic bodies

- neuron-like glomus (type-I) cells, synapses
- enveloped by glia-like sustentacular (type-II) cells
- inhibition of O_2-sensitive K^+ channels → depolarisation → Ca^{2+} entry → release of transmitters
- potential O_2-sensing mechanisms:
  - ROS (mitochondria, NADP oxidases)
  - mitochondrial inhibition → ↓ intracellular ATP
  - prolylhydroxylase/HIF
  - ↓ CO production by haemoxygenase-2

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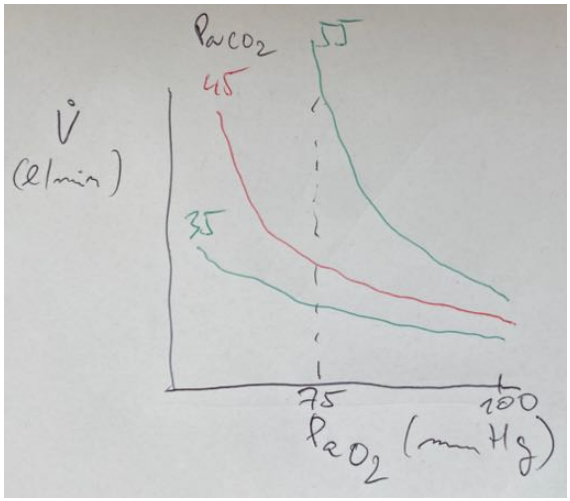
CO_2 potentiates ventilatory response to hypoxia



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Sensory receptors & reflexes

- Hering-Breuer inspiratory-inhibitory reflex
  - ↑ V_L → ↑switch-off neurons in medulla
- diving reflex
  - facial receptors, cold water
- sneeze reflex
  - receptors in nose
- aspiration reflex
  - mechanoreceptors in nasopharynx, moves material to pharynx for expectoration or swallowing
- cough reflex

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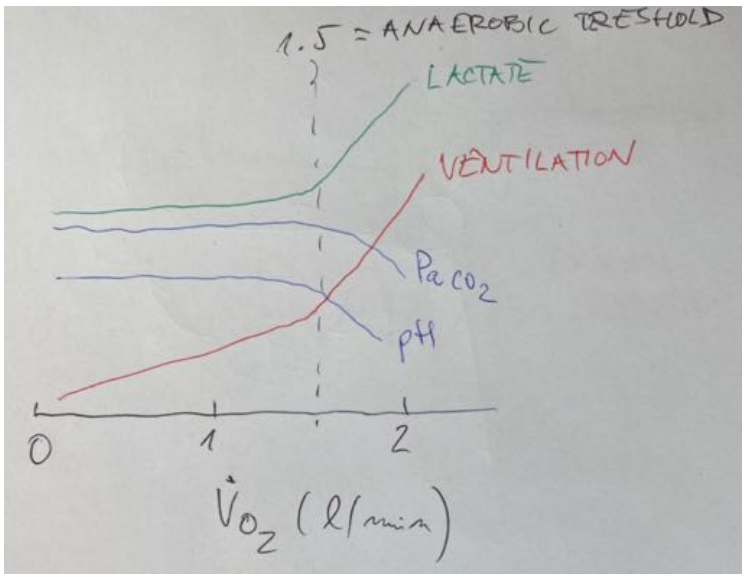
Exercise



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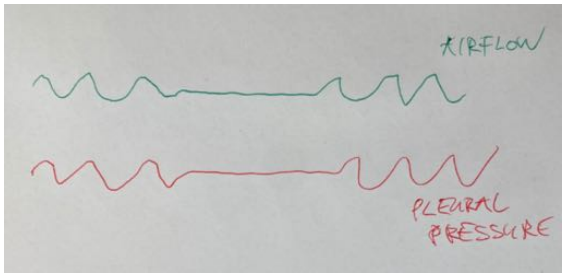
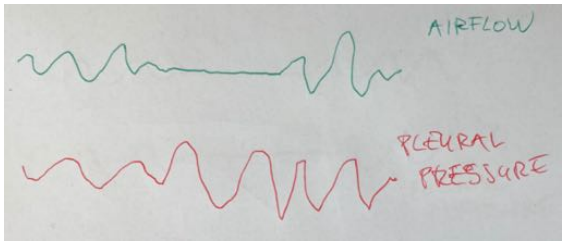
Sleep apnea



central



obstructive

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