

Human Physiology

Curated preclinical study track (not a medical degree, no licensure claim). Original explanations and practice only, following the reviewed course handout.

The fabric in motion

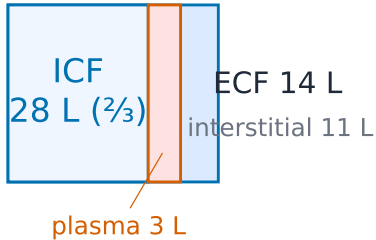
- The control frame first, then the great systems (excitation, circulation, respiration, kidney), then gut and hormones.
- Every claim is an equation you can evaluate - output, alveolar gas, **clearance**, Henderson-Hasselbalch.

Homeostasis: three tanks, one grammar

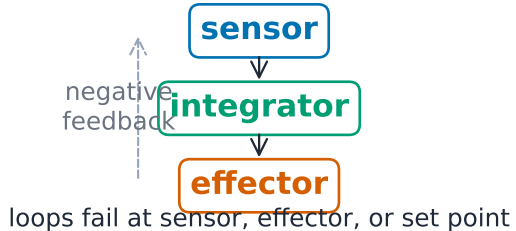
- 1 Tanks** 42 L = ICF 28 (2/3) + ECF 14 (1/3: plasma 3 + interstitial 11); water distributes by osmolality.
- 2 Loop** Sensor → integrator → effector around a set point: every later system is an instance.
- 3 Failure** Loops fail at sensor, effector or set point - a shifted set point is held perfectly (SIADH pattern).

42 L in three tanks; the loop every system speaks.

the three tanks
total body water 42 L



the control grammar

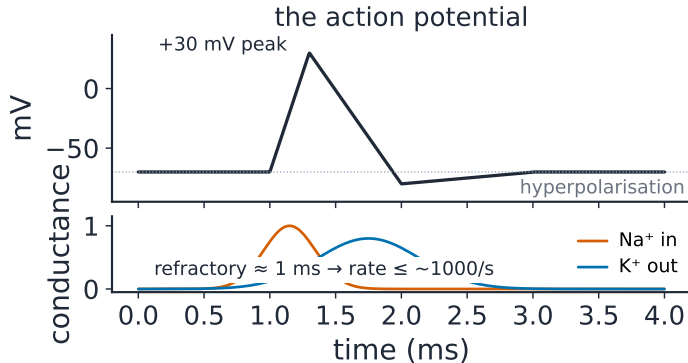


42 L in three tanks; the loop every system speaks.

Excitable cells: one sentence of electricity

- 1 **Spike** Rest -70 mV (K^+); Na^+ upstroke ($+30$, positive feedback); K^+ repolarisation; brief hyperpolarisation.
- 2 **Limits** Refractory ~ 1 ms caps firing $\sim 1000/s$; myelin $\rightarrow$ **saltatory conduction** up to ~ 100 m/s.
- 3 **Muscle** Spike $\rightarrow Ca^{2+} \rightarrow$ sarcomere: twitch 100 ms vs refractory 2 ms, so $\sim 50/s$ fuses into **tetanus** - never in the heart.

The action potential

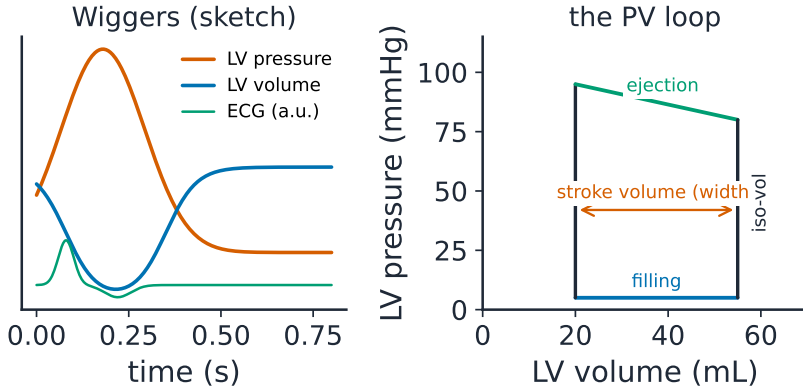


One sodium upstroke, one potassium repolarisation, one refractory gap.

Cardiovascular: the three equations

- 1 **Output** $CO = HR \times SV: 70 \times 70 = 4.9 \text{ L/min}$; $MAP = CO \times SVR$; $MAP \approx DBP + (SBP - DBP)/3 \approx 93 \text{ mmHg}$.
- 2 **Loop** PV loop: width = **stroke volume**, area = work; preload widens (Starling), contractility tilts, afterload narrows.
- 3 **Shock** Haemorrhage: $CO \rightarrow 3$ with SVR up by two-thirds holds pressure at baseline while organ flow has fallen 40% - trust perfusion, not the cuff.

Cardiovascular physiology - the PV loop

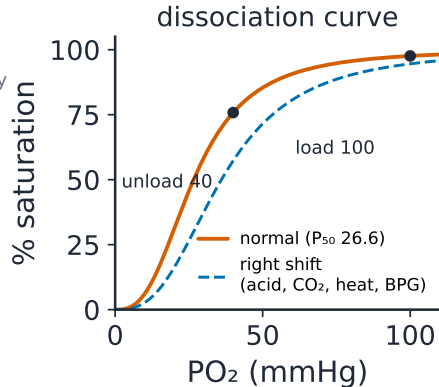
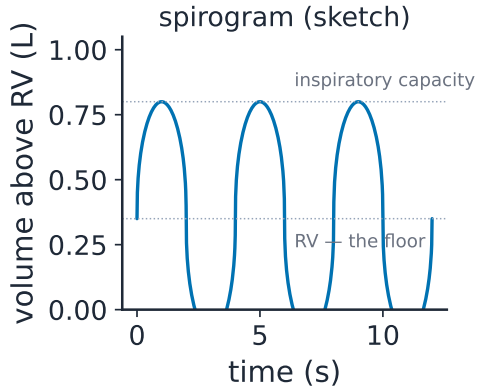


Wiggers sketch beside the pressure-volume loop (width = SV).

Respiratory physiology: one equation, one curve

- 1 Equation** Alveolar $PO_2 = 150 - (CO_2 \div 0.8) \rightarrow 100$ mmHg at CO_2 40; A-a gradient normal 5–15.
- 2 Sorting** Shunt and V/Q mismatch WIDEN the A-a gradient; hypoventilation and altitude keep it normal.
- 3 Curve** P_{50} 26.6 mmHg; loads 100 $\rightarrow$ 97%, unloads 40 $\rightarrow$ ~75%; right shift with acid, CO_2 , heat, BPG; saturation is not content.

Respiratory physiology - spirogram and curve

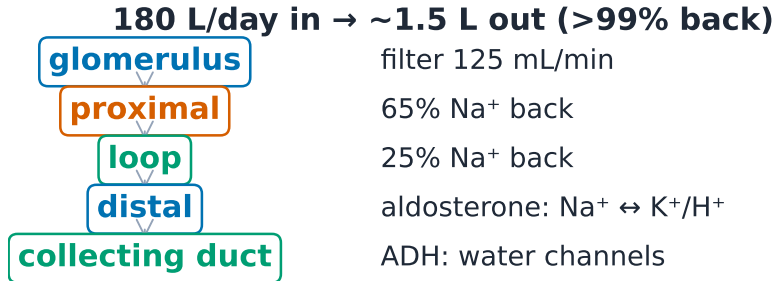


Spirogram sketch; dissociation curve with its right shift.

Renal: the chemists arithmetic

- 1 Filtration** GFR 125 mL/min $\rightarrow$ 180 L/day, >99% back: proximal 65% Na^+ , loop 25%, distal taps under **aldosterone** and **ADH**.
- 2 Clearance** $C = UV/P$: creatinine approximates GFR; PAH (one-pass) = renal plasma flow.
- 3 Acid-base** $\text{pH} = 6.1 + \log(\text{HCO}_3 \div (0.03 \cdot \text{PCO}_2))$; Winter: expected $\text{PCO}_2 = 1.5 \times \text{HCO}_3 + 8$ — mismatch = second disorder.

Renal physiology - transport map



The transport map with percentages and the two hormonal taps.

Gastrointestinal: nine litres, four stations

- 1 **Ledger** 9 L/day in (drink 2, food 1, secretions 6): jejunum the workhorse, ileum signs for B12 and bile salts, colon polishes ~1.3 L.
- 2 **Control Enteric nervous system** (the local plexus) under vagus and gastrin/secretin/CCK.
- 3 **Failure** Ileal resection: B12 out (years of stores) AND bile salts lost (days to weeks) - one segment, two clocks.

Absorption by segment with the nine-litre ledger.

9 L in → ~0.15 L out

stomach > **duod/jejunum** **ileum** > **colon** >

chyme + acid workhorse: sugars, B12 + bile salts
peptides, iron, folate (signed for here) water (~1.3 L), microbiota

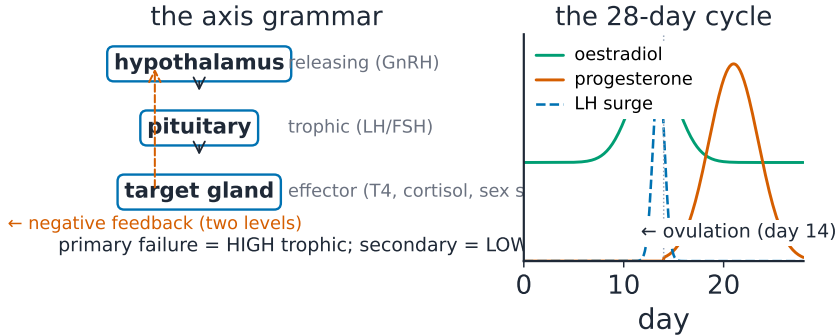
ileal failure = B12 deficiency AND bile-salt diarrhoea

Absorption by segment with the nine-litre ledger.

Endocrine: one grammar, every axis

- 1 **Axis** Releasing → trophic → effector → feedback at both higher levels; 28-day rhythm in reproduction.
- 2 **Labs** Primary failure = HIGH trophic; secondary = LOW both - one pattern pair retires a dozen syndromes.
- 3 **Cycle** Ovulation = oestradiol flipping to POSITIVE feedback once per cycle: the LH surge; unopposed oestrogen names the risk.

The axis grammar beside the 28-day cycle sketch.



The axis grammar beside the 28-day cycle sketch.

Check yourself

- **Cardiac output** at HR 70, SV 70 mL? (~5 L/min.)
- Alveolar PO₂ at CO₂ 40, R 0.8? (~100 mmHg.)
- Winter for HCO₃⁻ 12? (PCO₂ 26 ± 2.)
- Free T₄ low, TSH high? (Primary thyroid failure.)