2002a(1)/1996b(5): Explain briefly how oxygenation of organs can be maintained during isovolaemic haemodilution

Process
Isovolaemic haemodilution = replacement of a portion of blood volume with fluid which doesn’t possess oxygen carrying capacity
- **Nil effect on circulating volume**
  - crystalloid (NS, CSL)

Effect
- ↓concentration blood components
  - ↓[Hb]

O₂ content in blood determined by:

\[
CaO₂ (\text{mg/L}) = (\text{[Hb]} \times \text{SaO}_2 \times 1.34) + 0.03\text{PO}_2 \times \frac{100}{100}
\]
- Therefore, ↓Hb will ↓O₂ carrying capacity of blood

Compensation
Cardiovascular
Tissues are able to **autoregulate** local blood flow in order to meet the metabolic demand of the tissue
- Mechanisms of autoregulation:
  - **Metabolic**: ↑production of vasoactive substances in response to metabolite production
    - ↓pO₂
    - ↑lactate/ H⁺, ↓pH → with anaerobic metabolism
  - **Myogenic**: ↓stretch of arteriolar walls → reflex vasodilation (minimal effect here 2° isovolaemia)
- All will ↓tissue vascular resistance (TPR)

Heart is a demand pump → ↓TPR → ↓MAP

\[
\text{MAP} = \text{CO} \times \text{TPR}
\]
- Detected by high pressure baroreceptors (carotid sinus, aortic arch)
  - ↑SNS stimulation
    - ↑preload → venoconstriction (↑tendency for venous return)
    - ↑HR
    - ↑SV / contractility
- Overall effect = ↑CO

Respiratory
Fick Equation:

\[
\text{VO}_2 = Q(\text{CaO}_2 - \text{CvO}_2)
\]
where: \(\text{CaO}_2\) = arterial O₂ content, \(\text{CvO}_2\) = venous O₂ Content, \(Q = \text{CO}\) (see above)

Improve O₂ extraction
- ↓CvO₂
  - Improved tissue O₂ extraction
  - **Bohr Effect** → shift OHDC to the right
    - Not available to the heart 2° normally high extraction ratio (typically 55-65%)

- **Late Effects**
  - ↓PO₂ → detected by chemoreceptors (1° carotid body)

By Amanda Diaz
- ↑SNS stimulation of respiratory centre
  - ↑RR
  - ↑ tidal vol → recruit more alveoli for O₂ transfer
- Overall effect → ↑MV
- This effect results in only small ↑CaO₂ → therefore is a late sign

**Additional**
- ↓ viscosity of blood (↓η)
  - ↓Hct
  - ↓ resistance of vessels according to Hagan-Poiseuille equation → further improves local tissue flow

Point A is the equilibrium point of VR and CO during normal resting conditions. Isovolaemic haemodilution → ↓TPR (2° dilatation of tissue beds) → ↑tendency for VR causing a clockwise rotation of the VR curve at the same right atrial pressure. The equilibrium point b/n VR and CO then moves to point B indicating an ↑CO.