SNS COLLEGE OF ALLIED HEALTH SCIENCE

Affiliated to The Tamil Nadu Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIOPULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME: CPB and Perfusion Technology

UNIT II

TOPIC: Perfusion Flow Pressure

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EMPATHIZE: Why CPB Matters

Complex cardiac surgeries require temporary circulatory support

CPB replaces heart and lung function during surgical intervention

Critical understanding: adequate perfusion maintains organ viability

Challenge: maintaining balance between flow and pressure

DEFINE: Flow, Pressure & Resistance

- **Flow (F) = Pressure Difference (ΔP) / Resistance (R)**

Ohm's Law for Hemodynamics

- **Flow:** Volume of blood moving through vessel (L/min)
- **Pressure Difference (ΔP):** MAP gradient driving circulation
- **Resistance:** Opposition to flow from vessel walls & viscosity

Electric current = Voltage/Resistance

$$I = \frac{V}{R}$$

V = IxR
I = V/R
R = V/I

Ohm's law triangle

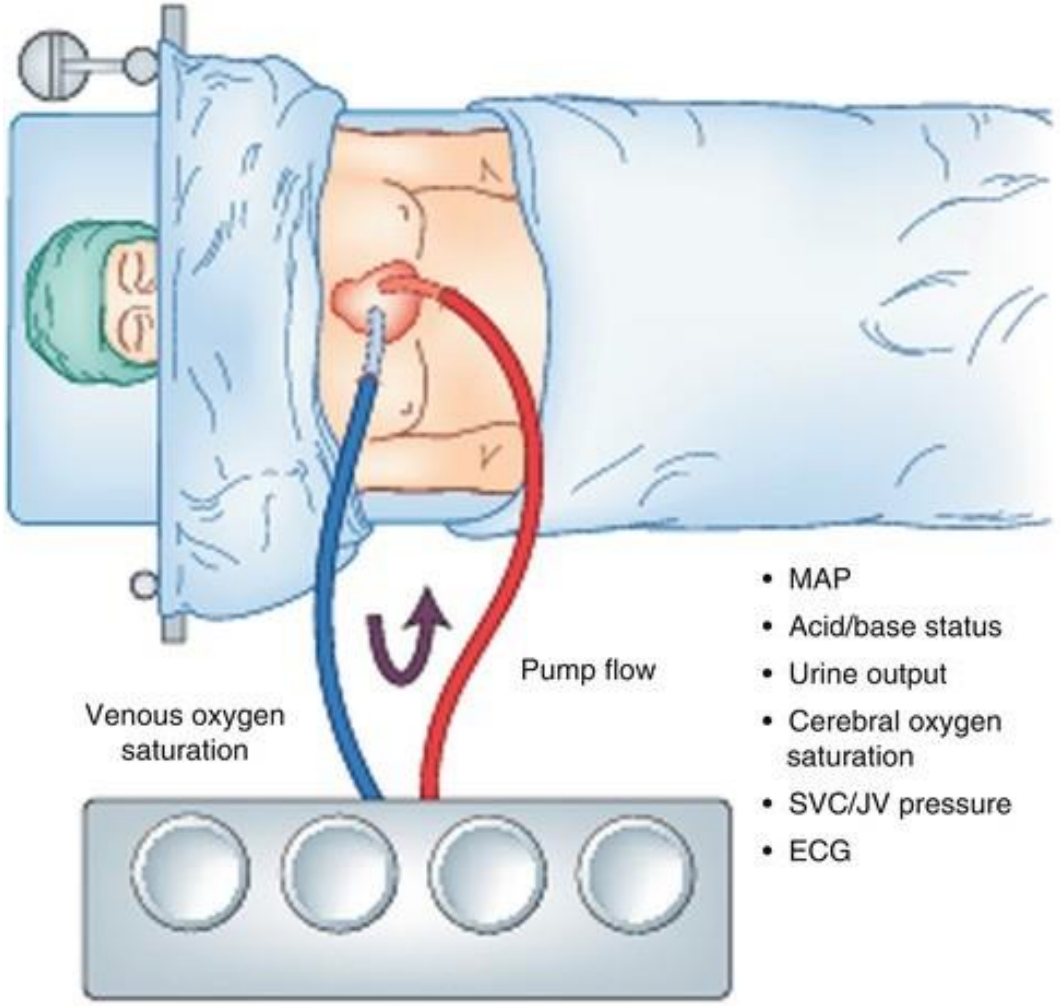
DEFINE: Pressure & Resistance Mechanisms

Mean Arterial Pressure (MAP)

- Normal: 70-100 mmHg during CPB
- MAP < 70 mmHg = Risk of organ hypoperfusion

Systemic Vascular Resistance

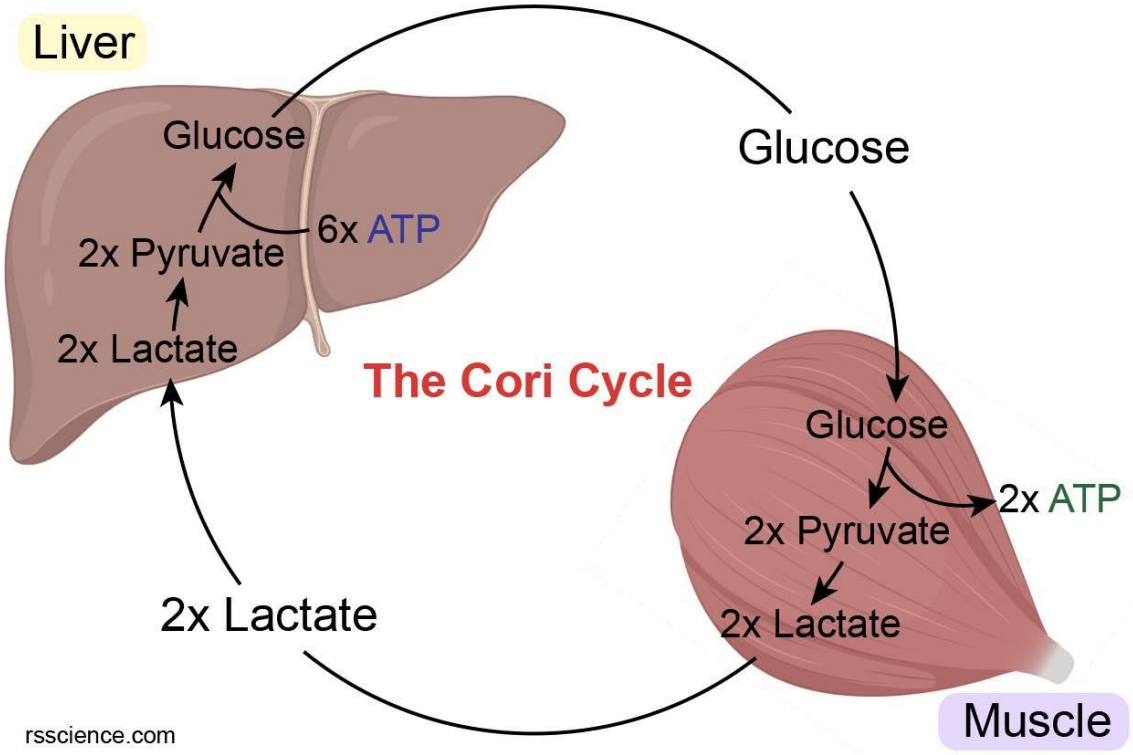
- Decreases during CPB due to loss of pulsatile flow
- Hypothermia & Hemodilution reduce resistance



IDEATE: Optimal Perfusion Flow Rates

- **Standard Flow:** 2.0-2.5 L/min/m^2 (normothermia)
- **Low Flow:** 1.2 L/min/m^2 (moderate hypothermia)
- **Deep Hypothermia:** 0.5-1.5 L/min/m^2

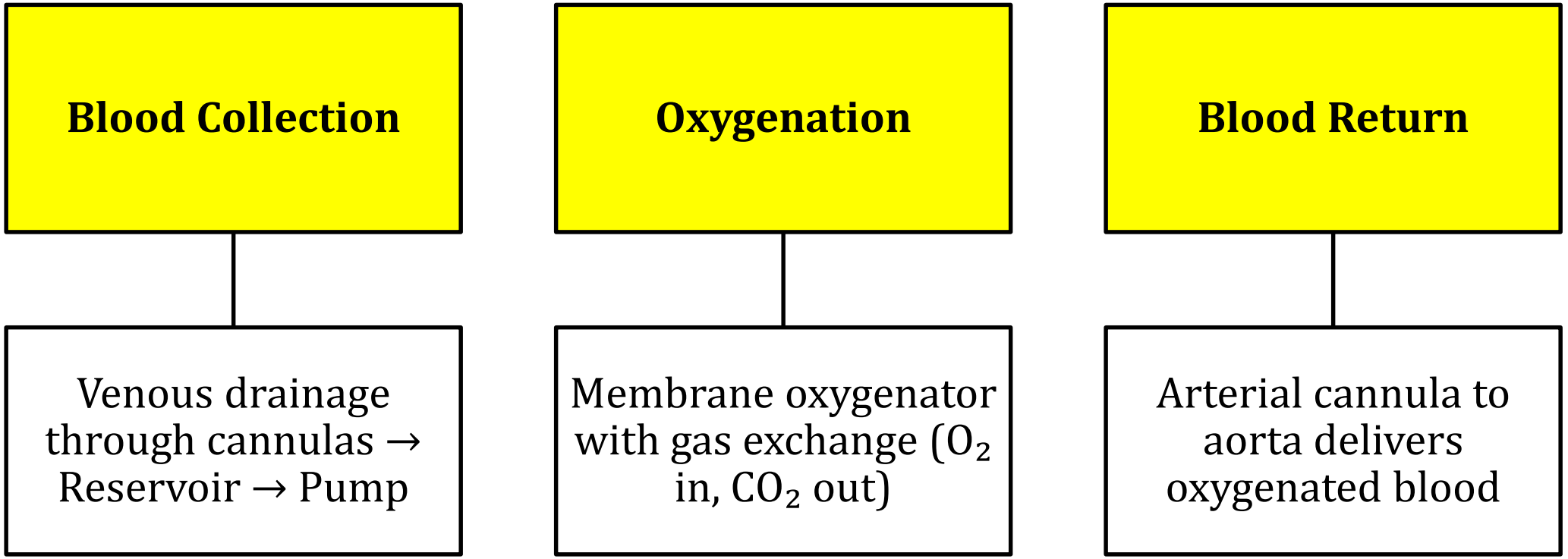
- **Clinical Decision:** Flow rate selection depends on temperature management, surgical requirements, and organ perfusion needs



IDEATE: Oxygen Delivery During CPB

- **Indexed Oxygen Delivery (iDO_2) = Flow × Hb × SaO_2 × 1.34 / Body Surface Area**
- **Flow:** Pump output directly influences oxygen delivery
- **Hemoglobin (Hb):** Oxygen carrying capacity (affected by hemodilution)
- **SaO_2:** Arterial oxygen saturation (maintained ~100%)
- **Target iDO_2:** >250 mL/min/m^2 for adequate perfusion

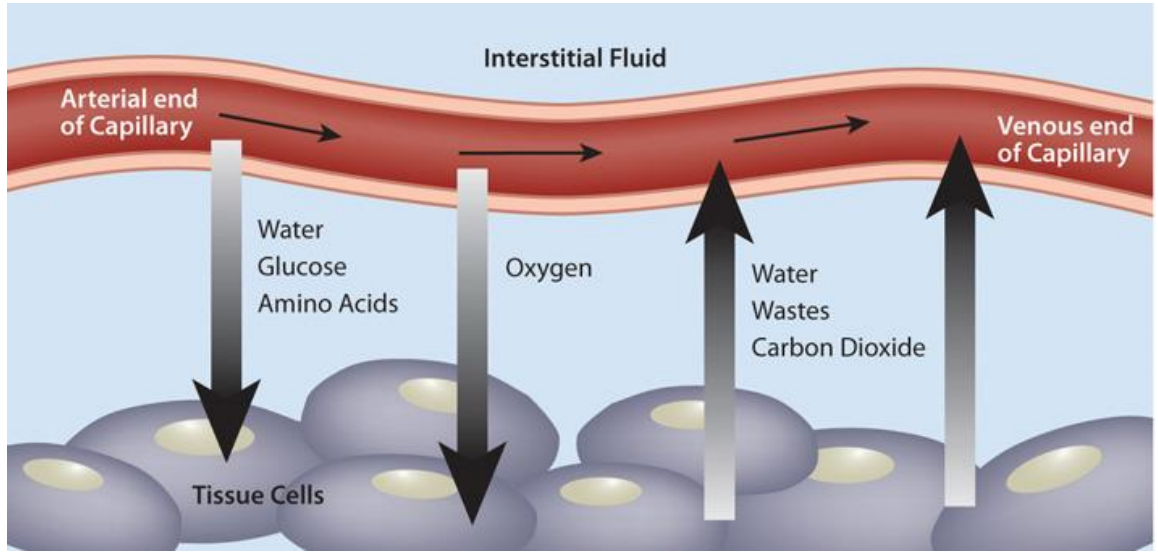
PROTOTYPE: CPB Circuit Organization



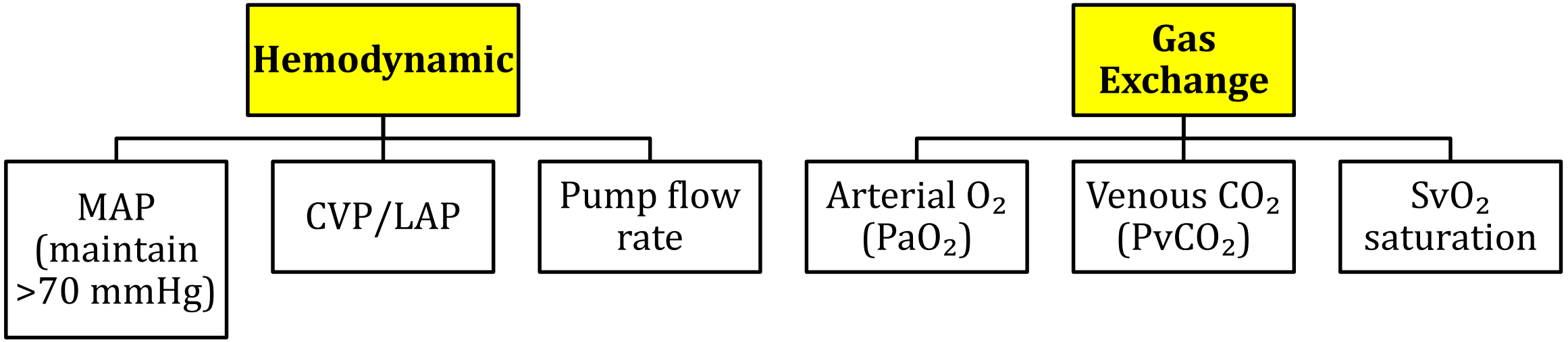
PROTOTYPE: Flow & Pressure Independence

Critical CPB Principle: Unlike normal physiology, flow and pressure are independent during CPB

- Increased MAP does NOT automatically increase organ perfusion
- Adequate pump flow is essential for tissue oxygenation
- Kidney perfusion primarily dependent on pump flow rate
- Cerebral perfusion influenced by both pressure and $PaCO_2$
- **Clinical Pearl:** Maintain MAP >70 mmHg AND adequate flow for optimal organ protection

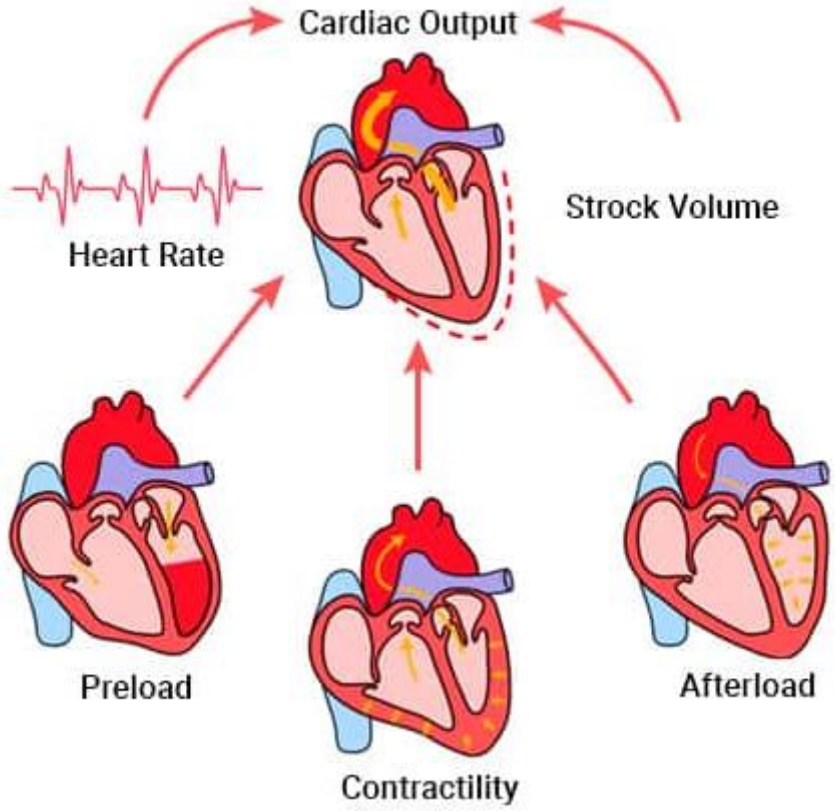


TEST: Monitoring Parameters



TEST: Systemic Oxygen Uptake (VO_2)

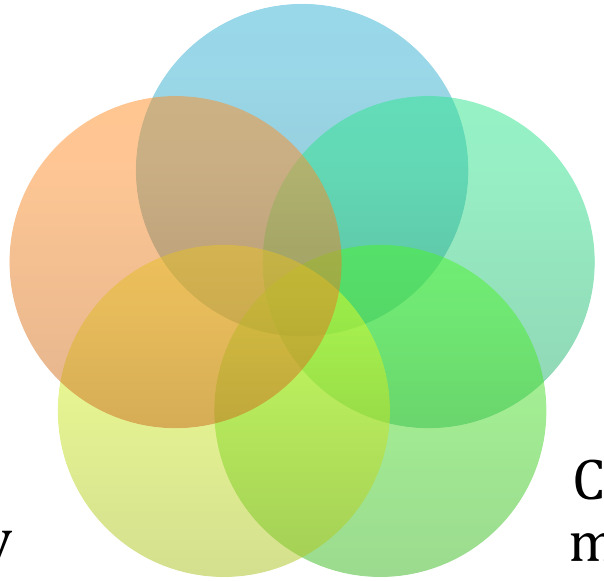
- **VO_2 = Cardiac Output × (CaO_2 - CvO_2)**
- **CaO_2:** Arterial oxygen content (oxygenated blood)
- **CvO_2:** Venous oxygen content (deoxygenated blood)
- **A-V O_2 Difference:** Reflects tissue oxygen extraction
- Low flow (1.5 L/min/m^2) with hypothermia = reduced systemic VO_2



TEST & ITERATE: Clinical Optimization

Goal: Minimize organ ischemic injury while optimizing surgical field

Embolic load and red cell trauma increase with turbulent high-velocity flow



Renal protection during CPB: MAP >70 mmHg, maintain pump flow

Inflammatory response reduced with lower flow velocities

Cerebral autoregulation maintained by adequate perfusion pressure

Summary

Empathize:	Define:	Ideate:	Prototype:	Test & Iterate:
Understand surgical requirements and organ needs	Establish pressure-flow relationships and physiology	Optimize flow rates and oxygen delivery strategies	Configure CPB circuit for specific patient needs	Monitor and adjust parameters for organ protection

References

- https://www.ncbi.nlm.nih.gov/books/NBK482190/
- https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2024.1257631/full
- https://www.sciencedirect.com/science/article/pii/S0022522319342989
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THANK YOU