

How Heart Rate Changes with Body Demand

The intrinsic, neural, and hormonal mechanisms that regulate cardiac activity.

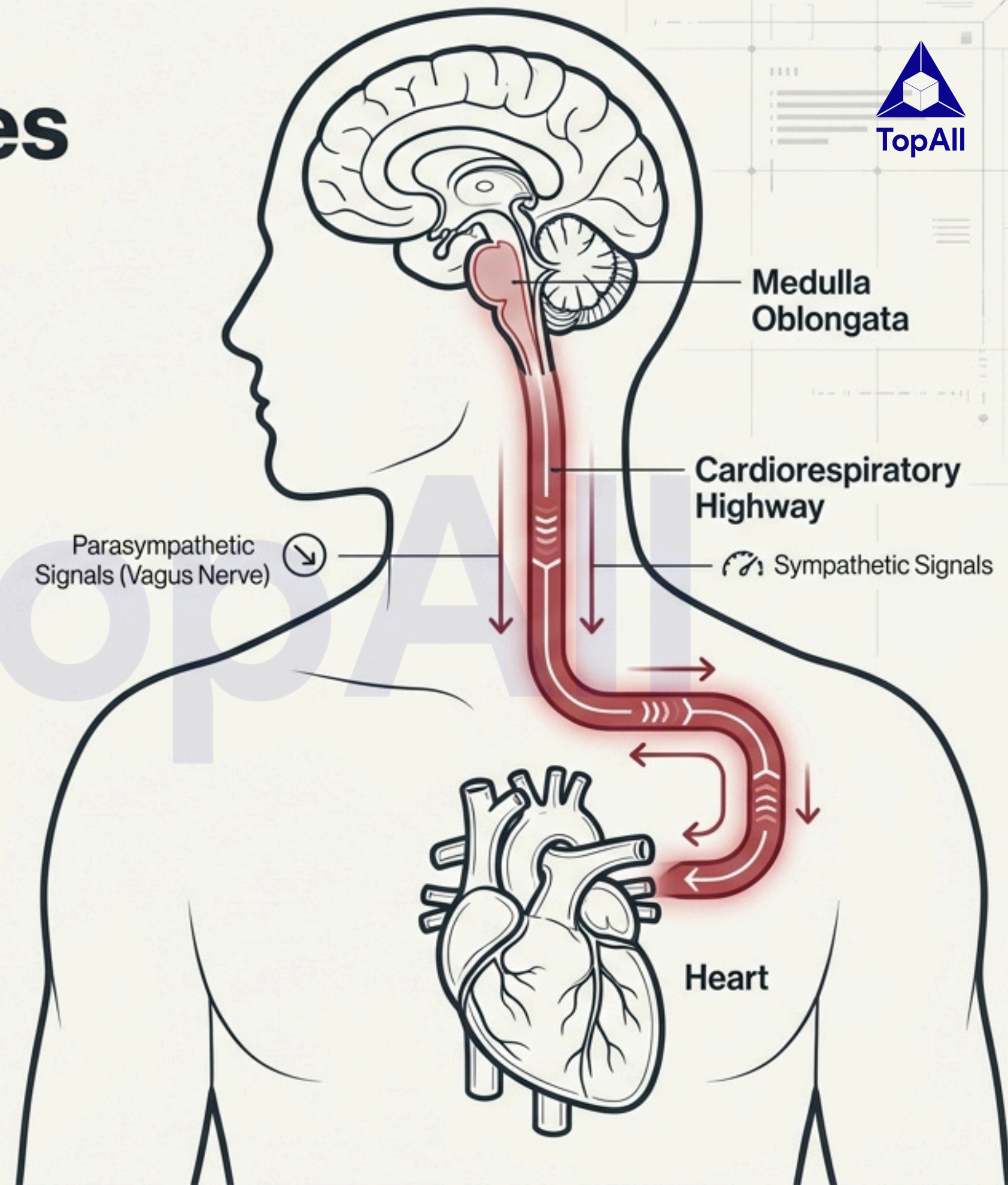
⚙️ **Intrinsic Control:** SA Node (Pacemaker) 🗑️

🧠 **Neural Regulation:** Autonomic Nervous System (ANS)

🧪 **Hormonal Influence:** Adrenaline, Thyroxine

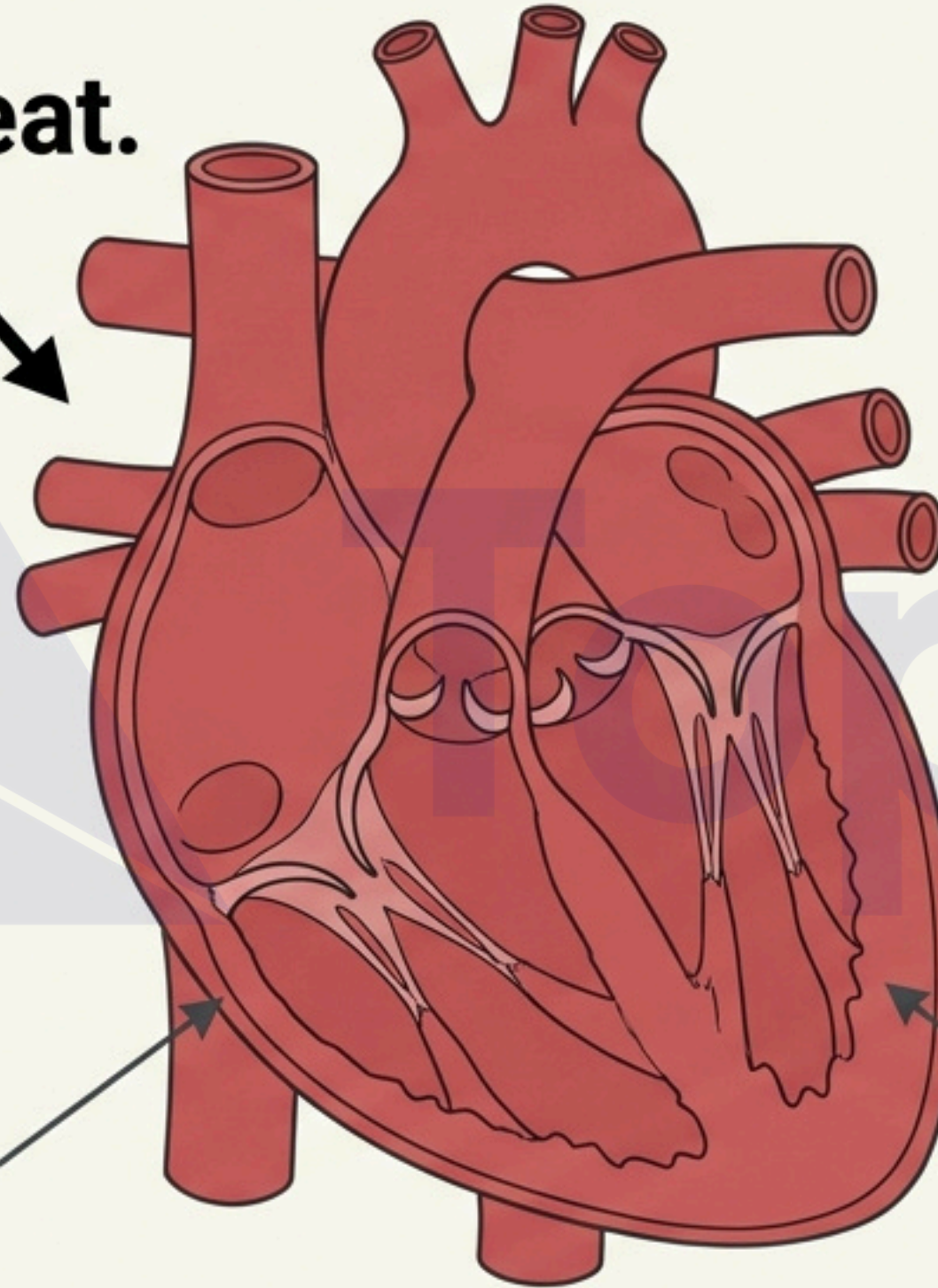
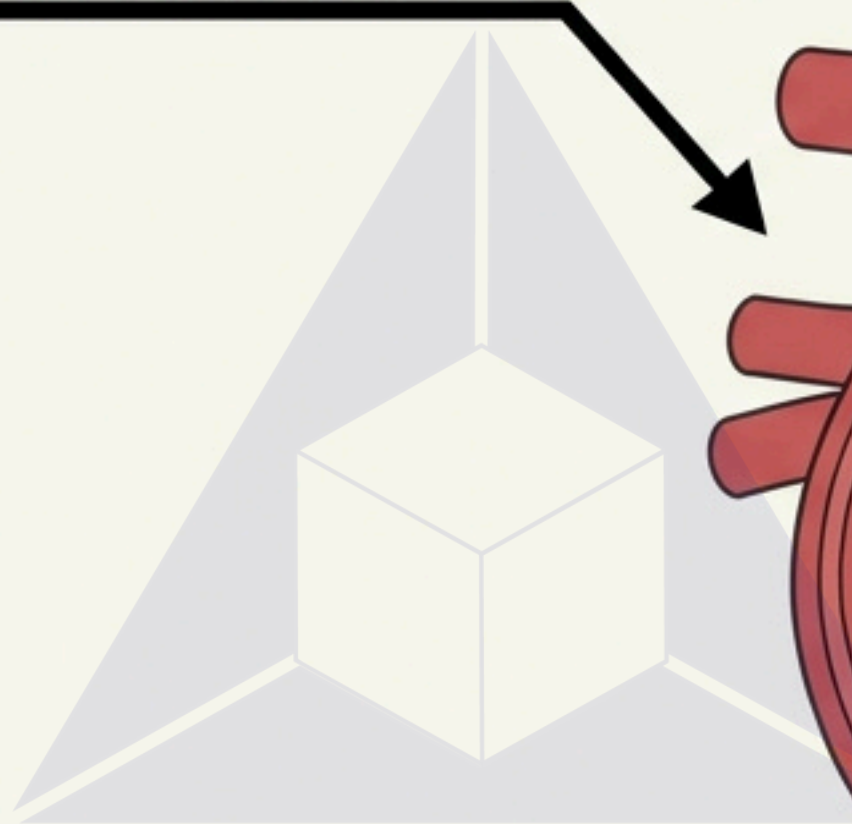
📡 **Feedback Loops:** Baroreceptors, Chemoreceptors

Biological Dashboard: Integrative Cardiac Control Systems



Engine Block

**The heart does not
need the brain to beat.**



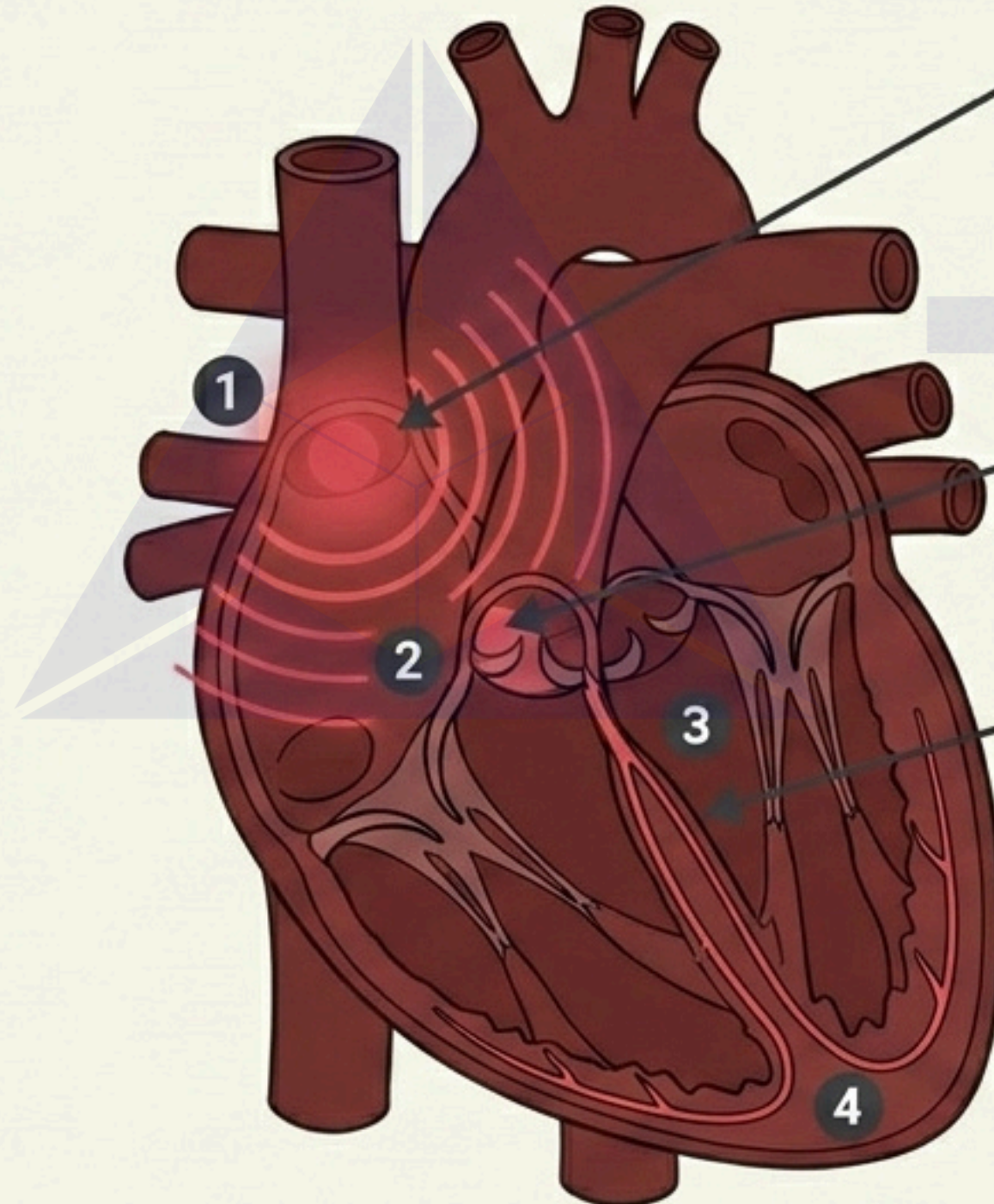
MYOGENIC

The heart's normal activities are auto-regulated by specialized muscles rather than external nerve impulses.

Unlike skeletal muscles that require direct neural commands to move, cardiac musculature generates its own rhythmic contractile activity.

The Internal Pacemaker

The nodal musculature is autoexcitable—it generates action potentials without any external stimuli.



THE CONDUCTION PATHWAY

1. SAN (Sino-Atrial Node)

Generates 70–75 action potentials per minute, establishing the resting rhythm.

2. AVN (Atrio-Ventricular Node)

3. AV Bundle (Atrio-Ventricular Bundle)

4. Purkinje Fibres

Transmitting the signal throughout the ventricular musculature.



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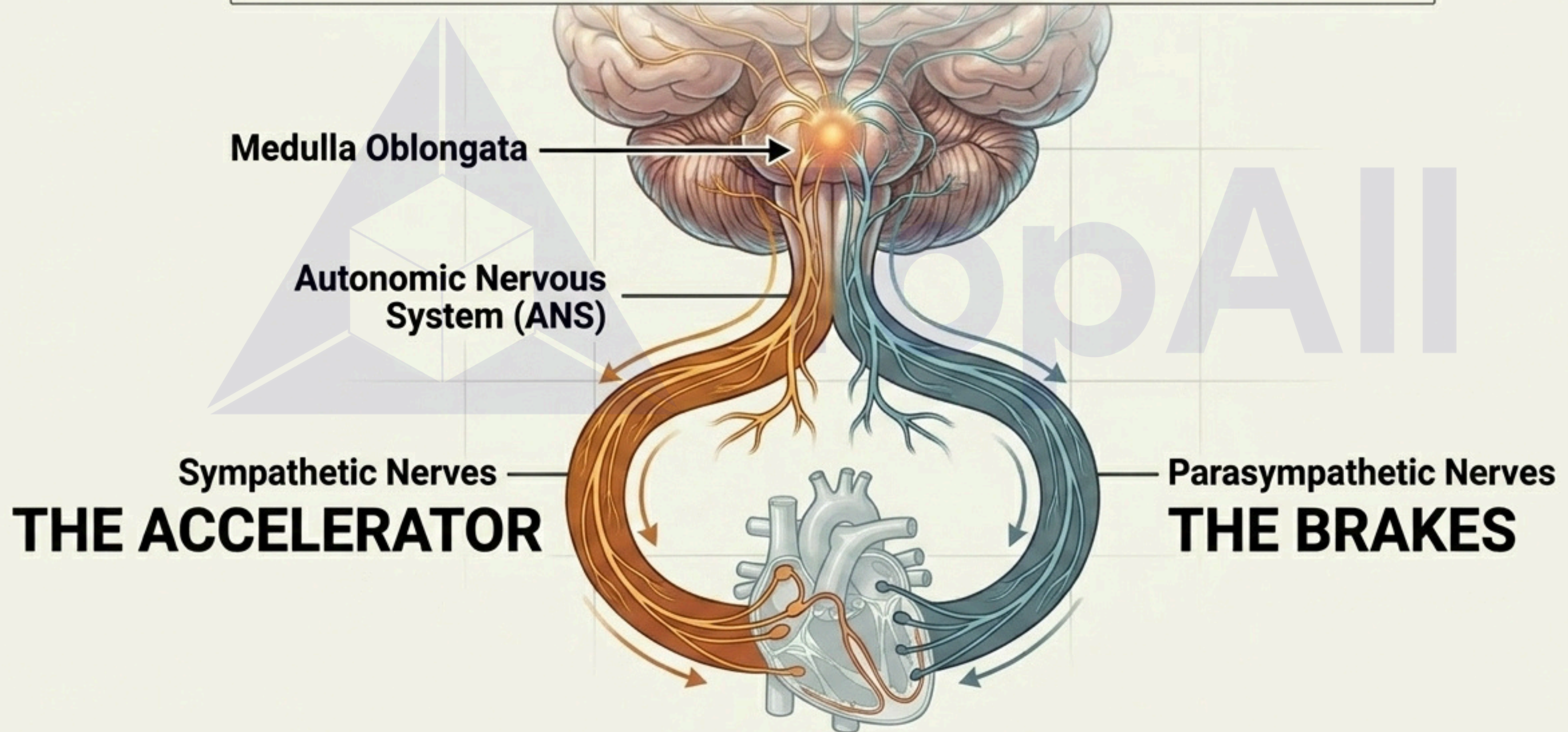
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The Override Switch: External Regulation

While the heart is auto-regulated, it must adapt to the body's changing demands (exercise, stress, rest). A specialized neural center moderates cardiac function.



Sympathetic System: The Accelerator

TRIGGER: High body demand (e.g., physical exertion, acute stress).



Biological Dashboard



↑ Rate of Heart Beat

Pace increases far above the SAN baseline.



↑ Ventricular Contraction

The physical strength of the pump increases.

$$\text{Heart Rate } (\uparrow) \times \text{Contraction Strength } (\uparrow) = \text{Cardiac Output } (\uparrow)$$

The total volume of blood pumped per minute surges to deliver maximum oxygen and nutrients to tissues.

Parasympathetic System: The Brakes

TRIGGER: Return to rest, digestion, and low body demand.

Medulla



Parasympathetic Nerves



Heart

Biological Dashboard



↓ **Rate of Heart Beat**

Pace slows back toward or below the resting baseline.



↓ **Action Potential Conduction**

The speed of the electrical signal traveling through the nodal tissue decreases.

$$\text{Heart Rate } (\downarrow) \times \text{Conduction Speed } (\downarrow) = \text{Cardiac Output } (\downarrow)$$

Total blood volume pumped per minute drops, conserving energy during rest periods.

The Chemical Boost & Final Synthesis

3. Hormonal Boost

Adrenal Medulla.
Delivers a sustained chemical boost for increased output.

ADRENAL MEDULLARY HORMONES

Provide a secondary, chemical pathway. Traveling through the bloodstream, they complement sympathetic nerves to further increase Cardiac Output.

2. Neural Override

Medulla Oblongata & ANS.
Provides rapid, immediate acceleration or braking.

1. Intrinsic Control

Nodal Tissue / Myogenic.
Generates the baseline pace.

Hierarchy of Control





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