Mean arterial pressure Physiology

Mean Arterial Pressure (MAP) refers to the average arterial pressure during a single cardiac cycle encompassing both **systole** and **diastole** .

> **MAP is the perfusion pressure seen by organs in the body.** It reflects the driving force for blood flow and is vital for maintaining tissue and organ viability.

MAP Calculation

MAP is a **time-weighted average** , not a simple arithmetic mean, because **diastole lasts longer** than systole.

Standard Clinical Formula:

Where:

- **DBP** = Diastolic Blood Pressure
- **SBP** = Systolic Blood Pressure
- **PP** = Pulse Pressure (SBP - DBP)

  Since diastole occupies about two-thirds of the cardiac cycle, **MAP is closer to diastolic pressure** .

High-Yield Note

- **Normal MAP Range** : 70–100 mmHg
- **Minimum for organ perfusion** : ~60 mmHg
- **MAP < 60 mmHg** ? Risk of **organ ischemia**
- **MAP > 100 mmHg** ? Risk of **vascular injury and end-organ damage**

Determinants of MAP

MAP is a function of both **cardiac output (CO)** and **systemic vascular resistance (SVR)** .

Stroke Volume (SV) is affected by:

- **Preload** : End-diastolic volume; ? blood volume = ? preload
- **Contractility** : Inotropy of myocardium
- **Afterload** : Resistance the heart must pump against (? afterload = ? SV)

Heart Rate is regulated by:

- **Chronotropy** (rate)
- **Dromotropy** (conduction speed)
- **Lusitropy** (relaxation ability)

Clinical Relevance of MAP

MAP Value	Clinical Interpretation	Potential Consequences
> 100 mmHg	Hypertensive emergency risk	? Cardiac workload, ? clot formation, arterial injury
60–100 mmHg	Optimal perfusion range	Adequate tissue oxygenation
< 60 mmHg	Inadequate perfusion	Cerebral ischemia, renal failure, organ damage

Physiologic and Systemic Regulation

Cardiovascular System

- Controls CO and SVR via:
  - **Baroreceptor reflexes** (carotid sinus, aortic arch)

- **Sympathetic and parasympathetic output**

Renal System

- **Renin-Angiotensin-Aldosterone System (RAAS)** increases:
  - Sodium & water retention ? ? blood volume ? ? preload and MAP
  - Vasoconstriction ? ? SVR

Autonomic Nervous System (ANS)

- Adjusts:
  - Heart rate (via beta-1 receptors)
  - Vascular tone (via alpha-1 receptors)

Why MAP ? Simple Average of SBP & DBP

- Systolic and diastolic phases are not equal in duration.
- **At rest** :
  - Systole = ~1/3 of cardiac cycle
  - Diastole = ~2/3 of cardiac cycle
- Simple averaging would **overestimate perfusion** .

Measurement Methods

Method	Description
Sphygmomanometer	Manual method using BP cuff; MAP calculated
Oscillometric BP Monitor	Automated; often provides MAP directly
Invasive Arterial Line	Gold standard in ICU settings; real-time measurement

Clinical Conditions Associated with Abnormal MAP

High MAP (> 100 mmHg)

Causes :

- Hypertension
- Pheochromocytoma
- Vasopressor overdose
- Hypervolemia

Risks :

- End-organ damage (e.g., kidney, brain, heart)
- Left ventricular hypertrophy
- Stroke or myocardial infarction

Low MAP (< 60 mmHg)

Causes :

- **Sepsis** (vasodilation + capillary leakage)
- **Hemorrhage** or **internal bleeding**
- **Heart failure**
- **Stroke** or neurogenic shock

Consequences :

- Hypoperfusion of vital organs
- Acute kidney injury
- Loss of consciousness
- Neuronal death

High-Yield Summary

Concept	Key Point
MAP Formula	MAP = DBP + 1/3(SBP - DBP)
Organ perfusion threshold	MAP ? 60 mmHg
Determinants of MAP	MAP = CO × SVR
Stroke volume influenced by	Preload, Afterload, Contractility
RAAS effect	? Plasma volume & SVR ? ? MAP
Baroreceptors	Regulate MAP via autonomic feedback
High MAP risk	Hypertension, stroke, cardiac damage
Low MAP danger	Organ ischemia, shock, death