Blood Pressure

measured as mmHg

Main factors affecting blood pressure:
1. cardiac output
2. peripheral resistance
3. blood volume

→ a change in any of these could cause a corresponding change in blood pressure

blood circulates by going down a pressure gradient:

pressure gradient depends on:
1. force of heart beat
2. peripheral resistance - counteracts pressure

Blood Flow = Difference in pressure
Peripheral resistance

Measuring Blood Pressure

use sphygmomanometer

usually use brachial artery

procedure:
   a. increase pressure above systolic to completely cut off blood flow in artery
   b. gradually release pressure until 1st spurt (pulse) passes through cuff = systolic pressure
   c. continue to release until there is no obstruction of flow sounds disappear = diastolic pressure

normal BP = 110-140 / 75-80 [mm Hg]

   top number = systolic pressure
               force of ventricular contraction

   bottom number = resistance of blood flow
                   may be more important
                   indicates strain to which vessels are continuously subjected
                   also reflects condition of peripheral vessels


**Pulse Pressure:**

Pulse Pressure = Systolic Pr – Diastolic Pr

eg. 120/80; then PP = 40 mmHg

**Mean Arterial Pressure:**

represents the average of Sys & Diast BP’s

MAP = Diastolic Pr + 1/3rd x Pulse Pressure

**Variations in Blood Pressure**

heart pumps ~5L (4.8) of blood per minute

→ 5 liters in systemic circuit
→ 5 liters in pulmonary circuit

**Systemic Circuit**

averages

\[
\text{difference} = 100 \text{ mmHg}
\]

high resistance:

62000 miles of vessels from L ventricle to R atrium

→ especially in arterioles

**arteries**

variable

systolic = 130-5 mmHg
diastolic = 85-90 mmHg

**capillaries**

relatively constant

35 – 15 mmHg

**veins**

relatively constant

6 – 1 mmHg
larger veins near 0 mmHg

**Pulmonary Circuit**

much fewer and shorter vessels

much lower resistance

averages

\[
\text{difference} = 10 \text{ mmHg}
\]

low resistance

→ no pulmonary edema
Control of Blood Pressure

natural variations or differences in Blood Pressure are caused by:

age

kids 90/60; adults 120/80; old 150/82
gender
race
socioeconomic status
mood
physical activity
posture

more significant factors that can cause variations in pressure are:

1. Physical Condition of the Heart
2. Peripheral Resistance
3. Blood Volume

1. Physical Condition of the Heart
   affects Cardiac Output
   already discussed cardiac output

2. Peripheral Resistance
   factors that affect peripheral resistance are
   a. mediated by autonomic nervous system
   b. the condition of the vessels themselves
   c. blood-born chemicals

   a. Vasomotor Control Center (medulla)
      works in conjunction with cardiac centers

      both arteries and veins can dilate or constrict to lower or raise BP

      mainly sympathetic control
      → activation can cause constriction
      eg. in skin or dilation eg in muscles

   b. Condition of vessels
      eg atherosclerosis inhibits flow
      → raises blood pressure

      eg. obesity leads to many additional vessels that blood must pass through
      → raises blood pressure

c. Blood Borne chemicals
numerous blood-borne chemicals influence short term control of blood pressure

act directly on vascular smooth muscle or on vasomotor system

**eg. NO**
secreted by endothelial cells
localized vasodilation $\rightarrow$ lowers BP
very brief effect, quickly destroyed
is the major antagonist to sympathetic vasoconstriction

eg. viagra stim production of NO

**eg. inflammatory chemicals**
histamines, kinins, etc
potent vasodilators $\rightarrow$ lower BP
increase capillary permeability

**eg. nicotine**
intense vasoconstriction $\rightarrow$ raise BP
simulates sympathetic release of NE

**eg. alcohol**
depresses VMC
inhibits ADH release
vasodilation (esp of skin vessels) $\rightarrow$ lowers BP
(also flushing of face)

3. Blood Volume
   a. Short Term Control of Blood volume
   
blood pressure is directly affected by the volume of fluids retained or removed from body:
   
greater bld volume $\rightarrow$ increases BP
   eg. excessive salts promote water retention
   lower bld volume $\rightarrow$ decreases BP
   eg. dehydration
   eg. internal bleeding

   kidneys act both directly and indirectly to help regulate arterial pressure:

   short term renal control = **Direct Control**

   high BP
   $\rightarrow$ triggers more filtration from kidney
   $\rightarrow$ greater urine output
→ lowers BP

low BP
→ triggers more reabsorption of water by kidney
→ lower urine output
→ raises BP

b. Long Term Renal Control of BP
   = Indirect Renal Control

   are slower to change

   can act as a system-wide control over whole body blood pressure
   → baroreceptors quickly adapt to long term
     (chronic) changes in blood pressure
   → stop “trying” to return to “normal”

renin-angiotensin mechanism
   if lower BP:
   → kidneys release enzyme = renin
   → renin triggers production of angiotensin II
   → angiotensin causes:
     vasoconstriction → raises BP
     release of ADH → conserves water to raise BP

Abnormal Blood Pressure

Hypotension
   low BP → systolic <100
   usually not a cause for concern
   → often associated with long healthy life
   but.
   in some may produce dizziness when standing up too quickly
     (esp in older patients)
   may be due to severe bleeding and lead to circulatory shock
   may hint at poor nutrition
eg. <blood proteins

Hypertension
   if transient → is normal:
     adaptation during fever, exercise, strong emotions
   if persistent is a cause for concern
30% of those >50 yrs old suffer from hypertension usually asymptomatic for first 10-20 yrs = silent killer
prolonged hypertension is a major cause of:
heart failure
vascular disease
kidney failure
stroke
aneurysms

high blood pressure affected by:
heredity
gender: men slightly higher risk of HBP
age: risk increases after age 35
race: African Americans at higher risk