TOTAL PERIPHERAL RESISTANCE:

The resistance of the entire systemic circulation is called total peripheral resistance.

TPR depends on-

- Elasticity of the vessel
- Viscosity of blood
- Velocity of blood
- State of lumen of vessel

PERIPHERAL RESISTANCE UNIT:

When pressure difference is 1 mm of Hg & flow is 1 ml/sec then it is 1 PRU.

Total peripheral resistance rises to 4 PRU when blood vessels are strongly contracted & decreases to 0.25 PRU when blood vessels are greatly dilated.
Total pulmonary vascular resistance – about 0.14 PRU

TPR increase in- Severe polycythemia

TPR decrease in-

- Beriberi
- Hyperthyroidism
- Anemia
- Arterio-venous fistula

Vasomotor center:

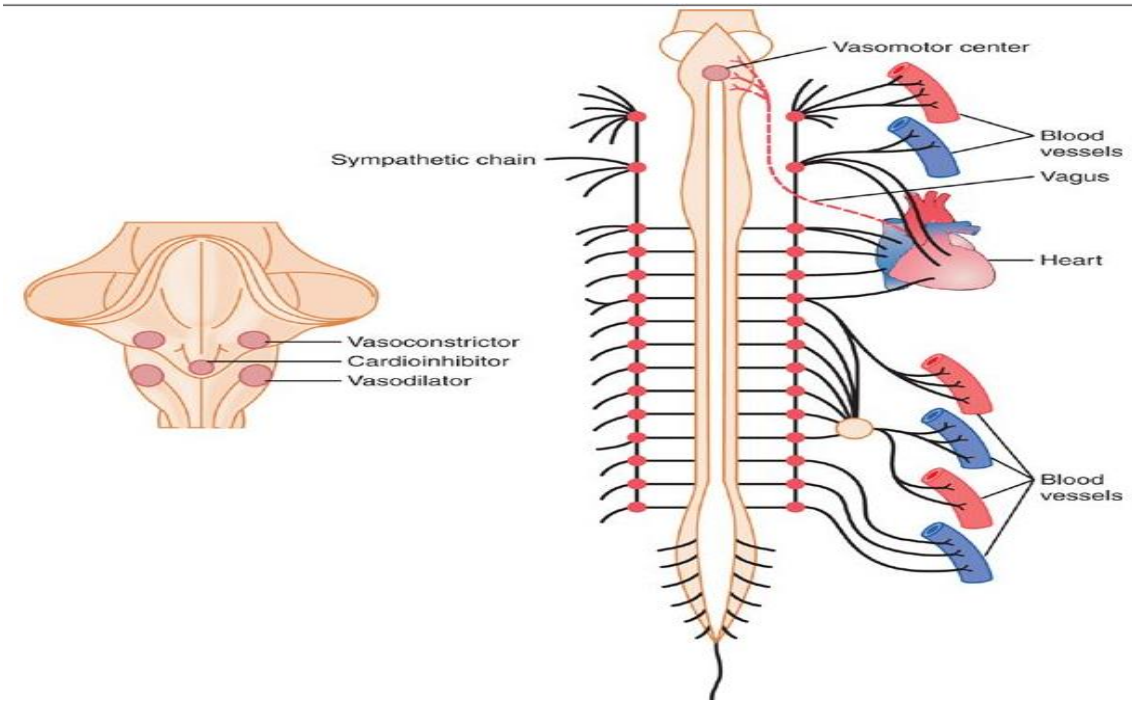


Fig: Vasomotor center

Vasomotor center located bilaterally mainly in the reticular substance of the medulla and the lower third of the pons.

This center transmits parasympathetic impulses through the vagus nerves to the heart and transmits sympathetic impulses through the spinal cord and peripheral sympathetic nerves to virtually all arteries, arterioles, and veins of the body.

Important areas in this center are-

1. A vasoconstrictor area located bilaterally in the anterolateral portions of the upper medulla. Stimulation of this area causes vasoconstriction.
2. A vasodilator area located bilaterally in the anterolateral portions of the lower half of the medulla. They inhibit the vasoconstrictor activity of this area, thus causing vasodilation.
3. A sensory area located bilaterally in the tractus solitarius in the posterolateral portions of the medulla and lower pons. The neurons of this area receive sensory nerve signals from the circulatory system mainly through the vagus and glossopharyngeal nerves, and output signals from this sensory area then help to control activities of both the vasoconstrictor and vasodilator areas of the vasomotor center, thus providing "reflex" control of many circulatory functions. An example is the baroreceptor reflex for controlling arterial pressure.

Vasomotor tone:

Under normal conditions, the vasoconstrictor area of the vasomotor center transmits signals continuously to the sympathetic vasoconstrictor nerve fibers over the entire body. This continual firing is called sympathetic vasoconstrictor tone. These impulses normally maintain a partial state of contraction in the blood vessels is called vasomotor tone.

BLOOD PRESSURE

Def: Blood pressure is the lateral pressure exerted by the moving column of blood on the wall of the blood vessels while flowing through it.

Blood pressure= Cardiac output × Total peripheral resistance.

TYPES OF BLOOD PRESSURE:

1. Systolic pressure: It is the maximum pressure during systole.
   It is about 110-140 mm of Hg (average 120 mm of Hg).
2. Diastolic pressure: It is the minimum pressure during diastole.
   It is about 60-90 mm of Hg (average 80 mm of Hg).
3. Pulse pressure: It is the difference between systolic & diastolic blood pressure.
   It is about 30-40 mm of Hg.
4. Mean pressure: It is the average pressure throughout the cardiac cycle.
   It is about 78-98 mm of Hg. Mean pressure in large & medium sized arteries average 95 mm of Hg.
   Mean pressure= Diastolic pressure + $1/3^{rd}$ of pulse pressure.

   This is because systole is slightly less than diastole, the mean pressure is slightly less than the value halfway between systolic & diastolic pressure.

Calculation:

A young man has BP 120/80 mm of Hg. What will be his pulse pressure & mean pressure?

Ans:

Pulse pressure = systolic pressure - diastolic blood pressure

=120 mm of Hg – 80 mm of Hg

=40 mm of Hg

Mean pressure= Diastolic pressure + $1/3^{rd}$ of pulse pressure

=80 mm of Hg + (1/3×40) mm of Hg

= 80 mm of Hg+ 13.33 mm of Hg

= 93.33 mm of Hg

SIGNIFICANCE OF DIFFERENT TYPES OF BLOOD PRESSURE:

1) Systolic pressure :
   - Indicate the extent of work done by heart
   - Indicate the force with which heart is working

   (Systolic pressure increases during exercise, meal, excitement. It decreases during sleep, rest)
2) Diastolic pressure:
   - It indicates the constant load against which heart has to pump
   - Increased pressure indicates heart is approaching failure
   - The index of peripheral resistance
3) Pulse pressure: Indicates cardiac output
4) Mean pressure: Increased mean pressure causes hypertension

❖Diastolic pressure is more important than systolic pressure:

Diastolic pressure is the level at which the heart is pumping blood. If the diastolic pressure is raised, heart is doing more work. Therefore, it may be hypertrophied. So, diastolic pressure is more important than systolic pressure.

- During measurement of blood pressure, some sounds are heard known as *korotkoff sound.*

  There are 5 phases of korotkoff sound-

  1) Tapping sound
  2) Murmur
  3) Loud sound
  4) Muffle sound
  5) Sound disappears

❖Effects of exercise on blood pressure:

After exercise, systolic pressure increases due to increase in force of contraction and stroke volume.

Diastolic pressure may remain unchanged or may fall. This is because the peripheral resistance is not altered by moderate exercise.

In severe exercise, the diastolic pressure reduced because the peripheral resistance decreases due to vasodilation in the exercising muscle.

BLOOD PRESSURE REGULATION MECHANISM:

1. Short term regulation of blood pressure :(occurs within seconds)

- Baroreceptor feedback mechanism
- Chemoreceptor feedback mechanism
- CNS ischemic mechanism

2. Intermediate term regulation of blood pressure: (occurs within minutes)

- Renin-angiotensin vasoconstrictor mechanism
- Stress relaxation of vasculature
- Capillary fluid shift mechanism

3. Long term regulation of blood pressure: (occurs within hours)

- Renin –angiotensin aldosterone mechanism
- Renal body fluid mechanism

Baroreceptors:

Baroreceptors are spray-type nerve endings that lie in the walls of the arteries. They are stimulated when stretched.

Baroreceptors are located in-

- The wall of each internal carotid artery slightly above the carotid bifurcation, an area known as the carotid sinus, and
- The wall of the aortic arch.

Baroreceptors are activated when blood pressure is increased above 30 mm of Hg then previous. Baroreceptors are activated 60 mm of Hg to 180 mm of Hg.

Baroreceptor mechanism regulates blood pressure during changes in body posture. The ability of the baroreceptors to maintain relatively constant arterial pressure in the upper body is important when a person stands up after having been lying down.

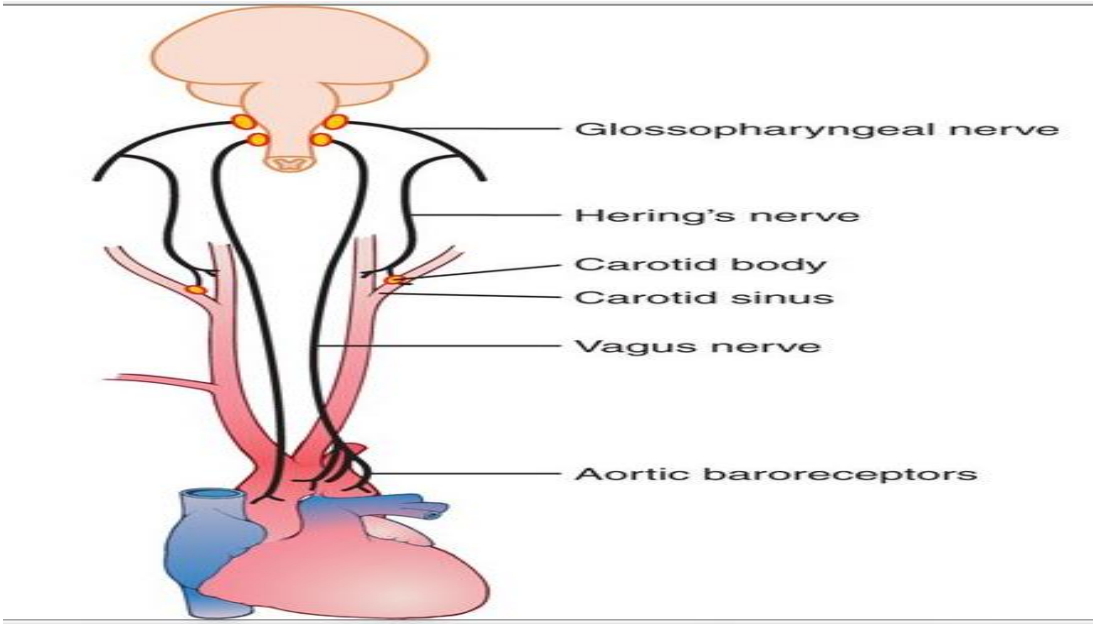
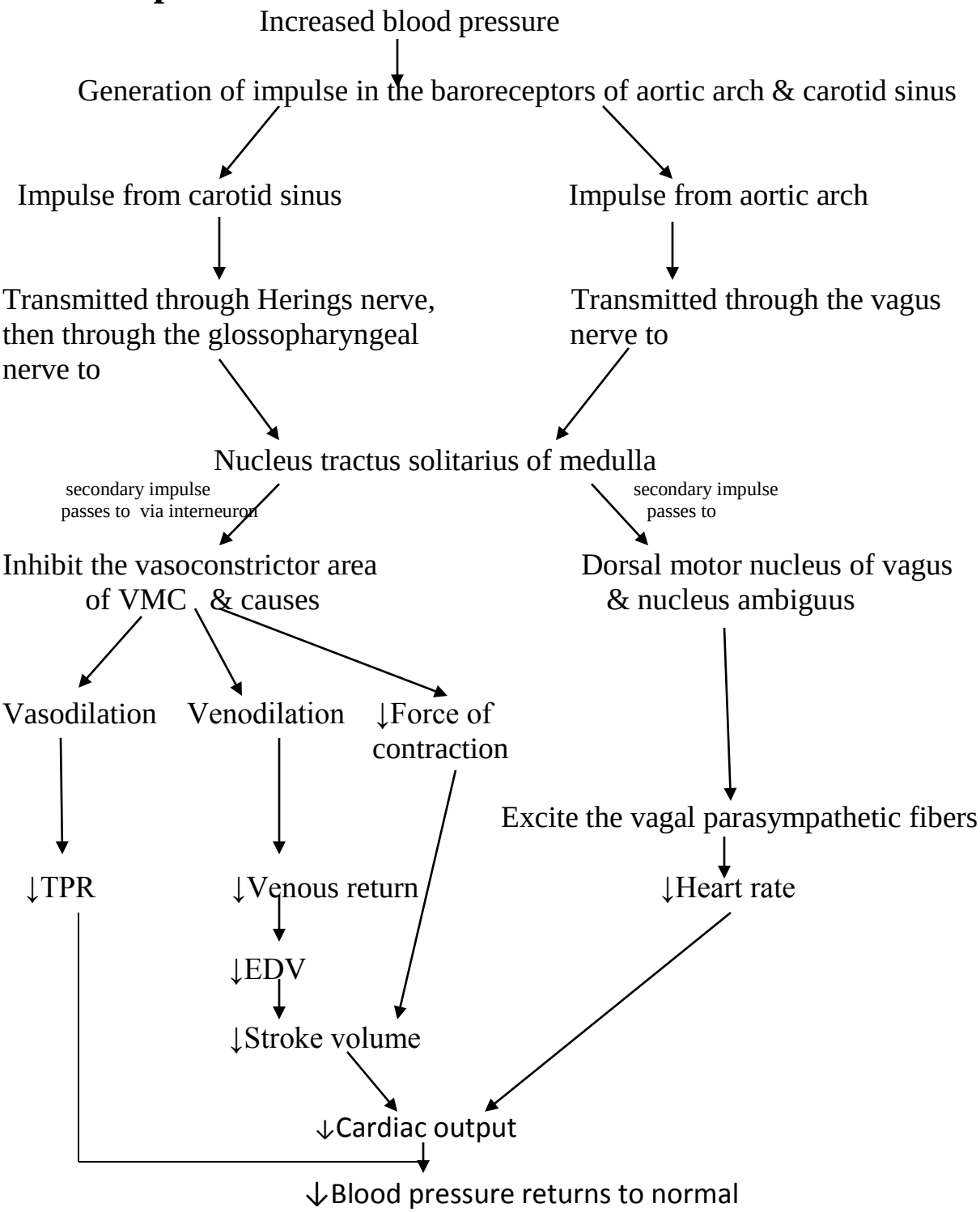


Fig: Baroreceptors

Q.Why baroreceptor system is called pressure buffer system?

Ans: Nerve from the baroreceptor is called buffer nerve. Baroreceptor system opposes either increases or decreases in arterial pressure, so it is called pressure buffer system.

Baroreceptor feedback mechanism:



Conversely, when BP is decreased, the reversed effects occur and blood pressure rises back towards normal.

Chemoreceptor feedback mechanism:

Sites of chemoreceptors-

Carotid bodies
Aortic bodies

Chemoreceptors are sensitive to the O_2 lack, CO_2 excess or H^+ excess.

Chemoreceptor mechanism:

↓Blood pressure

↓

↓Blood flow to chemoreceptor

↓

↓O_2, ↑CO_2, ↑H^+ in the chemoreceptor

↓

Chemoreceptors are stimulated

↓

Signal goes to vasomotor centre

↓

Stimulation of vasomotor centre

↓

Vasoconstriction

↓

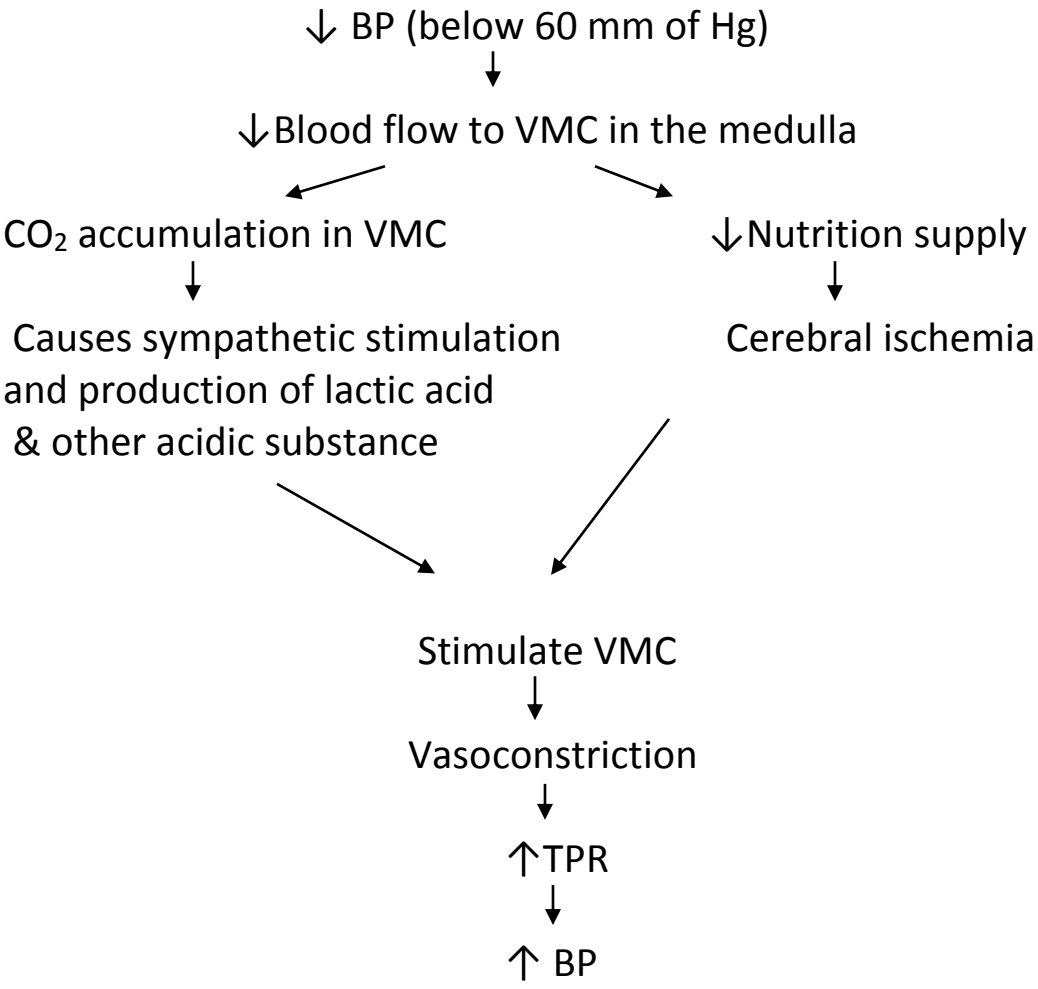
↑TPR

↓

↑BP

CNS Ischemic mechanism:

Increase in arterial pressure in response to cerebral ischemia is known as the *central nervous system (CNS)* ischemic response.

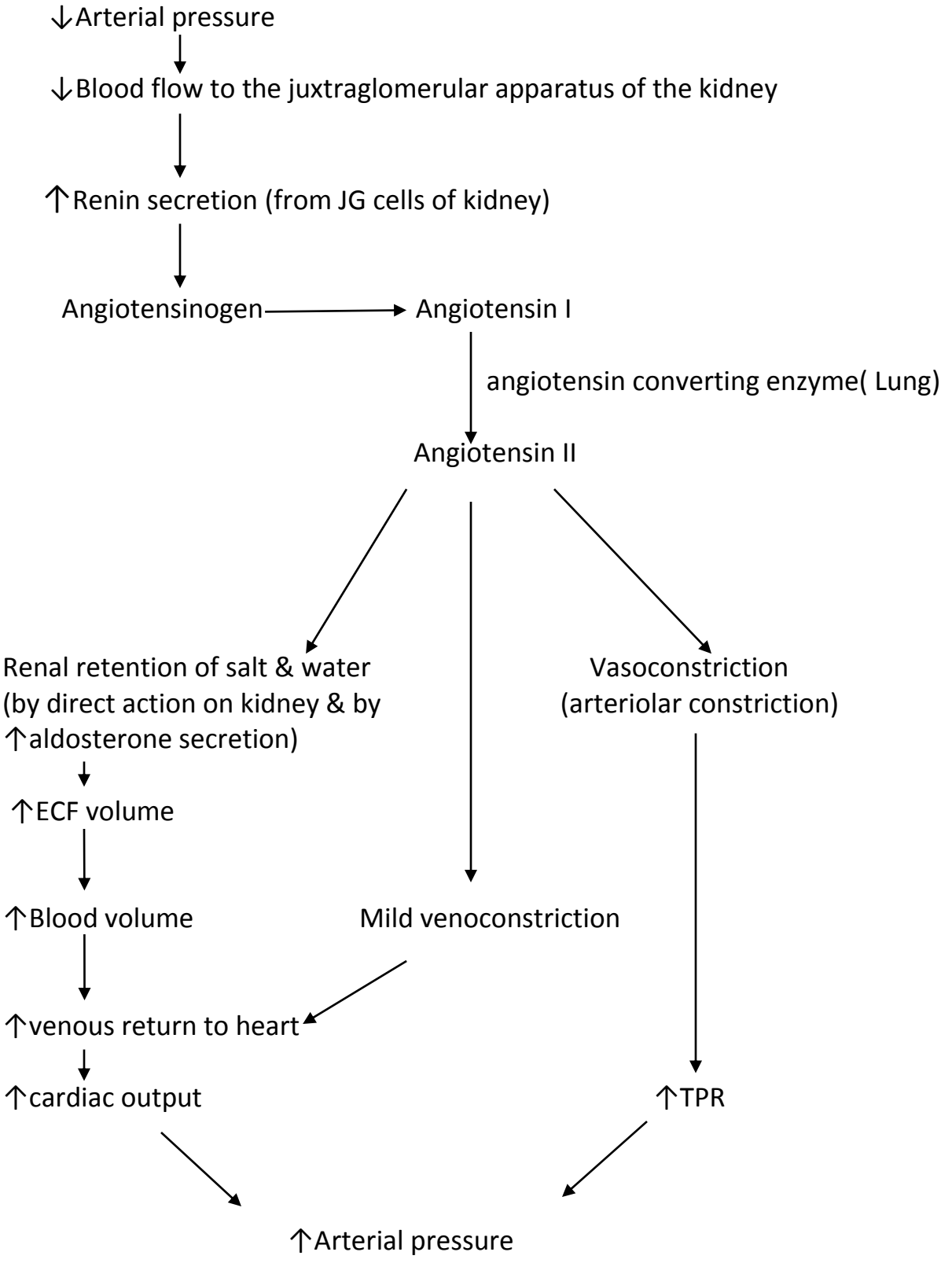


Importance:

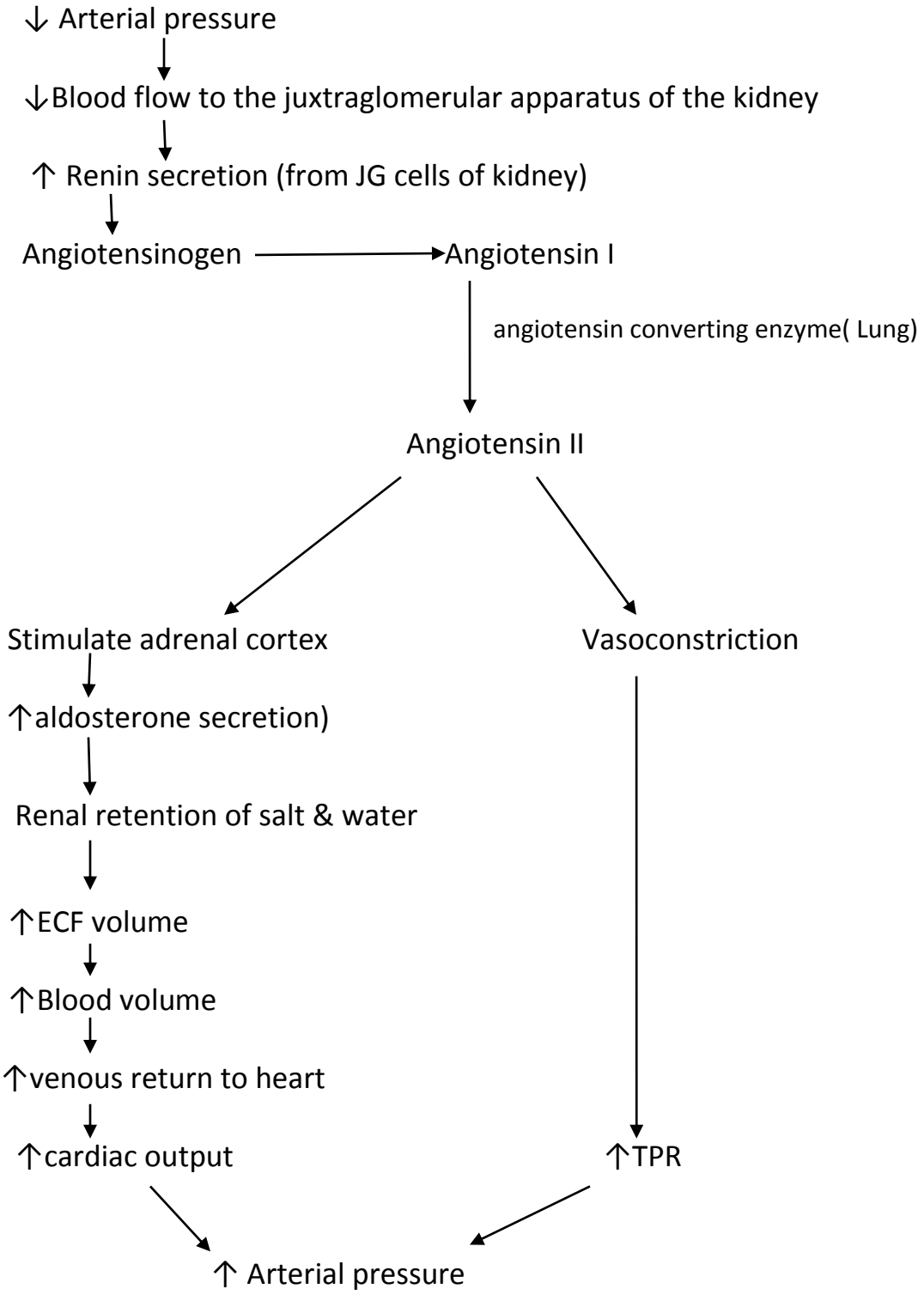
CNS Ischemic Response is activated when the arterial pressure below 60 mm Hg. This mechanism is more activated when pressure is 15 to 20 mm Hg. It is an emergency pressure control system that acts rapidly and very powerfully to prevent further decrease in arterial pressure whenever blood flow to the brain decreases dangerously close to the lethal level.

It is sometimes called the "last ditch stand" pressure control mechanism.

Renin-angiotensin vasoconstrictor mechanism for arterial pressure control:



Renin-angiotensin aldosterone mechanism for arterial pressure control:



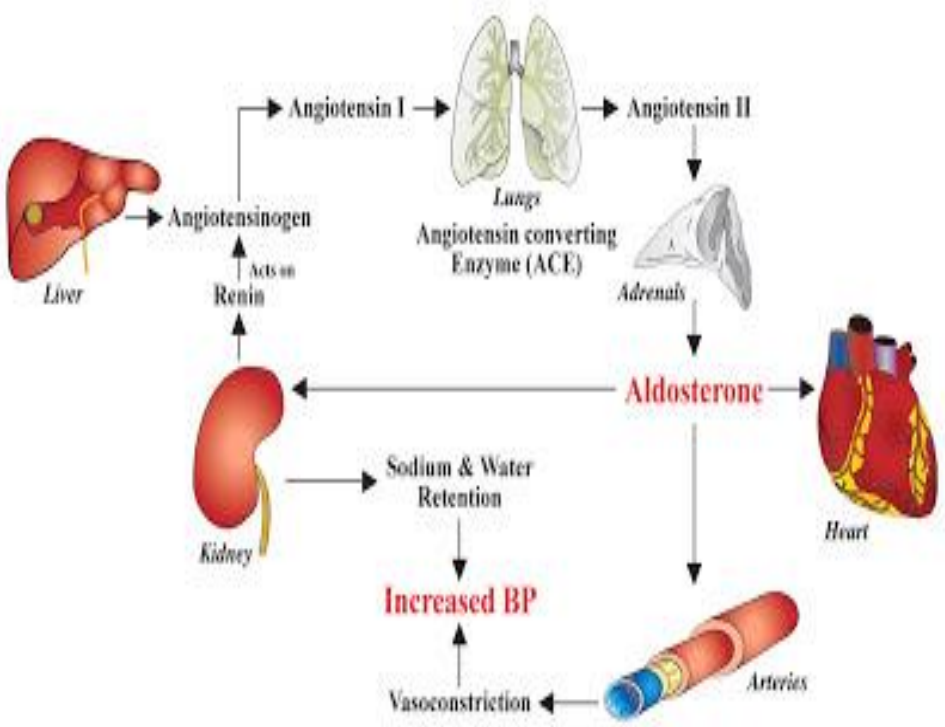


Fig: Renin angiotensin mechanism

Renal body-fluid feedback mechanism for control of arterial pressure:

↓ Arterial pressure

↓

↓ Renal output of salt & water

↓

Salt & water accumulation

↓

↑ECF volume

↓

↑ Blood volume

↓

↑Mean circulatory filling pressure

↓

↑Venous return

↓

↑Cardiac output

↓

↑Arterial pressure returns to normal

Hypertension: It is a clinical condition characterized by persistent rise of systemic arterial pressure above the normal range.

A mean arterial pressure greater than 110 mm Hg is considered to be hypertensive.

Types:

1. Essential (primary) hypertension
2. Secondary hypertension

Essential (primary) hypertension: Means the hypertension is of unknown origin. About 90 to 95 percent hypertensive patient suffer from essential hypertension.

In most patients, excess weight gain and a sedentary lifestyle play a major role in causing hypertension.

Secondary hypertension: In about 5% cases, hypertension is due to consequence of a specific disease or abnormal salt retention or peripheral vasoconstriction.

Causes:

- Alcohol
- Pregnancy
- Pheochromocytoma
- Cushing syndrome
- Polycystic kidney disease

Factors affecting BP

- **Sex** M > F …due to hormones/ equal at menopause.
- **Age** Elderly > children …due to atherosclerosis.
- **Emotions** ↑ due to secretion of adrenaline & noradrenaline.
- **Exercise** ↑ due to ↑ venous return.
- **Hormones** …↑ (e.g. Adrenaline, noradrenaline, thyroid H).
- **Gravity** ↑ Lower limbs > upper limbs.
- **Race** Orientals > Westerns … ? dietry factors, or weather.
- **Sleep** ↓ due to ↓ venous return.