

1. Homeostasis | Functional Organization of the Human Body and Control of the "Internal Environment"

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Human Physiology

↳ Attempts to explain the specific characteristics and mechanism of human body that make it a living being.

- 25 trillion RBC
- 100 trillion (entire body) cells

* 60% of adult human → fluid.

2/3rd of it → ICF

1/3rd of fluid - ECF (extracellular fluid)

* The extracellular fluid is also called **internal environment of the body**.

Or the **milieu interieur**

↳ coined by Claude Bernard.

* **Extracellular** | **Intracellular**

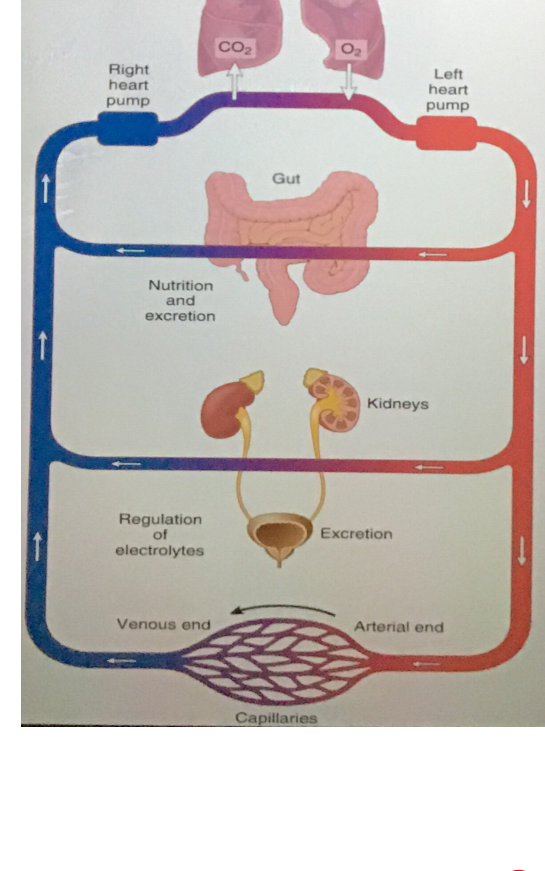
- Large amount of Na, Cl⁻ & bicarbonate
- Nutrients for cells
- O₂, glucose, fatty acid, amino acid.
- Large amount of K⁺, Mg²⁺ & Phosphate ions.

Homeostasis

↳ coined by Walter Cannon in 1929.

* **Disease** - state of disrupted homeostasis.

The discipline of **pathophysiology** seeks to explain how the various physiological processes are altered in diseases or injury.



- Overall circular of blood.

* On average, all the blood in the circulation transverse the entire circulation once/min. at rest.

* And as many as 6 times when super active.

Example of Control Mechanism

(**Baroreceptor System**) - Present in the walls of bifurcation region of the carotid arteries in the neck & in the arch of aorta in the thorax.

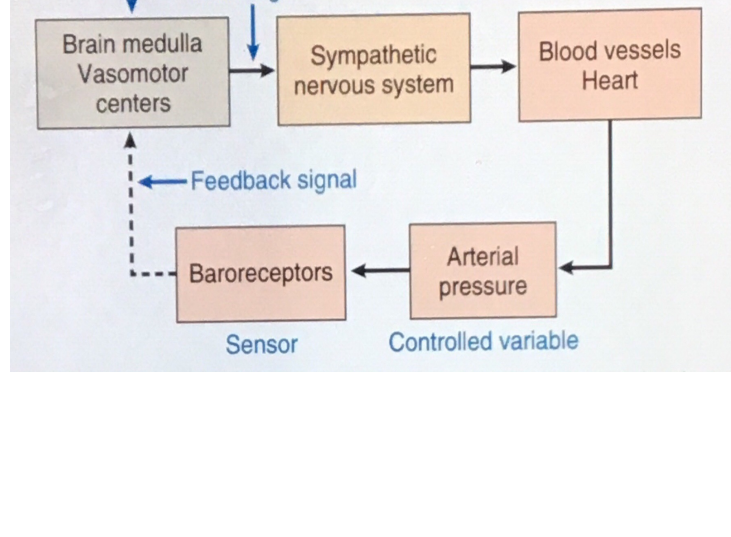


Fig: -

Negative feedback control of arterial pressure by the arterial baroreceptors. Signals from the sensor (baroreceptors) are sent to medulla of the brain, where they are compared with a reference set point. When arterial pressure increases above normal, this abnormal pressure increases nerve impulses from the baroreceptors to the medulla of the brain, where the input signals are compared with the set point, generating an error signal that leads to decreased sympathetic system activity. Decreased sympathetic activity causes dilation of blood vessels and reduced pumping activity of the heart, which return arterial pressure toward normal.

Normal Range of ECF

	Normal Value	Normal Range	Approximate Short-Term Nonlethal Limit	Unit
Oxygen (venous)	40	35-45	10-1000	mm Hg
Carbon dioxide (venous)	45	35-45	5-80	mm Hg
Sodium ion	142	138-146	115-175	mmol/L
Potassium ion	4.2	3.8-5.0	1.5-9.0	mmol/L
Calcium ion	1.2	1.0-1.4	0.5-2.0	mmol/L
Chloride ion	106	103-112	70-130	mmol/L
Bicarbonate ion	24	24-32	8-45	mmol/L
Glucose	90	75-95	20-1500	mg/dl
Body temperature	98.4 (37.0)	98-98.8 (37.0)	65-110 (18.3-43.3)	°F (°C)
Acid-base	7.4	7.3-7.5	6.9-8.0	pH

Characteristics of Control System

(a) Negative feedback

- Most control system in our body.
- As in CO₂ regulating mechanism, Arterial pressure - reg. mech.

Gain of a Control System :-

The degree of effectiveness by which a control system stabilises itself.

As:- 1st person with no baro-receptor } 2nd person with baroreceptor system.
 100 mm Hg → 175 mm Hg } 100 mm Hg → 125 mm Hg
 Δ = 75 mm Hg } Δ = 25 mm Hg

Correction of -50

$$\text{Gain} = \frac{\text{Correction}}{\text{Error}}$$

$$\text{gain} = \frac{-50}{25} = -2$$

Gain & Effectiveness of a system

(with -ve sign)

(b) Positive feedback :-

↳ Sometime cause vicious cycle and Death.

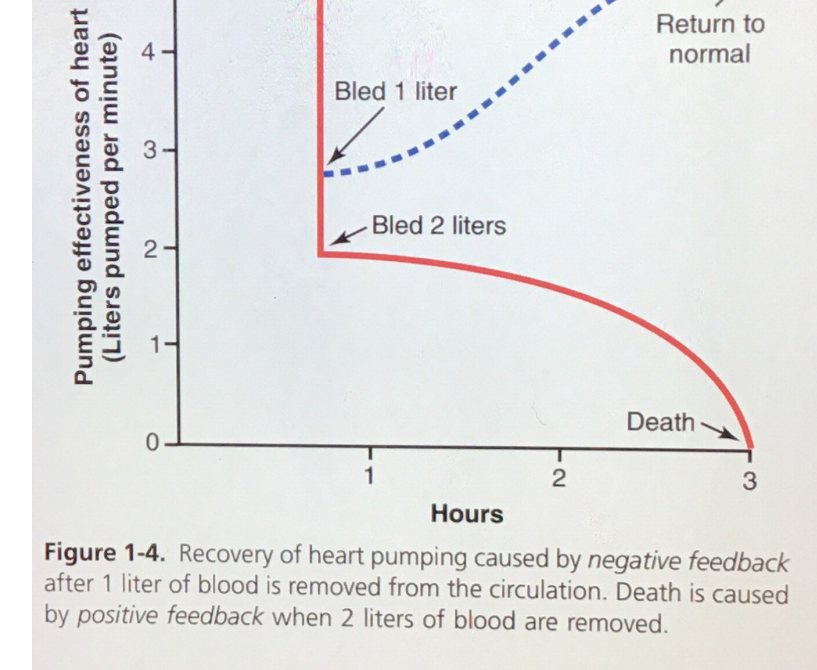


Figure 1-4. Recovery of heart pumping caused by negative feedback after 1 liter of blood is removed from the circulation. Death is caused by positive feedback when 2 liters of blood are removed.

Figure 1-4 shows an example in which death can ensue from the positive feedback. This figure depicts the pumping effectiveness of the heart, showing that the heart of a healthy human being pumps about 5 liters of blood per minute. If the person is suddenly bled 2 liters, the amount of blood in the body is decreased to such a low level that not enough blood is available for the heart to pump effectively. As a result, the arterial pressure falls and the flow of blood to the heart muscle through the coronary vessels diminishes. This scenario results in weakening of the heart, further decrease in pumping, a further decrease in coronary blood flow, and still more weakness of the heart; the cycle repeats itself again and again until death occurs. Note that each cycle in the feedback results in further weakening of the heart. In other words, the initiating stimulus causes more of the same, which is positive feedback. Positive feedback is better known as a "vicious cycle," but a milder degree of the same, which is negative feedback control mechanisms of the body, and the vicious cycle then fails to develop. For instance, if the person in the aforementioned example is bled only 1 liter instead of 2 liters, the normal negative feedback mechanisms for controlling cardiac output and arterial pressure can counterbalance the positive feedback and the person can recover, as shown by the dashed curve.

* Positive feedback can sometimes be useful :-

- (1) Blood clot.
- (2) Child birth.
- (3) Nerve signal.

* Actually +ve feedback is a part of -ve feedback.

(c) Feed-forward Control :-

(Adaptive control)

- Again and again signal until it is corrected.
- It, in a sense, is a negative feedback.

