

WELCOME

TO

PHYSIOLOGY DEPARTMENT

Undergraduate Medical Student

Four phases

First little disappointing

- Neither you see patients nor learn about drugs
- Confined to classrooms and laboratories learning about normal structure/ functions of human body

Disease is nothing but deviation from normal

Unless you understand normal
you cannot understand abnormal

Second

- Start seeing patients
- Continue learning in classrooms /laboratories about
 - Disease process
 - Germs
 - Scientific basis of drugs as therapeutic tools
 - Legal medicine

By the end of second phase, foundation laid

Third

Build on the foundation of phase one and two

- Start learning the clinical subjects
- Start examination of patients

At the end of third phase

Final Examination

Still you are not qualified to assume full responsibility of patients

Fourth

- Skill oriented training
- Period of rotating internship of one year

During which patient care is taken under the supervision of senior physician/ surgeons

Special Subject

Community Medicine / Preventive and Social Medicine

- Taught during whole course of MBBS.
- Given much importance because prevention is not only better but easier and cheaper than cure
- Prevention does not mean preventing the disease from occurring but it covers an entire spectrum starting with **The positive concept of health promotion & reduction in the adverse effect of illness**

Hippocrates- Greek Physician

Charaka - Indian Physician

Susruta - Indian Surgeon

Physiology

- Concept based
- Discuss
- Corelate

Physis -- nature logos -- discourse

Physiology --- Knowledge of nature

The term physiology was used as a synonym for natural philosophy.

(philein: to love, Sophia: wisdom).

A student of nature has to be a lover of wisdom.

Physiology and Philosophy taken as same

Physiology

study of function of living organisms

Philosophy

study of wisdom

Physiology

- is the science of functioning of living systems
- and the scientific methods applied to determine how organisms/ systems/ organs/ cells/ biomolecules carry out the chemical / physical functions in a living system

Beginning of physiology

In Ancient Greece, **Aristotle** emphasised on the relationship between structure and function

Galen, was the first scientist to use experiments to probe the function of the body. He laid great stress on teleology, looking for a purpose in everything in body

Galen was the founder of experimental physiology

William Harvey

- First physiologist of the world
- He discovered circulation of blood

Herman Boerhaave (1660-1738)

- sometimes referred to as a father of physiology
- first described the term Physiology for the science of body functions
- established Physiology as an independent discipline in medical curriculum

Albrecht von Haller (1708-1777)

wrote the first textbook of physiology,
Elementa Physiologiae

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Claude Bernard (1813–1878)

- propounded the concept of “**milieu interieur**”
(internal environment)

His statement was that living organisms are never at rest but constantly undergo to maintain internal equilibrium.

**He established Physiology as
scientific basis of medicine**

The concept of **constancy of internal environment** was further elaborated and championed as

HOMEOSTASIS

by American physiologist **Walter Cannon**
(1871–1945).

Physiology as Scientific basis of Medicine

- Life is a dynamic process
- Cells of the body work like machines, consume fuels and produce waste
- Optimum environment required
 - Right composition of ECF
 - Appropriate pH
 - Temperature et

- Each organ-system makes some contribution towards providing optimum conditions for the functioning of all the cells of body
- With the cooperative/coordinated activity of all parts of body, the conditions under which cells function are maintained at a reasonably constant level

This constancy is known as homeostasis

<i>Homoio</i>	similar
<i>Stasis</i>	position

- The basis of health is the organism's success in maintaining this balance, the concept elaborated by Cannon who named the dynamic state as homeostasis
- He showed that the body could adjust to meet serious external/internal danger.

Homeostasis

1

Study of physiology is essentially a study of how each organ-system contributes to homeostasis.

Threat to homeostasis

The dynamic nature of life

The hostile forces in our environment

Our body is equipped

- To face the threat
- To detect the challenges
- To appropriate response to neutralize the challenge.

Homeostasis

Health depends on the success of these responses

- When the responses are inadequate in relation to the challenge, person falls ill
- But even in illness, recovery from illness depends on the same type of responses which operate in good health
- The fact had been recognized by **Hippocrates as long ago as 400 BC when he stated**

The body possesses the means for its recovery from illness

Staying healthy



Avoid needless challenge

Overuse of body

Misuse of body

Dust inhalation

Dim light

Heavy weight lifting

Improve response

Healthy food

Healthy lifestyle

Exercise

Duty as Doctor (during illness)

Re-assurance

1. Every thing will be fine

(Homeostasis takes care of challenge)

2. Not to be impatient

(Homeostasis takes some time for correction)

3. Some measures to assist the body in its struggle against the disease

4. To detect the cause

Either challenge is more or response is less

Work with nature, not against it

and for that you need knowledge of physiology

Control system

- Negative feedback
- Positive feedback - Vicious cycle – adverse effect/useful effect
- Adaptive control

Control Systems

- A control system is basically designed to maintain a controlled variable at a **set point**
- The value of the controlled variable is continuously monitored by a **sensor**
- The current value of the controlled variable is conveyed by the sensor to controller in the form of a **feedback signal**

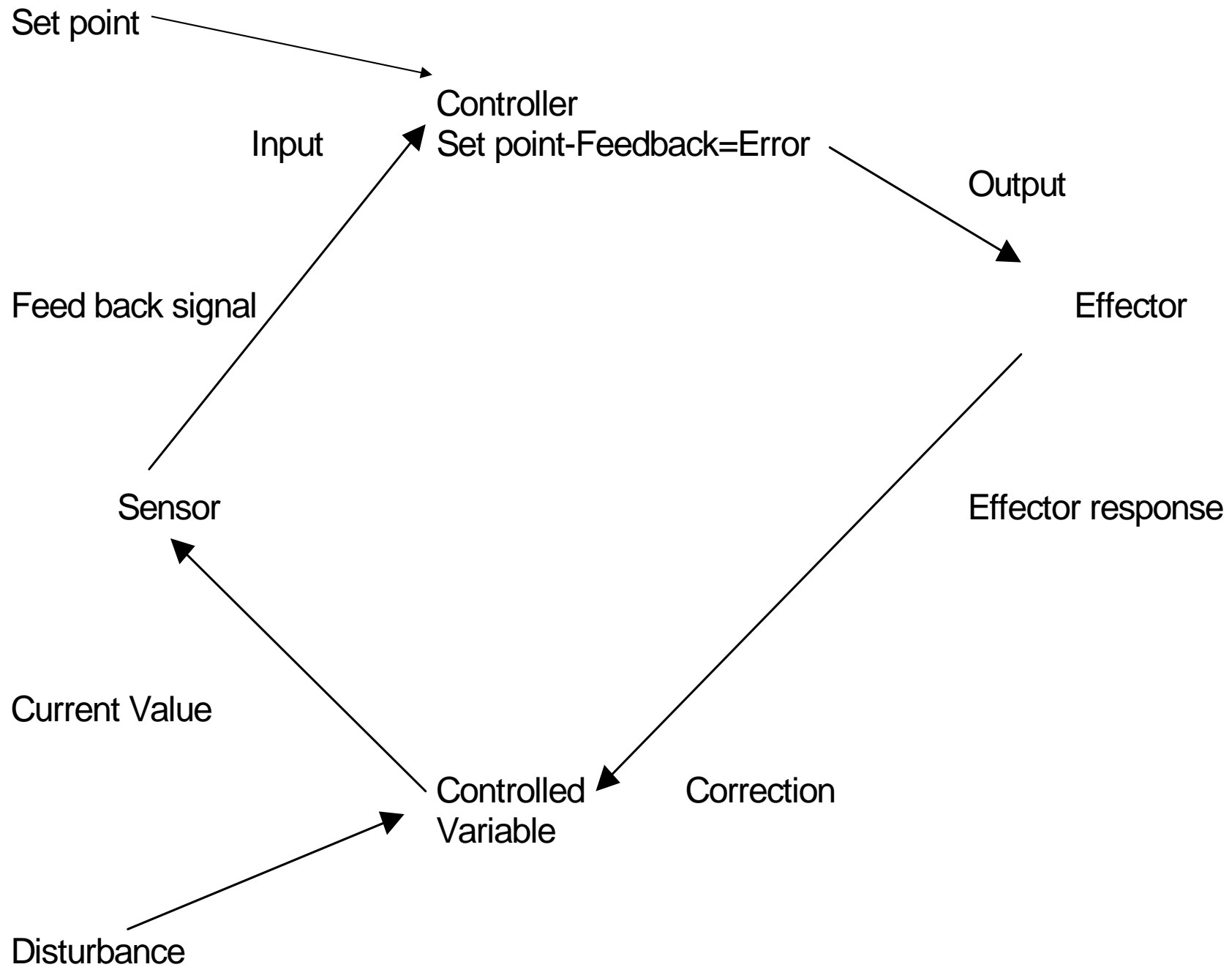
Control Systems

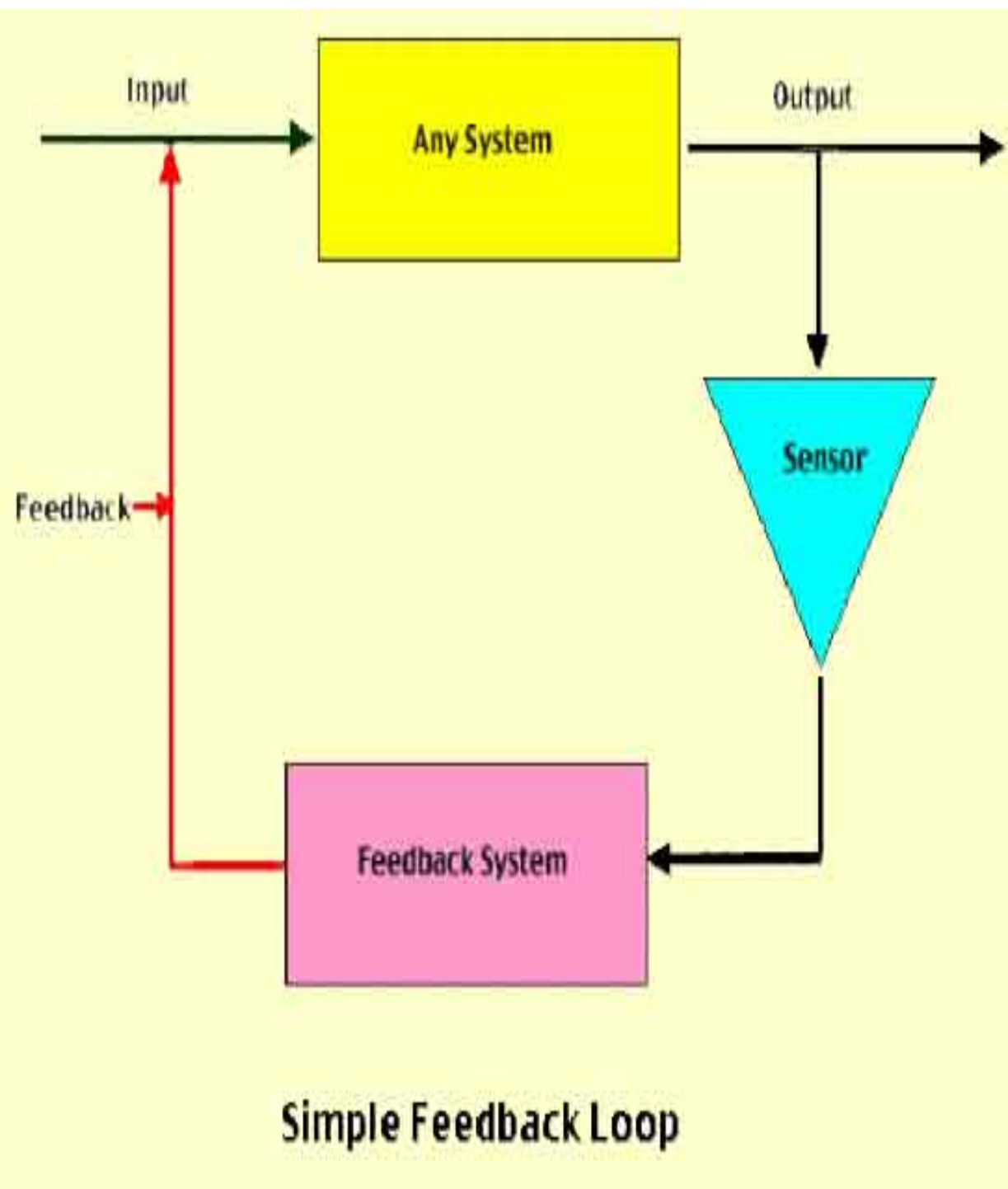
- The feedback signal is naturally affected by any **disturbance** which alters the value of the controlled variable
- The controller compares the feedback signal with the set point and the difference between the two is called the **error**
- The output of the controller conveyed to an **effector**

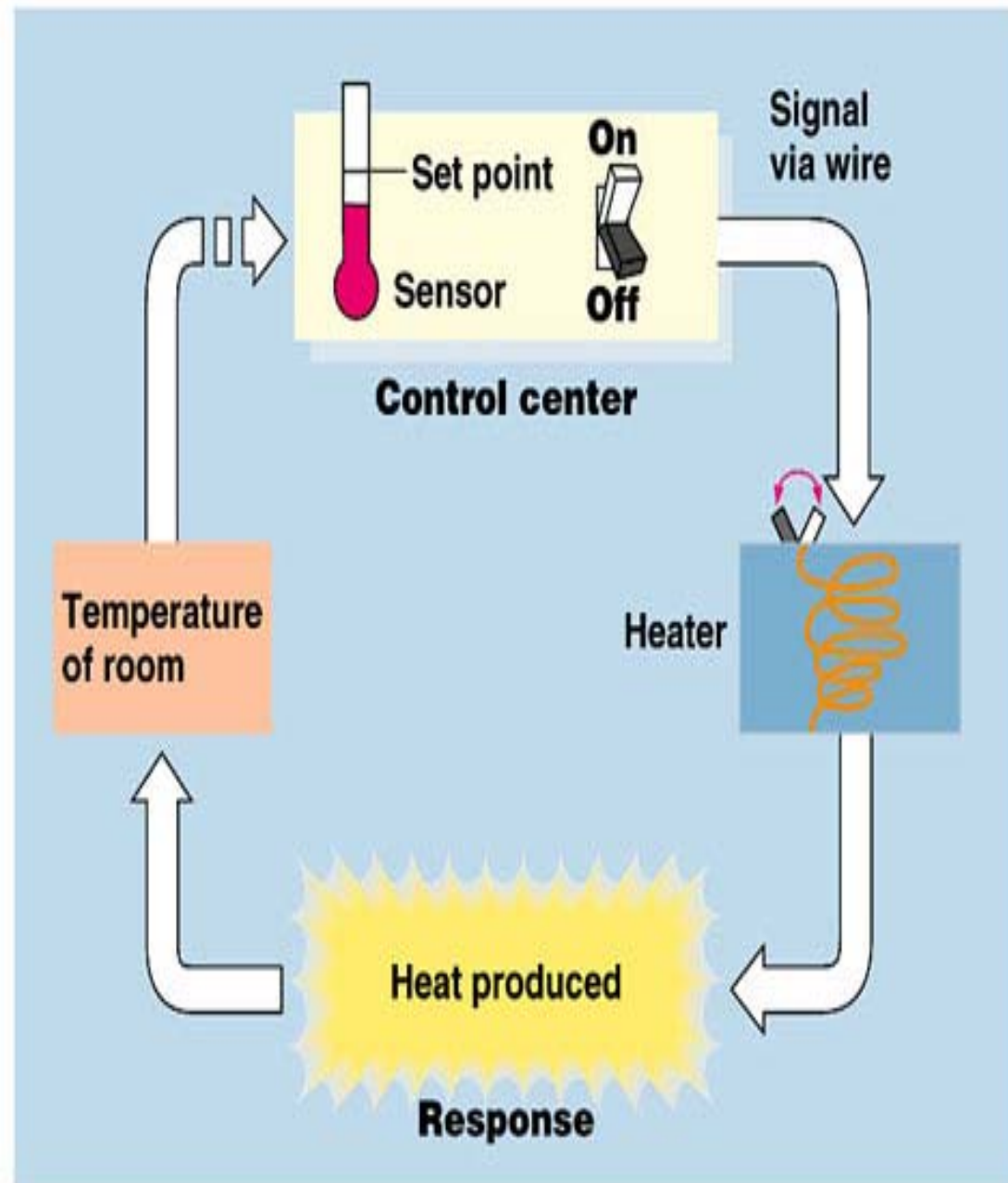
Control Systems

- As a result, the effector applies a correction which takes the controlled variable towards the set point
- Most of the regulatory system of body follows this characteristic pattern

A control system such as this one is called a negative feed back system because the effector response is negative to the initiating stimulus (disturbance)

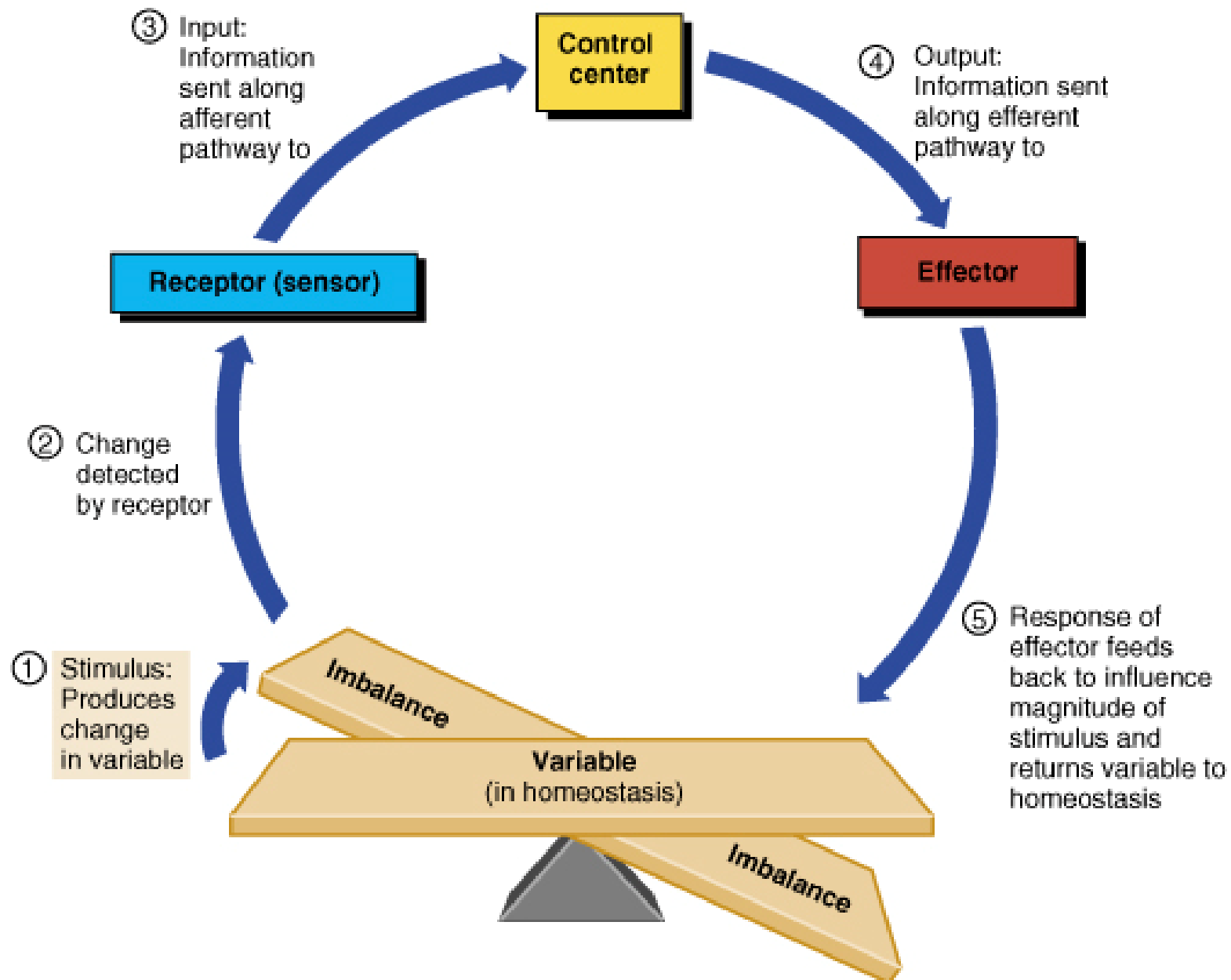


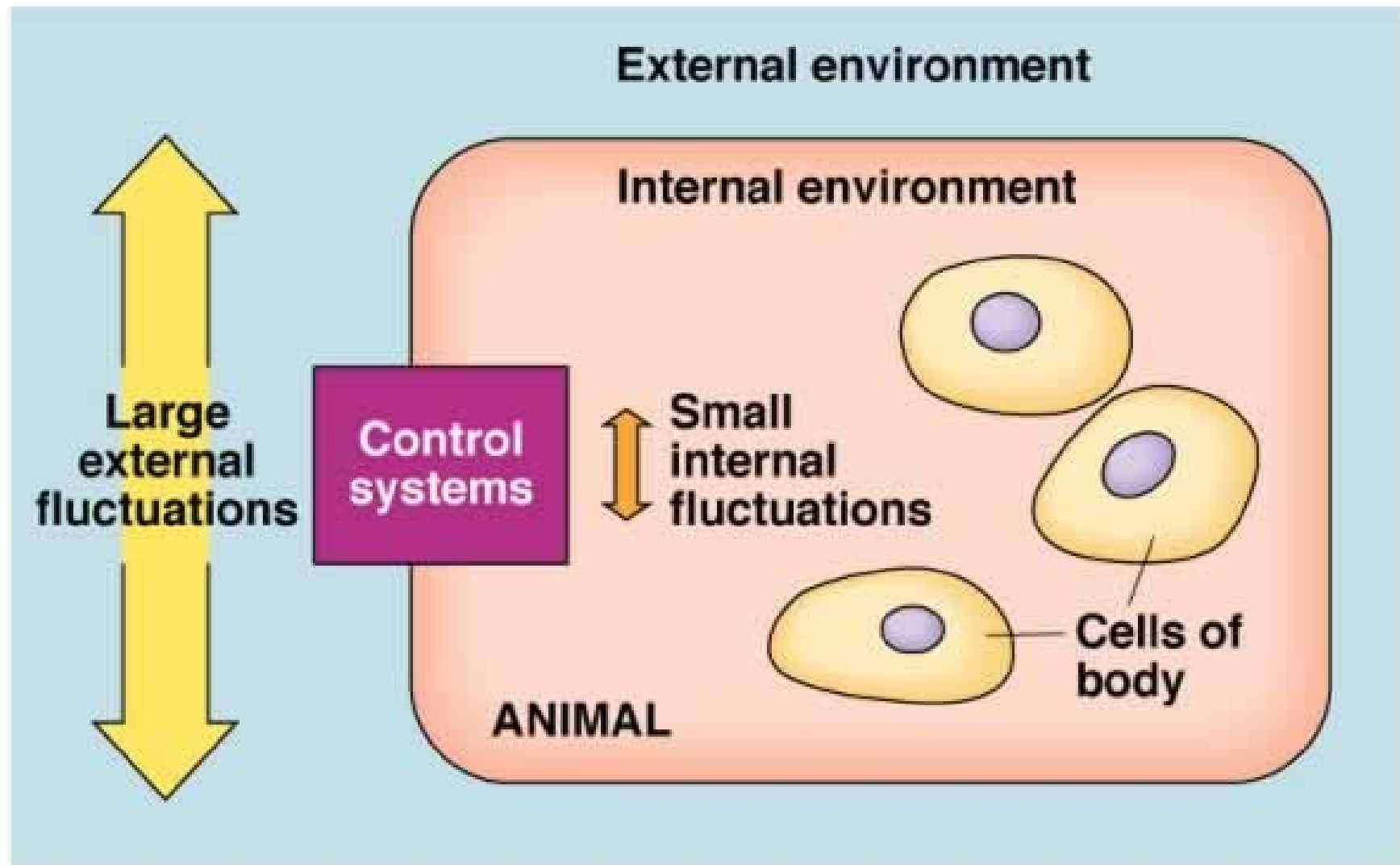




(a) Control of room temperature

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POSITIVE FEEDBACK

- If a disturbance increases the value of controlled variable, the controller will respond to disturbance by increasing the value of controlled variable still further
- Now the feedback signal gets still stronger resulting in a still stronger response
- Thus the control system actually **increases the rate** at which the disturbance would produce its effect and also increases **magnitude** of the effect.

Positive feedback

- Less common in the body
- Whereas negative feedback systems are designed to resist change, positive feedback systems reinforce change
- Positive feedback systems move the controlled variable even further away from a steady state

Example

Using the furnace and temperature example, the room would get progressively hotter

Positive feedback-- useful

- During labour, uterine contractions push the fetus towards cervix. Stretching of cervix stimulates uterine contraction by positive feedback
- Blood coagulation reactions are autocatalytic in nature, thrombin triggers the formation of more thrombin (Cascade)

Positive feedback- Vicious cycle - harmful

Force of contraction in heart decreases in
circulatory shock

Positive / Negative feedback

Mild degree of positive feedback can be overcome by negative feedback and vicious cycle fail to develop

Regulation

1. Nervous system
2. Endocrine system (Hormones)

Coupling

- Sometimes two control systems are coupled -- when simultaneous changes in effectors of both are likely to be useful
- Hypoxia stimulates respiration
- But because of the coupling of respiratory and cardiovascular control systems, the BP also rises simultaneously

- In hypoxia, if in addition to hyperventilation, the blood pressure also rises, it is helpful because it increases blood flow through the organs
- Similarly fall in BP stimulates respiration thus increasing the oxygen availability

REGULATORY FACTOR (R)

is a measure of accuracy of regulation

Disturbance leads to some residual change in the controlled variable in spite of regulatory system, but, to a lesser extent.

$$R = \frac{\text{Change with regulation}}{\text{Change without regulation}}$$

Gain of control system

- The degree of effectiveness with which a control system maintains constant condition is determined by the gain of negative feed back
- The control system is not 100 % efficient
- Some error always remain ,
- Gain is

$$\frac{\text{correction}}{\text{error}}$$

How to calculate Gain

BP – 120 mm of Hg

Hmg occurs and BP becomes

100 mm with regulation and

60 mm without regulation

Error -- 20 mm

Correction 40 mm

Gain $40 / 20 = 2$

- Correction – 40 mm
- error ---- 20 mm
- Gain $40 / 20 = 2$

Gain

BP 100 BT given → 175mm hg
 (BR not functioning)

 ↓
 125mm hg
 (BR functioning)

CORRECTION-- 50mm hg

BP \uparrow 25mm hg remains-- called **Error**

GAIN

Gain--- Correction / Error

$$50 / + 25 = 2$$

A cold exposure which is expected to bring the body temperature down to 20°C actually brings it down only to 36.5°C.

Thus the observed change is only 0.5°C

Expected change without regulation 17°C

Correction 16.5°C

Gain $16.5^{\circ}\text{C} / 0.5^{\circ}\text{C} = 33$

The gain of the system is 33.

Gain in temp control in cold is -33

Anticipatory Control

- Some variables, which are regulated very accurately, are controlled by anticipating a disturbance.
- Instead of monitoring only the controlled variable, the controller also monitors the factors which may lead to a disturbance.
- In this way the correction can be initiated before the disturbance has actually taken the value of the controlled variable much away from the set point

Temperature homeostasis

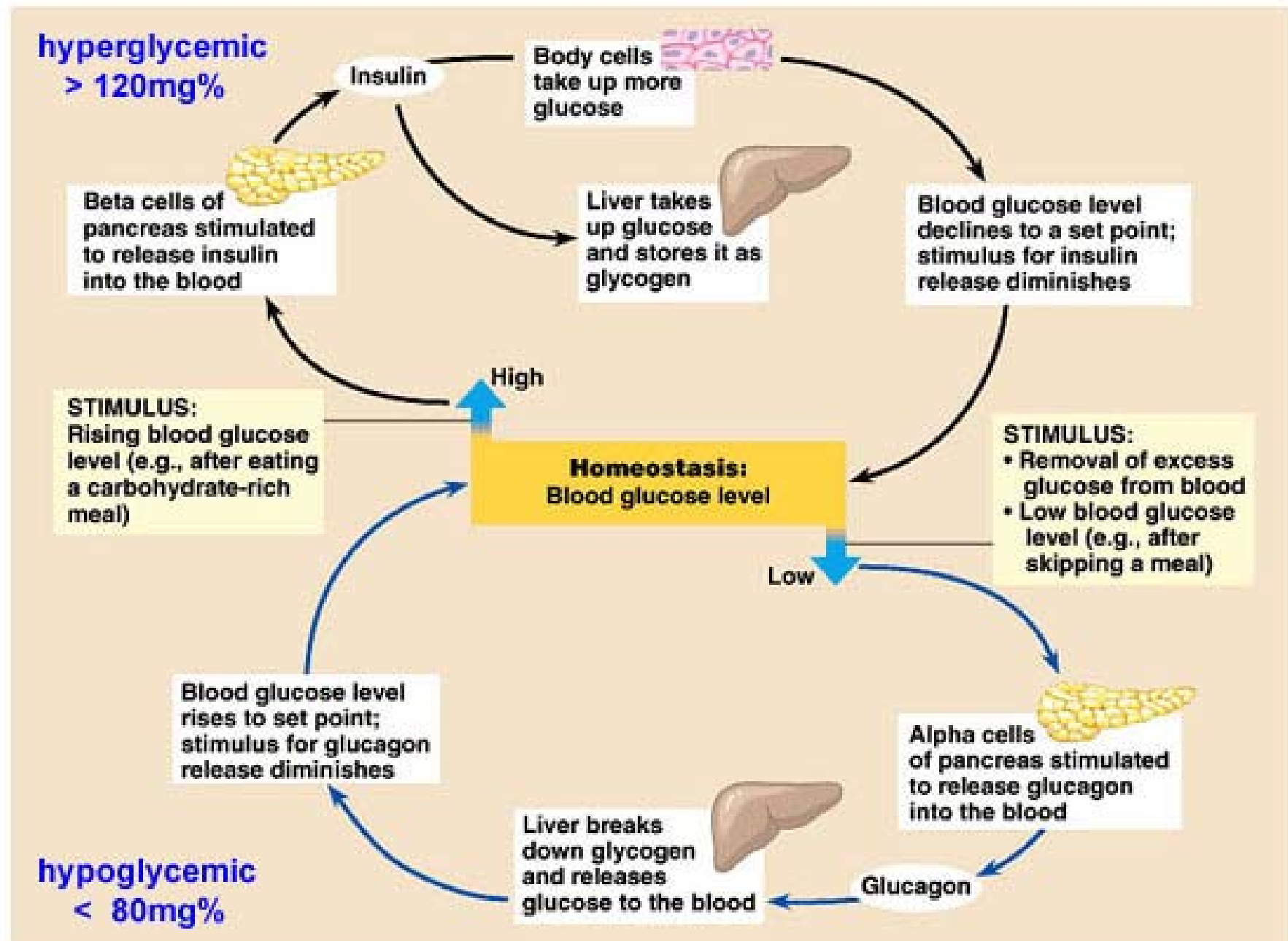
In humans, temperature is controlled by the **hypothalamus**.

The thermoregulatory centre receives input from two sets of thermoreceptors

- a. Receptors in the hypothalamus monitor the temperature of the blood as it passes through the brain (the core temperature)
- b. receptors in the skin monitor the external temperature.

Thermoregulation

- The hypothalamic thermo-sensors detect changes in the controlled variable - body temperature
- In addition, the hypothalamic controller also monitors the environmental temperature by being in touch with the cutaneous thermoreceptors
- Thermoregulatory responses is initiated before the changes in environmental temperature have succeeded in changing body's core temperature
- That is why thermoregulation has such a high gain



Complexities in Control systems

Servomechanisms

- In some control systems, the set point is not a fixed entity
- The stretch reflex which regulates muscle length is an example of a servo mechanism
- The resting muscle length of a given skeletal muscle changes in different positions of limb
- the set point at which the length is regulated is different in different positions of the limb.

QUESTION --

If we have homeostatic mechanisms for regulating blood pressure , why do some people get hypertension ?

