Homeostasis

Def. – maintenance of the constancy of the internal environment of the body.

Internal environment – milieu interieur
extracellular fluid which includes interstitial fluid.

Volume and composition of this fluid should be maintained constant (within narrow limits) in spite of changes in external environment for the normal function of cell.

Failure of homeostasis leads to disease

Control systems of the body –

- genetic control in all the cells

- systems working within the organs

control function of individual organs

- systems operating throughout the

entire body to control interrelation between the organs

Composition of ECF is same all over the body because of constant mixing of interstitial fluid and blood and circulation of blood

Some regulating systems and their functions –

Resp. system - CO_2 content

Liver and pancreas – glucose

Kidney – conc. of ions

CVS – blood flow and temp regulation

Nervous and endocrine systems regulate the function of other systems

Components of control system –

1. sensor to detect disturbance,
2. controlling center,
3. effector

Homeostatic Mechanisms-

1. Negative feedback mechanism
2. Positive feedback mechanism
3. Feed forward or anticipatory mechanism

Imp

1.Negative feedback mechanism –

- most common

- the effect of controlling system is in the opposite direction of change in the parameter so that disturbance is minimized.

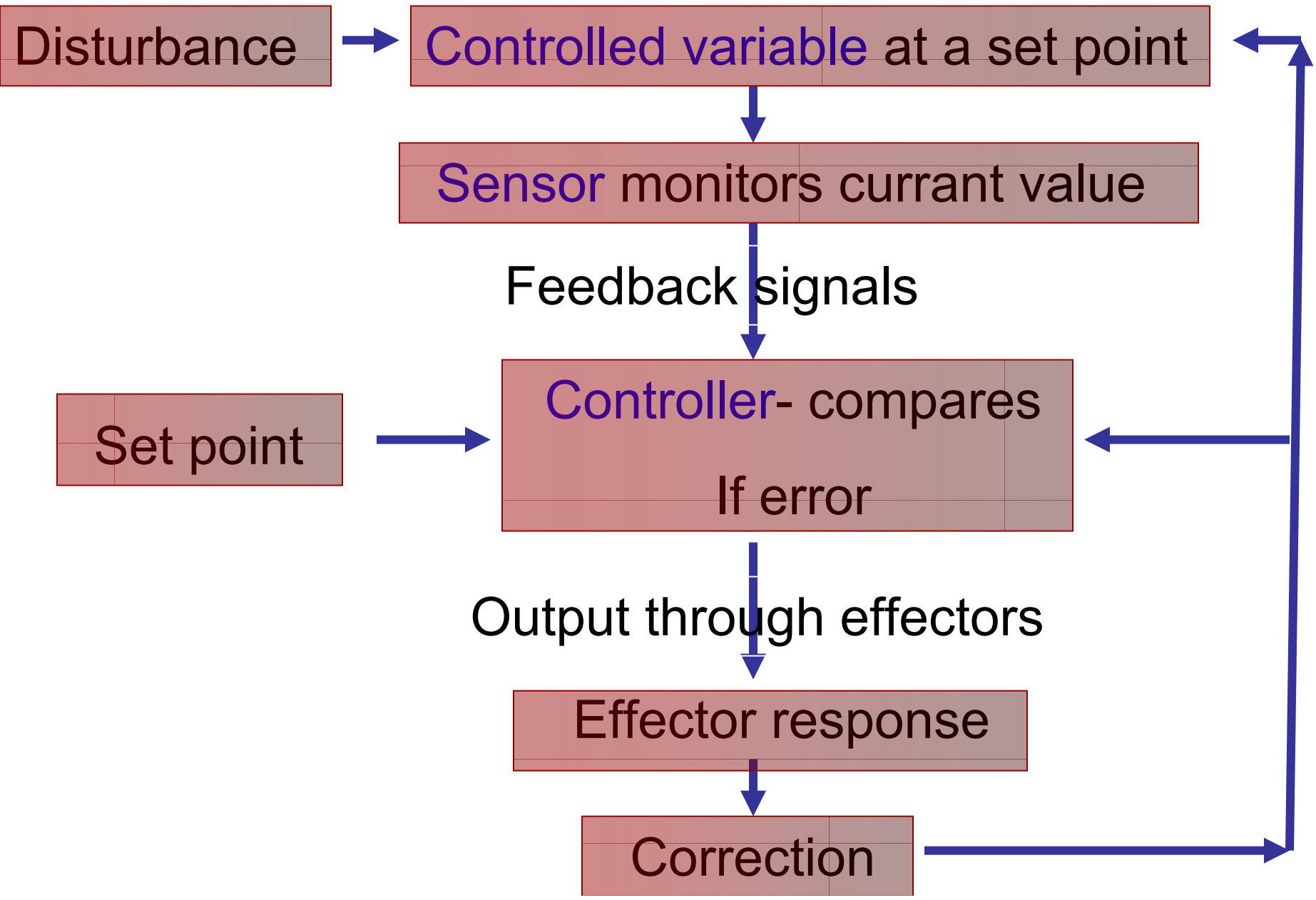
e.g.

regulation of blood pressure by baroreceptors,

regulation of hormonal secretion,

regulation of P_{CO2} of ECF.

Components of -ve feedback regulation



Characteristics –

-the disturbance is not corrected immediately – latency – dead time so oscillations are possible

-The disturbance is not corrected completely – residual change

-Regulation factor = change with regulation / change without regulation

-Effectiveness of regulating system –

Gain =

correction applied / residual change

-ve feedback mechanism

E.G. if large vol of blood is transfused without baroreceptor system increase in blood pressure is 100 mmof Hg to 175 mm of Hg and with baroreceptors it is 125 mm of Hg then,

Regulation factor is 25 / 75 = 1/3

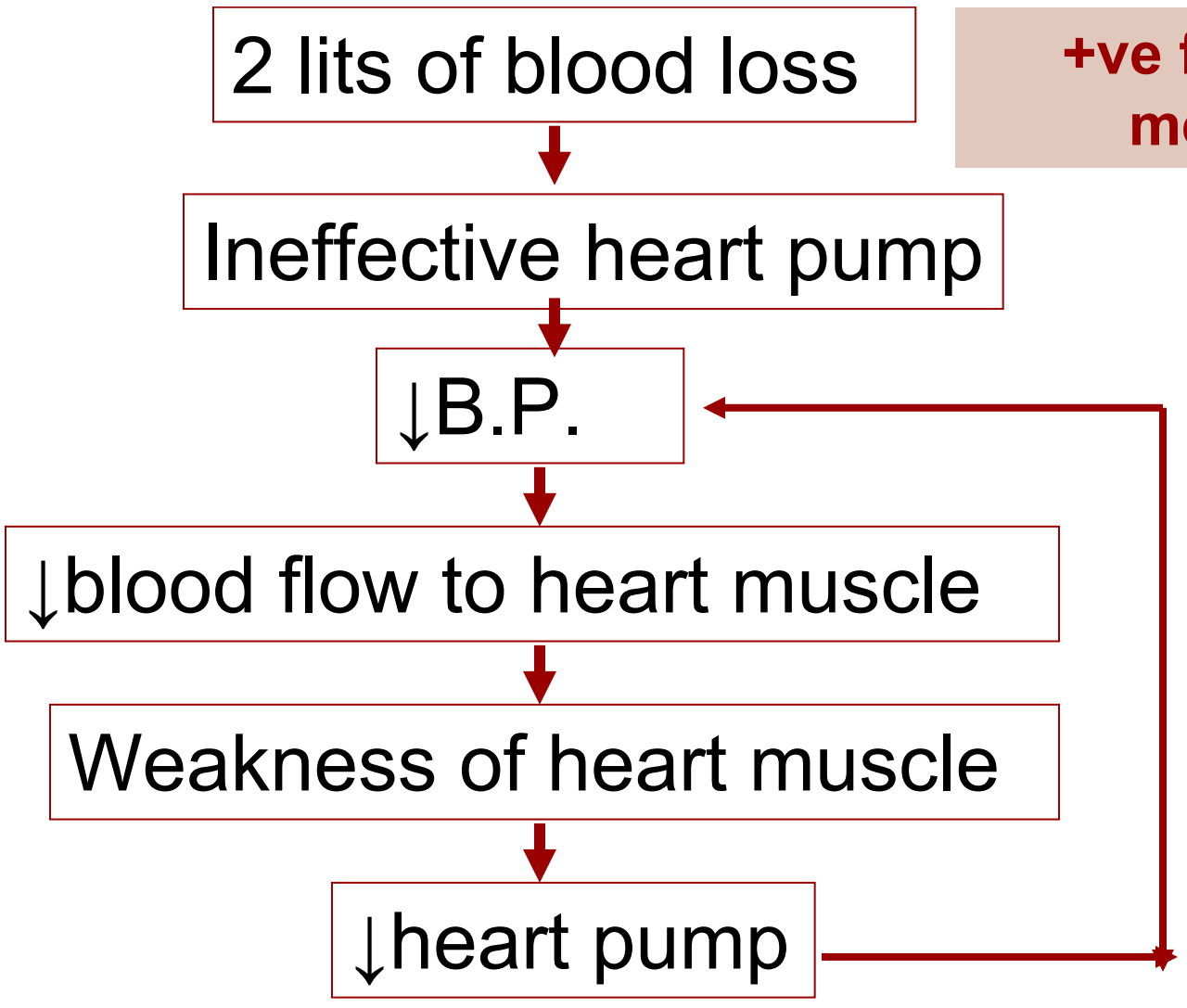
Gain is -50 / +25 = -2

Gain of body temp.regulating system is -33

Imp

Positive feedback mechanism –

the effect of regulating system magnifies the error and sets in vicious cycle which stops only when the initial stimulus is removed.



Vicious cycle stops when blood volume is corrected

Examples of Useful +ve feedback regulation – for rapid magnification of basic corrective mechanisms

1. Hodgkin's cycle for Na^+ transport during AP
2. Oxytocin secretion during parturition
3. LH surge for ovulation
4. Enzymatic cascade for blood coagulation
5. Activation of digestive enzymes

3. Feed forward mechanism – anticipatory mechanism – conditioned reflex

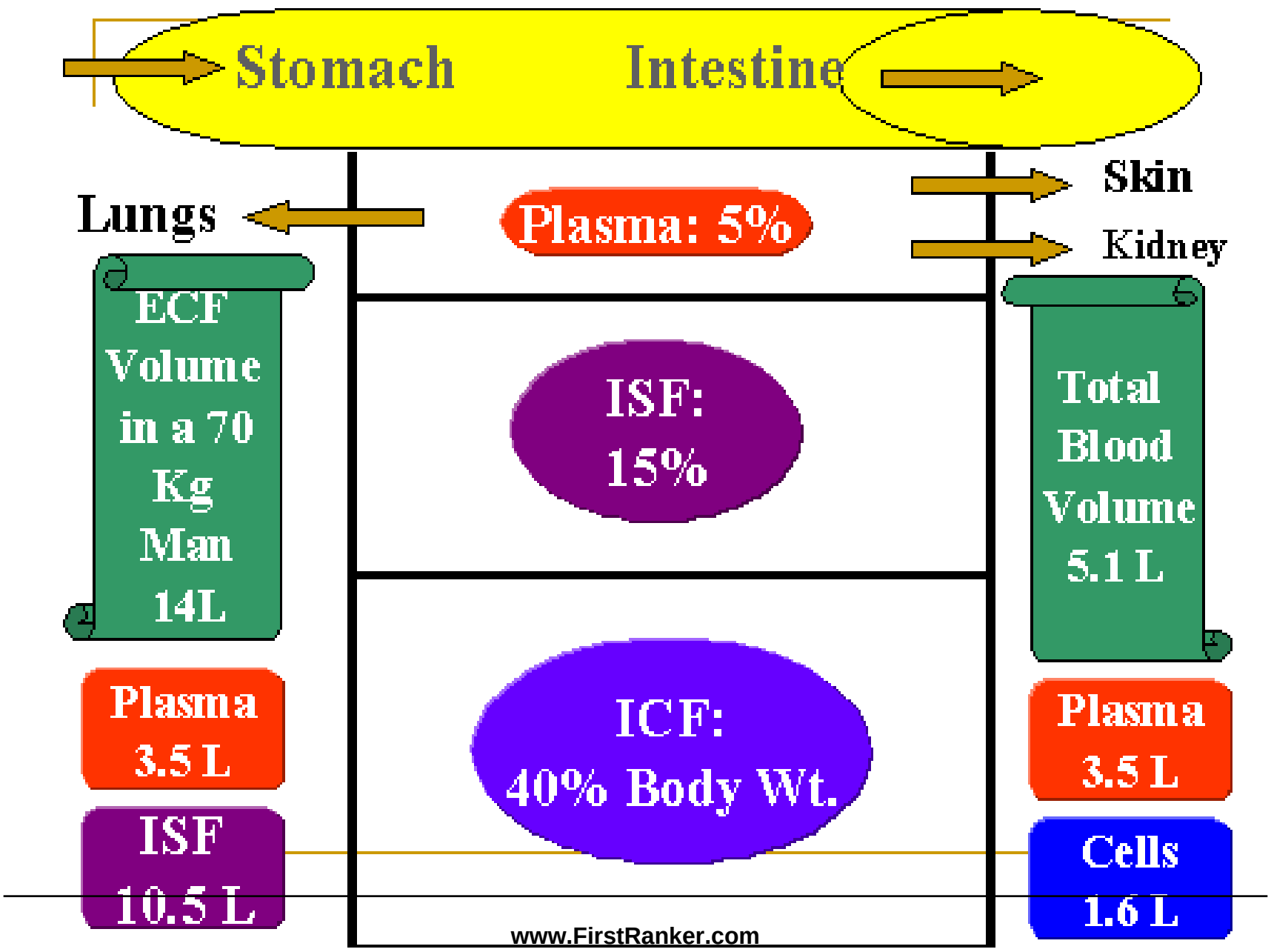
By detecting rate of change rapid anticipatory corrective measures which may not be accurate e.g. acceleration, exposure to cold

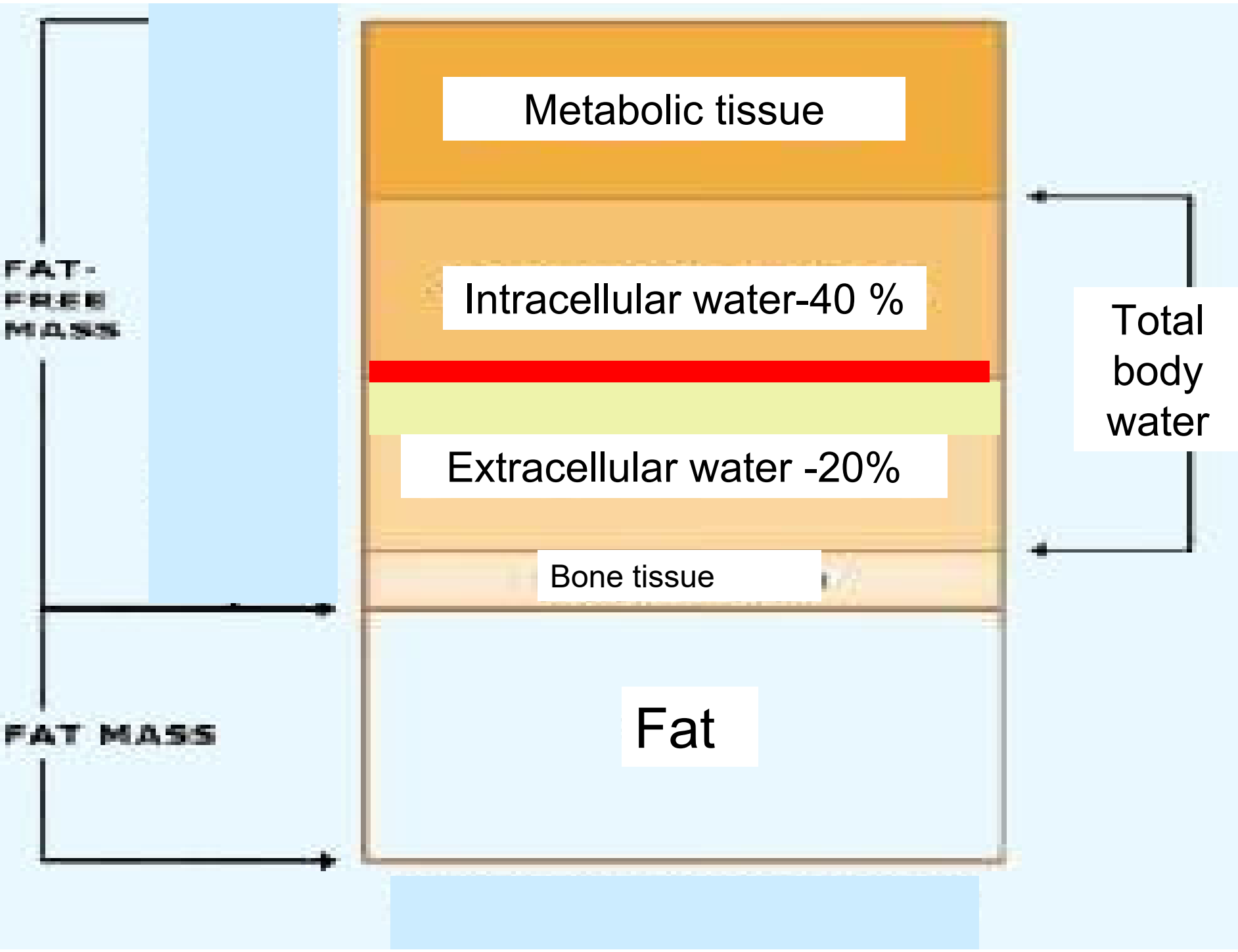
Limitations –

- age

Undamped oscillations due to long dead time and more gain of system – overcorrection

e.g. Chyene Stoke's breathing, clonus during deep reflexes





Body fluid compartments-

60% of body wt.(70kg.) – 42 lits.

ICF-2/3 -28lits

2 lits in RBC

Plasma -3lits - 5% 1/5

ECF – 1/3 – 14 lits

Interstitial fluid -11 lits. 3/4

Transcellular - 1-2 lits

7% of fluid in intravascular compartment

Body fluids

- 62% of body wt in males and 52 % in females
- 72% of lean body mass (adipose free)

body wt is 70kg in man

body water is 42 lits.

28 lits (2/3) ICF – 2 lits - intravascular

14 lits. (1/3) ECF – 3 lits - intravascular

Body fluids

Measurement of body fluid compartments-

- indicator dilution technique –
- Criteria for ideal dye –
  - Dye should get uniformly diluted only in the compartment whose whose volume is to be measured

Body fluids

- Dye should be nontoxic,
- should not change fluid volume,
- should not be metabolized, altered
- or excreted in significant amount
- should be able to estimate easily

Body fluids

Two spaces are calculated indirectly –

- Intracellular fluid compartment

(TBW – ECF)

- Extravascular fluid compartment

(ECF - plasma vol.)

Example

Inulin for ECF – 100 mg inulin injected

After 30 min. inulin conc in blood – 0.75 mg /dl

25 mg excreted in urine during 30 mins.

ECF vol = 100 – 25 / 0.75 = 10000 ml

= 10 lits.

Substances used –

TBW – D_2O, tritiated H_2O, aminopyrine

ECF – Na thiosulphate, sucrose, mannitol,

Intravascular fluid –

Plasma vol. - Evan's blue, T_{1824} , $^{131}I_2$

Hematocrit

Osmolarity of ECF = 290 mOsm / lit