



Homeostasis and Homeodynamism

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WHAT IS LIFE?

PHILOSOPHICAL DEFINITION

THEOLOGICAL DEFINITION

BIOLOGICAL DEFINITION

LIFE

CHARACTERISTICS OF LIVING ORGANISMS:

- **RESPIRATION**
- **NUTRITION & EXCRETION**
- **IRRITABILITY**
- **GROWTH & DEVELOPMENT**
- **LOCOMOTION**
- **REPRODUCTION**
- **DEATH**

ORIGIN OF LIFE

OVER >3 BILLION YEARS

INORGANIC



ORGANIC



BIOCHEMICAL

'LIVING'

Structure of DNA

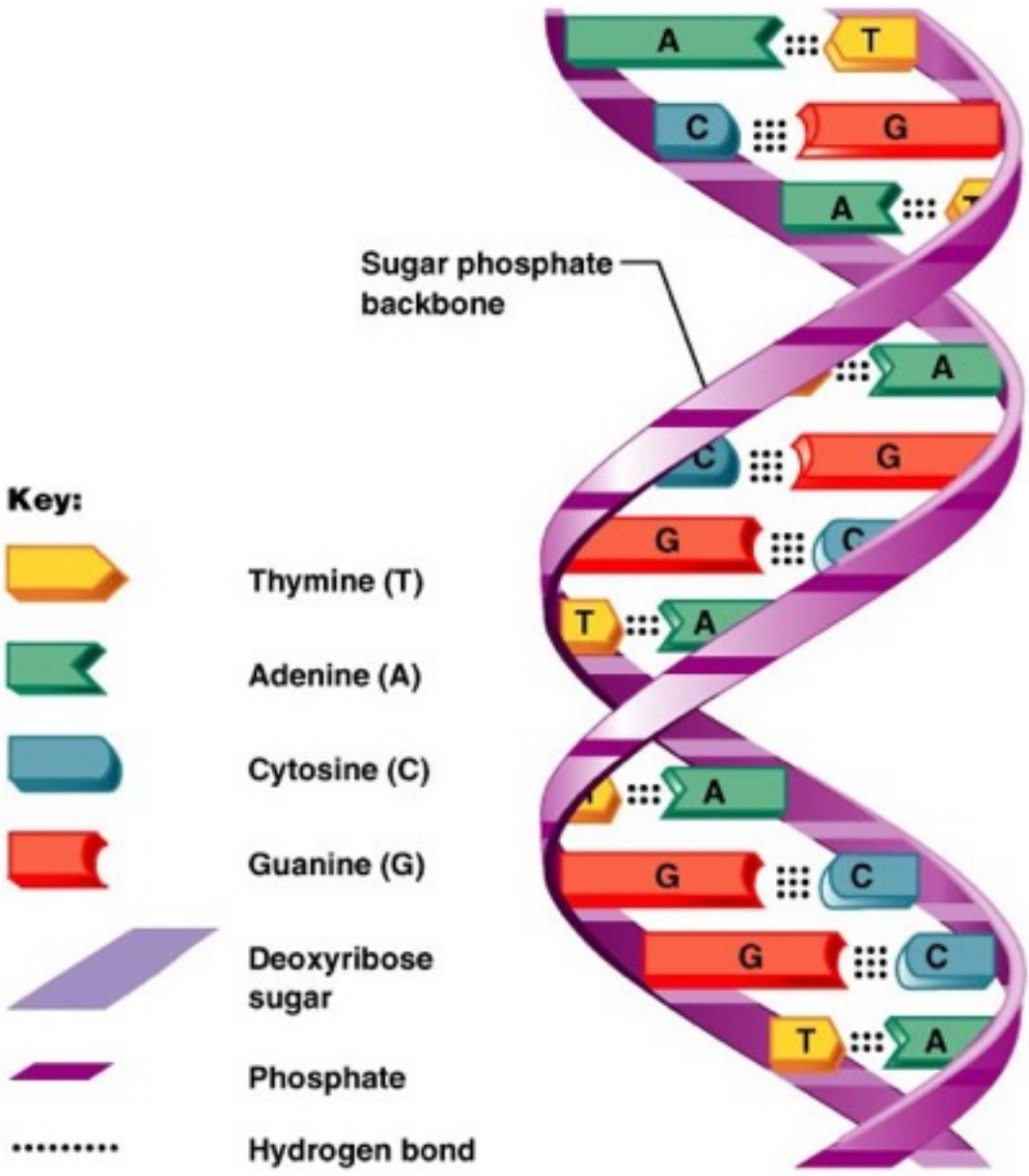



Figure 2.21b



BODY ORGANISATION I

- **SUB-CELLULAR**
- **CELL**
- **TISSUE**
- **ORGAN**
- **ORGAN SYSTEM**
- **WHOLE BODY**



LIFE CHARACTERISTIC	CELLULAR LEVEL	WHOLE BODY LEVEL
RESPIRATION	SUBSTRATE OXIDATION	OXYGEN IN, CO2 OUT
NUTRITION/EXCRETION	FROM OUT / IN CELL	INGESTION/ REMOVAL
IRRITABILITY	INNATE	VOLUNTARY, INVOLUNTARY
GROWTH & DEVELOPMENT	CELL DIFFERENTIATION	EMBRYO, FETUS, CHILD, ADULT, AGED
LOCOMOTION	CONTRACTILE, CILIA	EXTERNAL, INTERNAL
REPRODUCTION	REPLICATION, REPAIR	PROPOGATION OF SPECIES

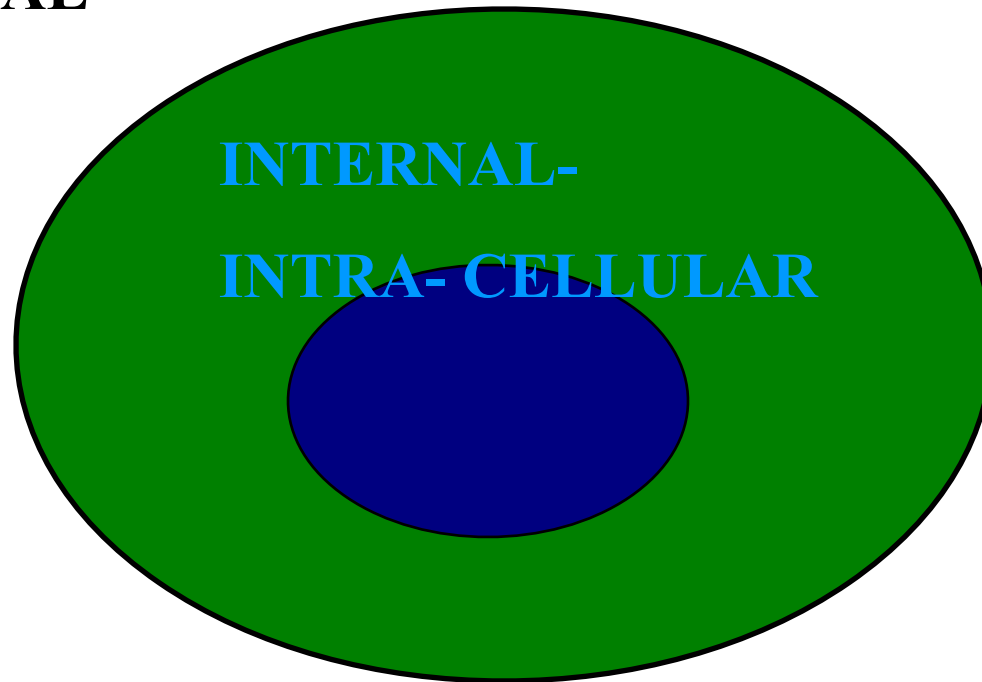


INTERNAL ENVIRONMENT

- **CONDITIONS THAT EXIST WITHIN THE BODY**
- **CLAUDE BERNARD 1878**
 - **'MILIEU INTERIEURE'**
- **DISTINCT FROM EXTERNAL ENVIRONMENT**
 - **SPECIFIC FOR**
 - **PARTICULAR ORGANISM**
 - **PARTICULAR LEVEL e. g. CELL, ORGAN, WHOLE BODY**

CELLULAR LEVEL

**EXTERNAL-
INTERSTITIAL**





ORGAN LEVEL

- **STOMACH**
 - **INTERNAL - ACIDIC pH**
- **THYROID GLAND**
 - **HIGH IODINE LEVEL**



ORGAN SYSTEM LEVEL

- **CVS**
 - **Blood pressure**
 - **Blood volume**
- **Respiratory system**
 - **Oxygen & carbon dioxide levels**



WHOLE BODY LEVEL

- **INTERNAL**
 - **TEMPERATURE**
 - **FLUID**
 - **ELECTROLYTES**
 - **OXYGEN**
- **EXTERNAL**
 - **ATMOSPHERE**
 - **TEMPERATURE**
 - **RADIATION**



INTERNAL ENVIRONMENT

- **RELATIVELY CONSTANT**
 - **RANGE OF NORMALITY**
- **GIVES THE ORGANISM A GREATER VERSATILITY AND FREEDOM OF CHOICE OF EXTERNAL ENVIRONMENT**



HOMEOSTASIS

- **WALTER CANNON**
 - **'SIMILAR CONDITION'**
- **IS THE MAINTENANCE OF INTERNAL ENVIRONMENT WITHIN A NARROW, PHYSIOLOGICAL RANGE OF PARAMETERS**



HOMEODYNAMISM

- **IMPLIES THAT THE MECHANISMS AND THE MAINTENANCE OF THE INTERNAL ENVIRONMENT ARE DYNAMIC OR IN ACTION RATHER THAN STATIC**



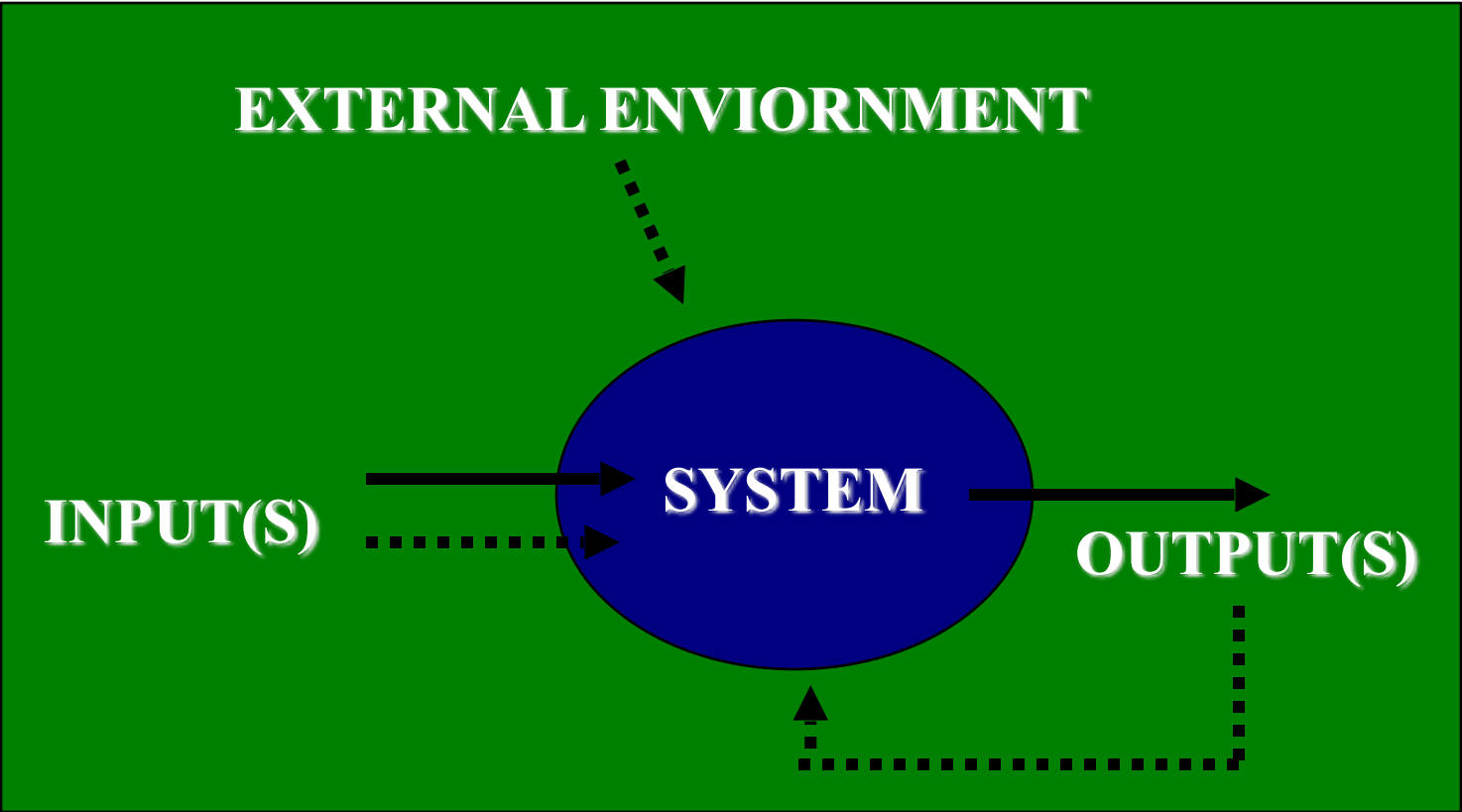
HOMEODYNAMISM

- **THERE ARE MEANS OF CONTROLLING THE VARIOUS PARAMETERS**
- **REQUIRES THAT THERE IS ORDERLINESS AND ORGANISATION IN THE LIVING SYSTEM**



PHYSIOLOGICAL RANGE

- **RANGE OF NORMALITY**
- **USUALLY NARROW**
 - e.g. p H 7.40 +/- 0.02
- **ACTUAL LEVEL MAY FLUCTUATE WITHIN RANGE**





CONTROL SYSTEMS

- OPEN LOOP ~
- CLOSED LOOP ~

CONTROL SYSTEMS

- **OPEN LOOP**

INPUT → **SYSTEM** → **OUTPUT**

(CONTROLLED

VARIABLE)

CONTROL SYSTEMS

- **CLOSED LOOP**

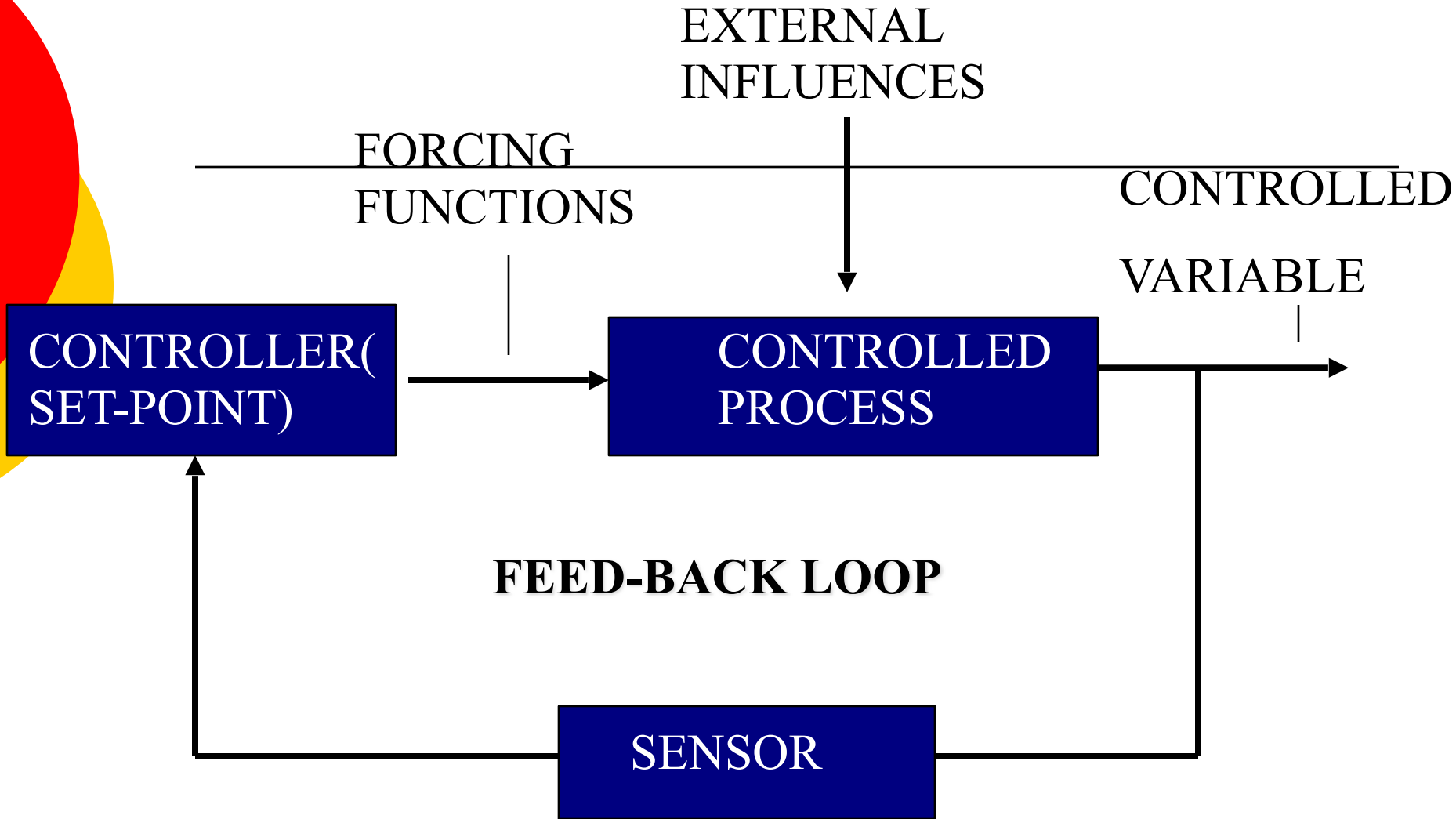
INPUT → **SYSTEM** → **OUTPUT**





TYPES OF CLOSED LOOP CONTROL SYSTEMS

- **FEED-BACK**
 - **NEGATIVE FEED-BACK**
 - **POSITIVE FEED-BACK**
- **FEED-FORWARD**
- **ADAPTIVE CONTROL**
- **COMBINATIONS OF ABOVE**



BASIC FEED-BACK CONTROL MODEL



CONTROL LEVELS

- **SUB-CELLULAR**
- **CELLULAR**
 - **ELECTROLYTE LEVEL, GLUCOSE LEVEL**
- **ORGAN**
 - **pH, SECRETIONS**
- **SYSTEM**
 - **BLOOD PRESSURE, RESP. RATE**
- **WHOLE BODY**
 - **TEMPERATURE, FLUID**



BODY FLUID & FLUID COMPARTMENTS




- **LIFE EVOLVED IN 'PRIMORDIAL**

- SEA'**

- **CELLS ADAPTED TO A FLUID ENVIRONMENT**

- **CELLS HAVE FLUID BOTH IN AND AROUND THEM**

- **A FLUID MEDIUM IS NECESSARY FOR LIFE**

- 
-
- **WE ARE 60% WATER**
 - **IN A 70KG MAN = 42 L**
 - **REST OF US:**
 - **PROTEIN 18%**
 - **FAT 15%**
 - **MINERAL 7%**



IMPORTANCE OF WATER

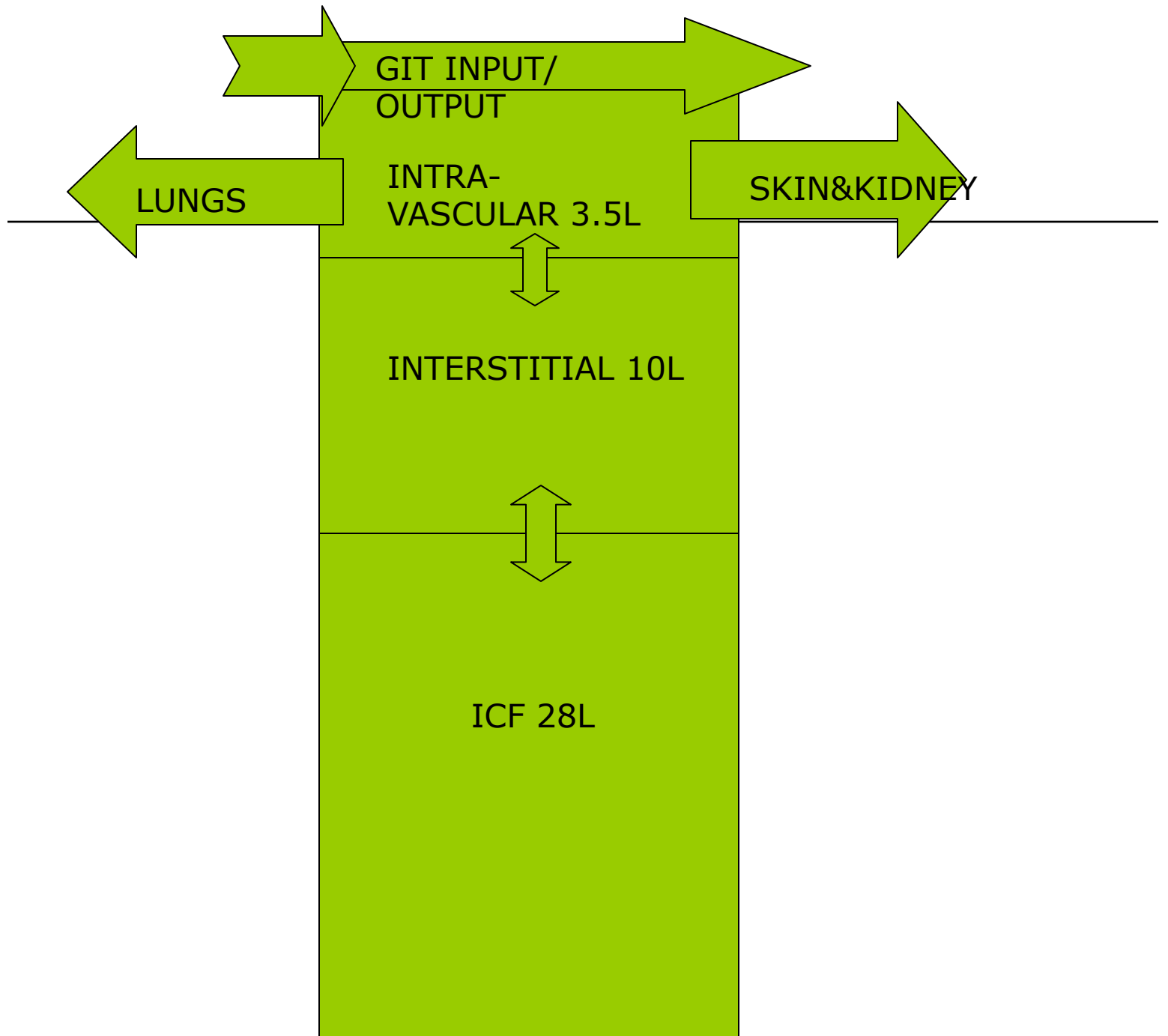
- **UNIVERSAL MEDIUM**
- **UNIVERSAL SOLVENT**
- **CONDUCTOR OF IONS**
- **OSMOTIC PRESSURE**
- **HIGH SPECIFIC HEAT CAPACITY**
- **END PRODUCT OF METABOLISM**
 - $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \longrightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$

FLUID COMPARTMENTS

- **TOTAL BODY WATER-
60% OF BODY WEIGHT
= 42 L**
- **2/3 OF TBW IS INTRA- CELLULAR
= 28 L**
- **1/3 OF TBW IS EXTRA- CELLULAR
= 14 L**

FLUID COMPARTMENTS

- **EXTRA- CELLULAR FLUID = 14 L**
 - **3/4 IS INTERSTITIAL FLUID = 10.0L**
 - **INTRA-VASCULAR = 3.5 L**
 - **REST IS TRANS-CELLULAR ~ 0.5 L**
 - **CEREBROSPINAL FLUID**
 - **JOINTS**
 - **BLADDER**
 - **PLEURAL, PERICARDIAL, PERITONEAL SPACE**



The Composition of the Body

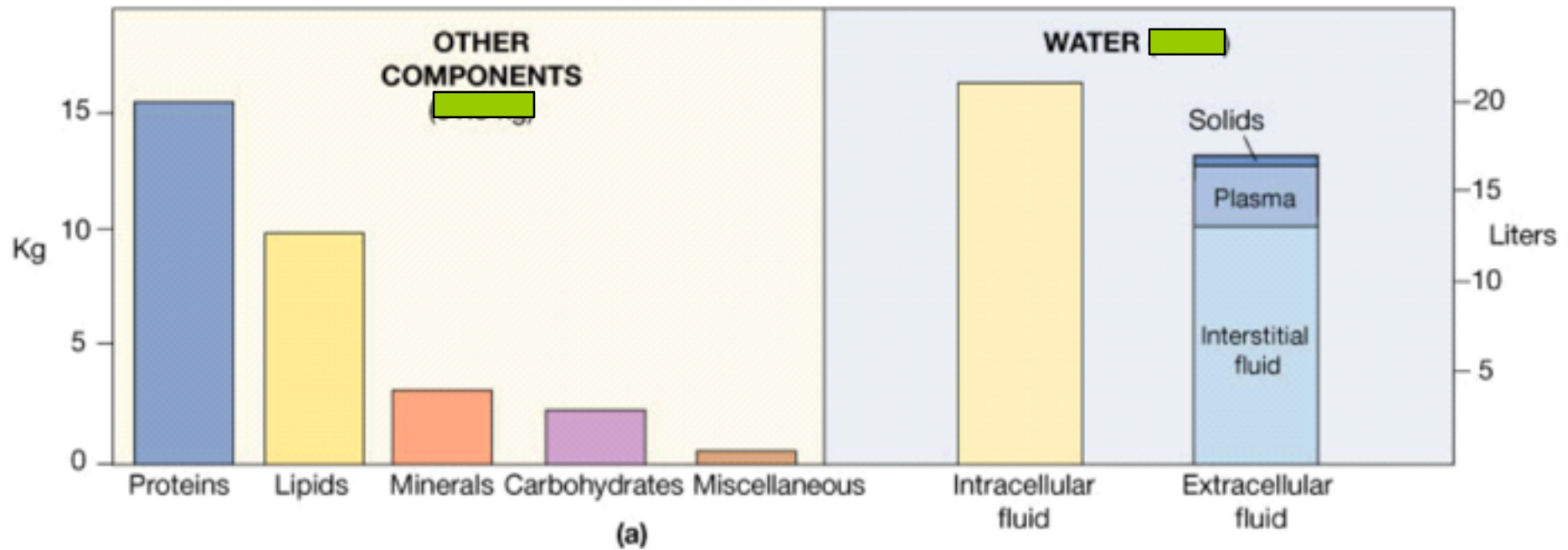


Figure 27.1a

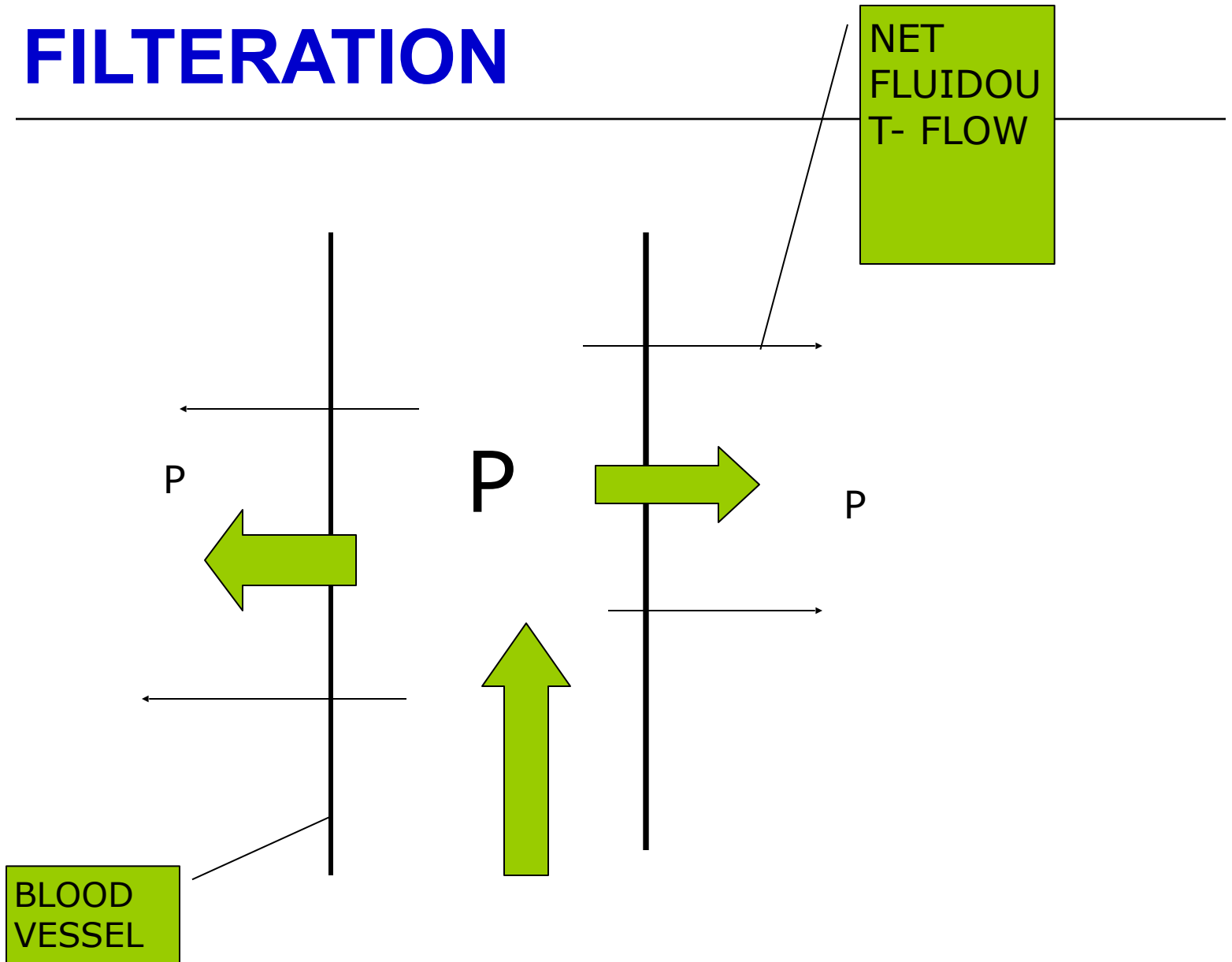


FLUID MOVEMENT

FILTRATION

- THIS IS THE MOVEMENT OF FLUID THROUGH A BARRIER FROM AN AREA OF HIGH PRESSURE TO AN AREA OF LOWER PRESSURE

FILTRATION



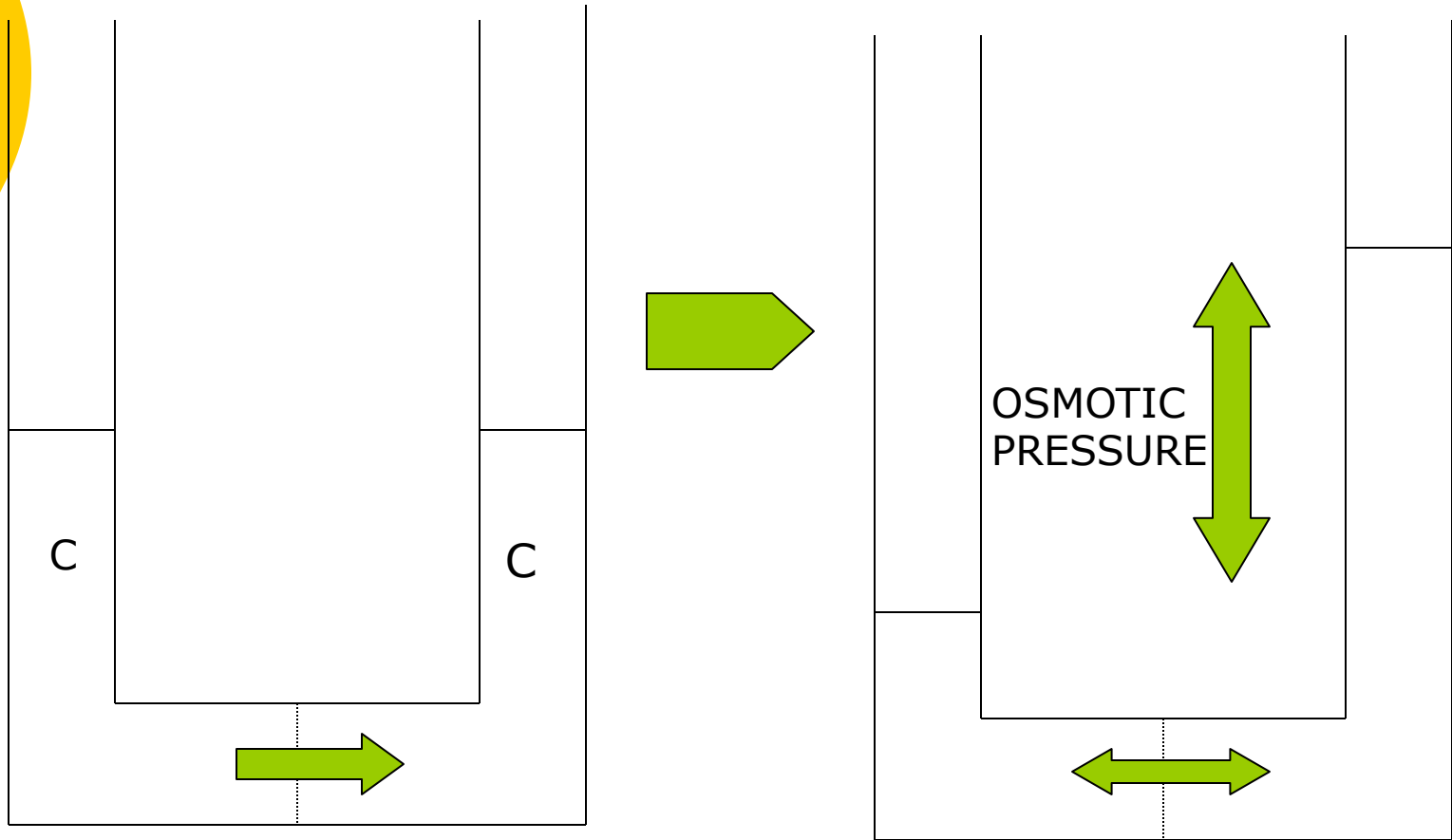


OSMOSIS

THE MOVEMENT OF SOLVENT THROUGH A SEMI-PERMIABLE MEMBRANE FROM AN AREA OF LOW TO HIGH SOLUTE CONCENTRATION

- **THE PRESSURE REQUIRED TO PREVENT SUCH A MOVEMENT IS OSMOTIC PRESSURE**

OSMOSIS





OTHER MECHANISMS

- PINOCYTOSIS
 - ENDOCYTOSIS OF WATER



SOLVENT DRAG

WHEN THERE IS MOVEMENT OF A SOLUTION, THERE IS 'BULK FLOW' OF THE SOLUTE



Fluid Balance

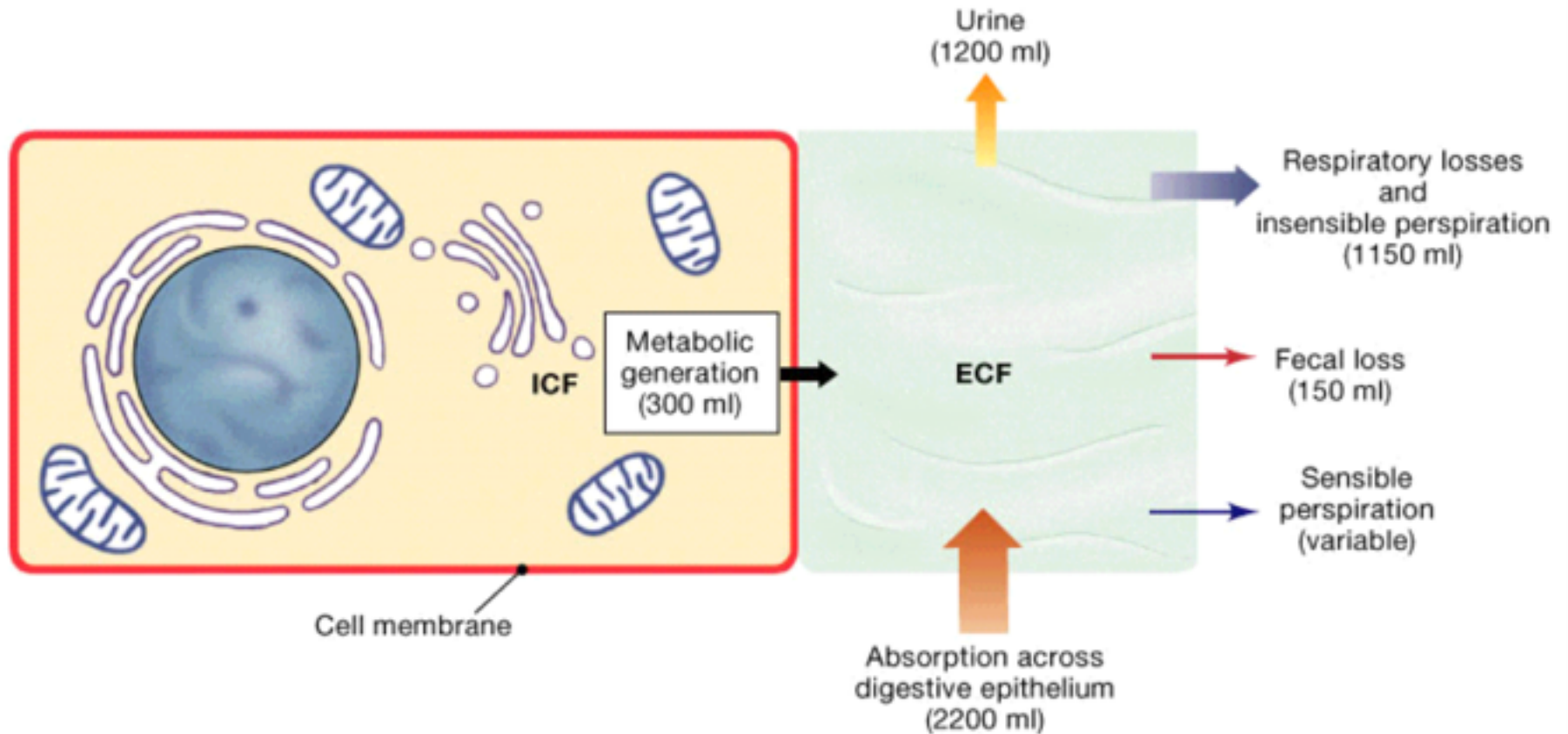
- **External Flux**
 - **Source**
 - Intake
 - Endogenous (200-500ml/24 hrs)
 - **Loss**
 - Urine- 500-600ml obligatory
 - Stool- 100-300 ml
 - Skin- 'insensible' 750 ml- 1L
 - Resp- 750ml



Fluid Balance II

- **Internal flux**
 - **Renal- Filtration/ reabsorption**
 - **Lymphatics**
 - **GIT-**

Fluid Exchanges





THANK YOU