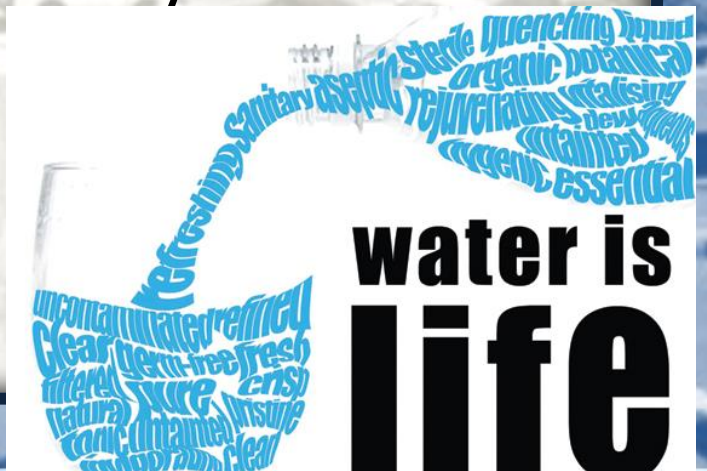

الجامعة الأردنية
١٣٨٢هـ ١٩٦٢م

Introduction

- ***Can You Imagine life without water?***
- Body fluids are vital to maintain normal body functioning
- Total body fluid (TBW), accounts for approximately 60% of total body weight
  - Intracellular
  - Extracellular

- Water is the body's primary fluid and is essential for proper organ system functioning and survival.

- People can survive days and sometimes even weeks without food, but that’s not the case with water as they cannot survive few days without it.

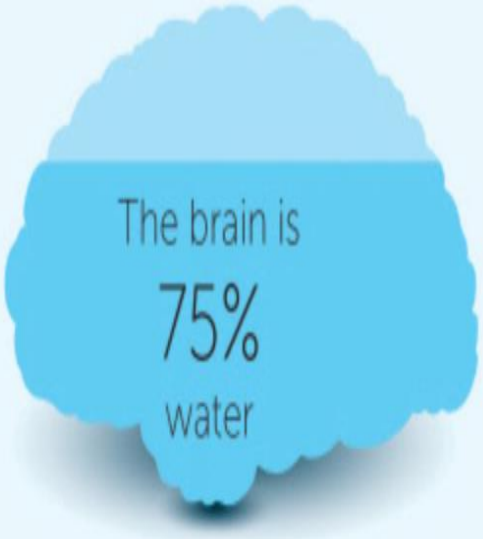


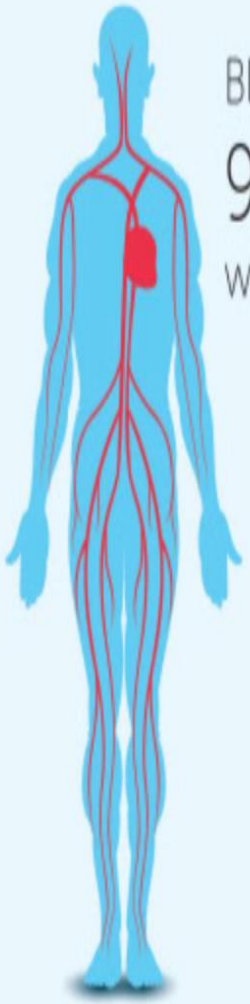
- Water has many functions in the body
  - Essential for Cell life .
  - Interfere in the Chemical and metabolic reactions .
  - Nutrients absorption and transport .
  - Regulate the Body temperature .
  - Elimination of waste products through urine .

How much of you is H2O

- • Body muscle mass is rich in water, while Adipose Tissue has a lower percentage of water content:
  - Overweight / obese people have a lower percentage of water compared to someone who's lean and muscular.
  - Women typically have a lower percentage of total body water than men due to a higher percentage of body fat.
  - Older adults tend to have a lower concentration of water overall, due to an age-related decrease in muscle mass
  - Children tend to have a higher percentage of water : weight-
    - as much as 70-80% in a full-term neonate.

THE HUMAN BODY IS

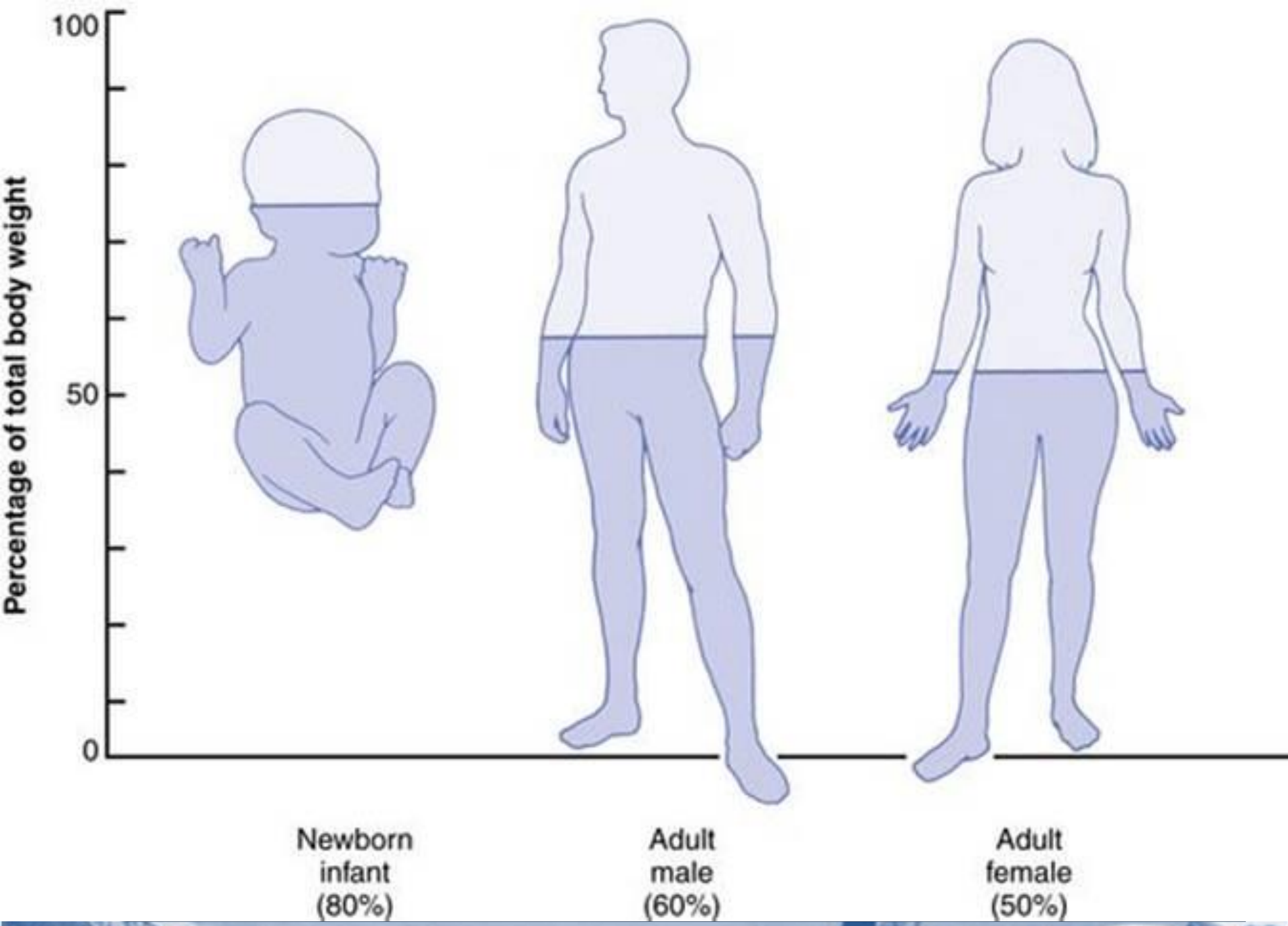




Blood is
92%
water

Bones
22%
water

Muscles
75%
water


100
50
0
Percentage of total body weight
Newborn infant (80%)
Adult male (60%)
Adult female (50%)

Intracellular fluids

- ***2/3*** of the total body water ***TBW*** .
- 40% of the total body weight

- Found inside the plasma membrane of the body's cells.
  - In humans (average 70 KG), the intracellular compartment contains on average about ***28 liters*** of fluid

Extracellular fluid

- Accounts for ***1/3*** of the ***TBW***:
- 20% of the total body weight
  - Interstitial
  - Intravascular

Extracellular fluid

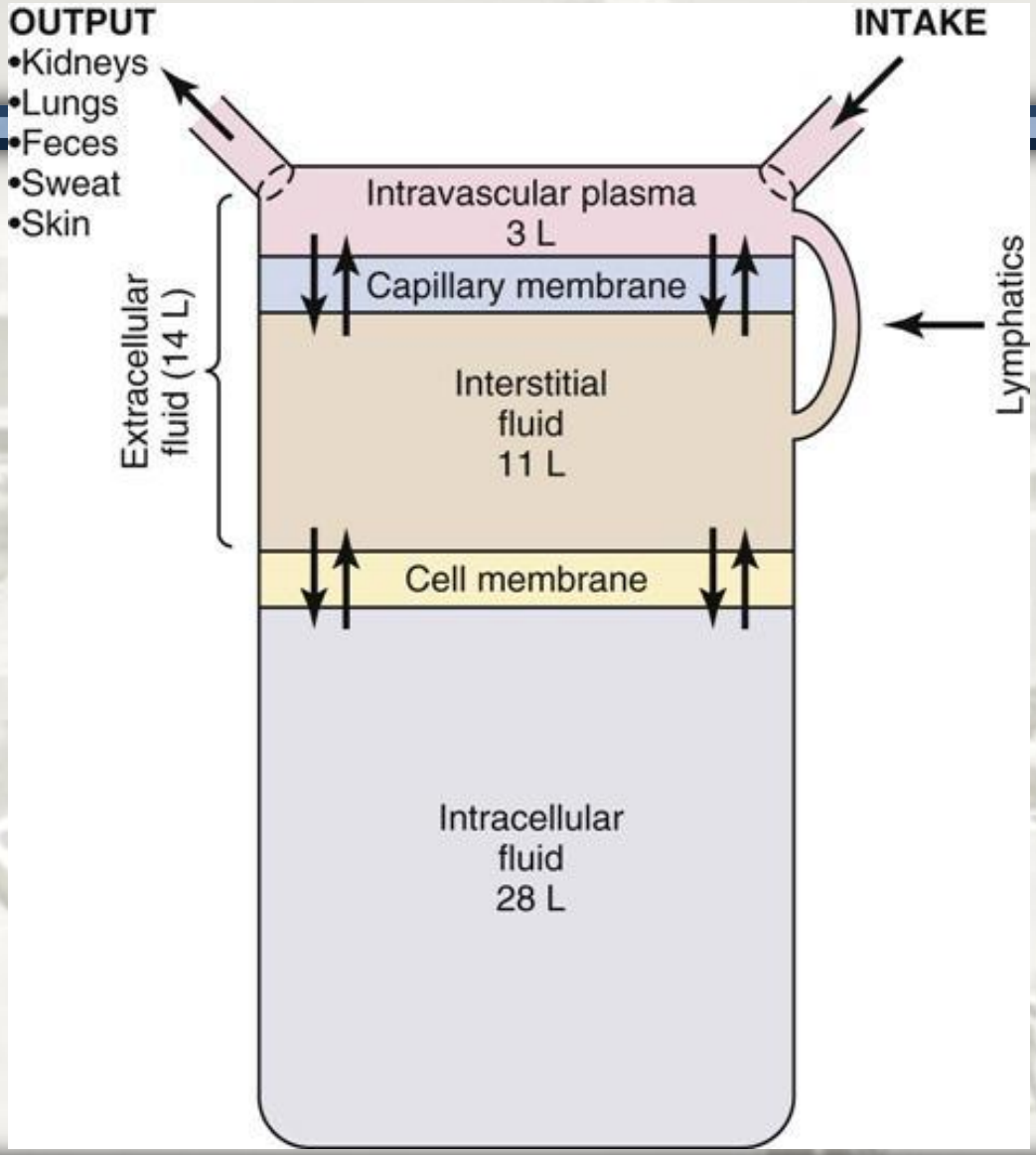
Interstitial compartment

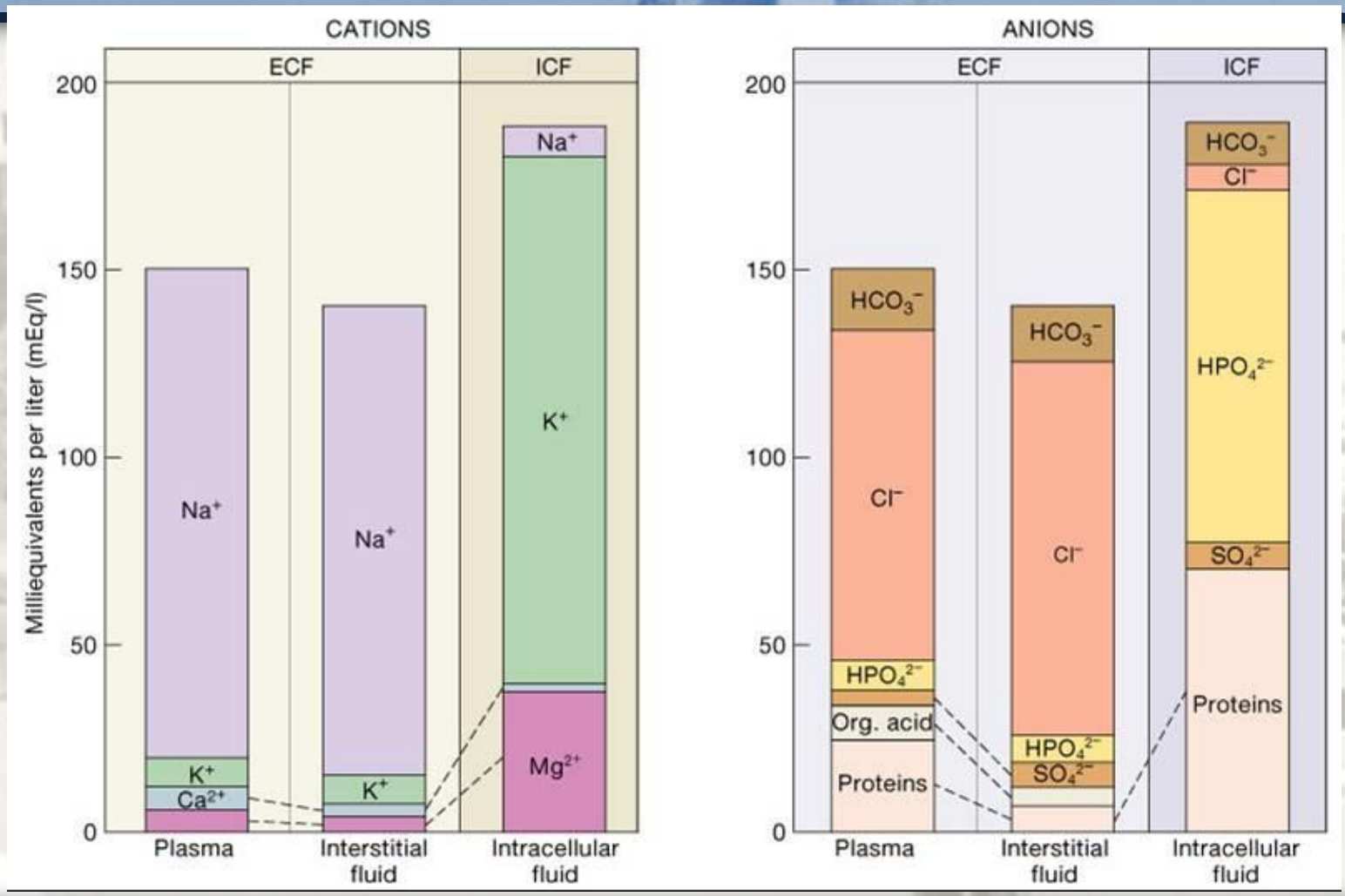
- Its the small, narrow space between tissues or parts of an organ. It is filled with what is called interstitial fluid
- When excessive fluid accumulates in the interstitial space, edema develops.
  - In the average male (70 kg) human body, the interstitial space has approximately ***10.5*** liters of fluid (***15%*** of the ***TBW***)

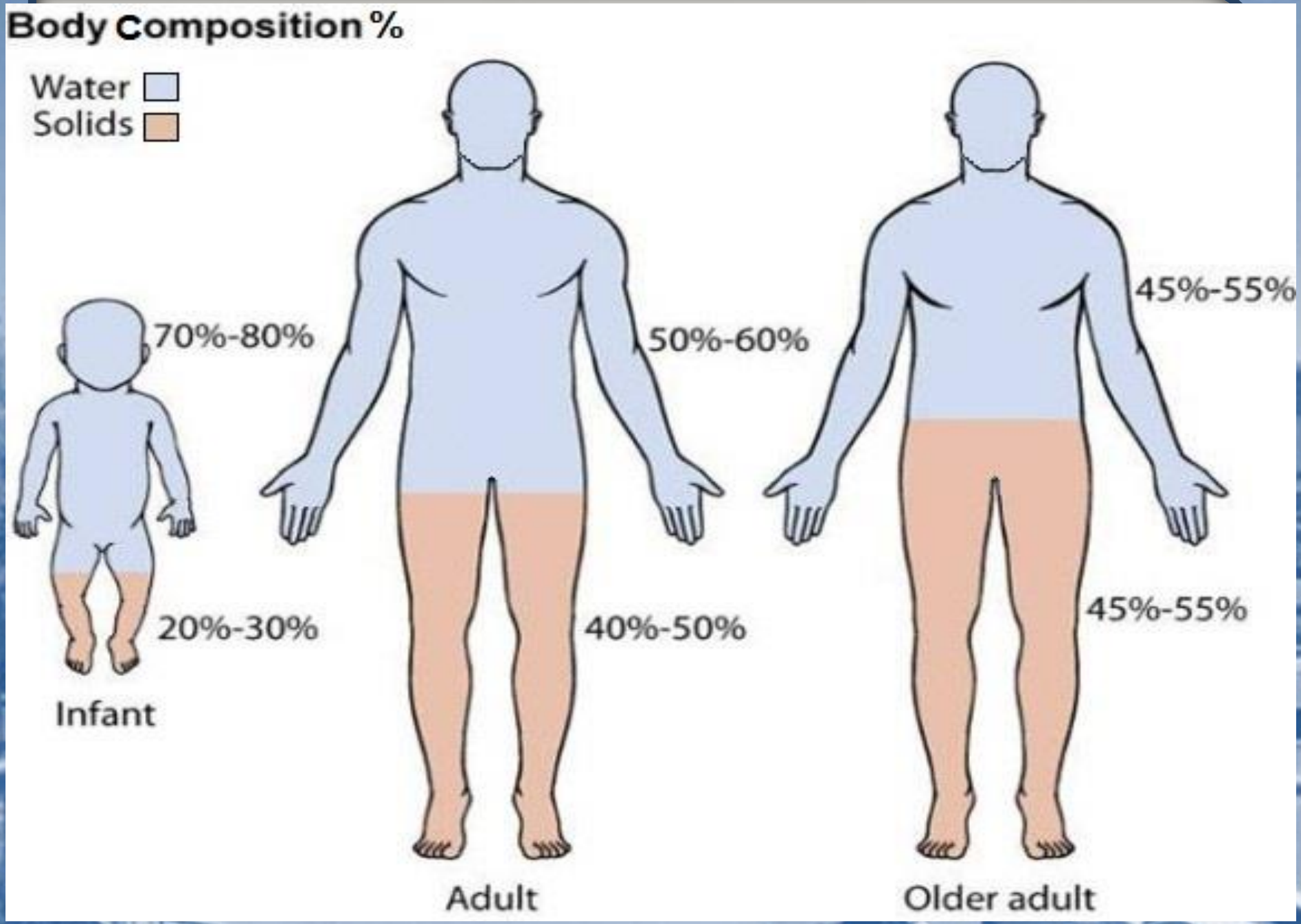
- It acts as the microenvironment that allows movement of ions, proteins and nutrients across the cell barrier .

Extracellular fluid

- **Intravascular compartment**
  - The main intravascular fluid in humans is blood; the average volume of blood in humans is approximately ***70-75 ml/kg***

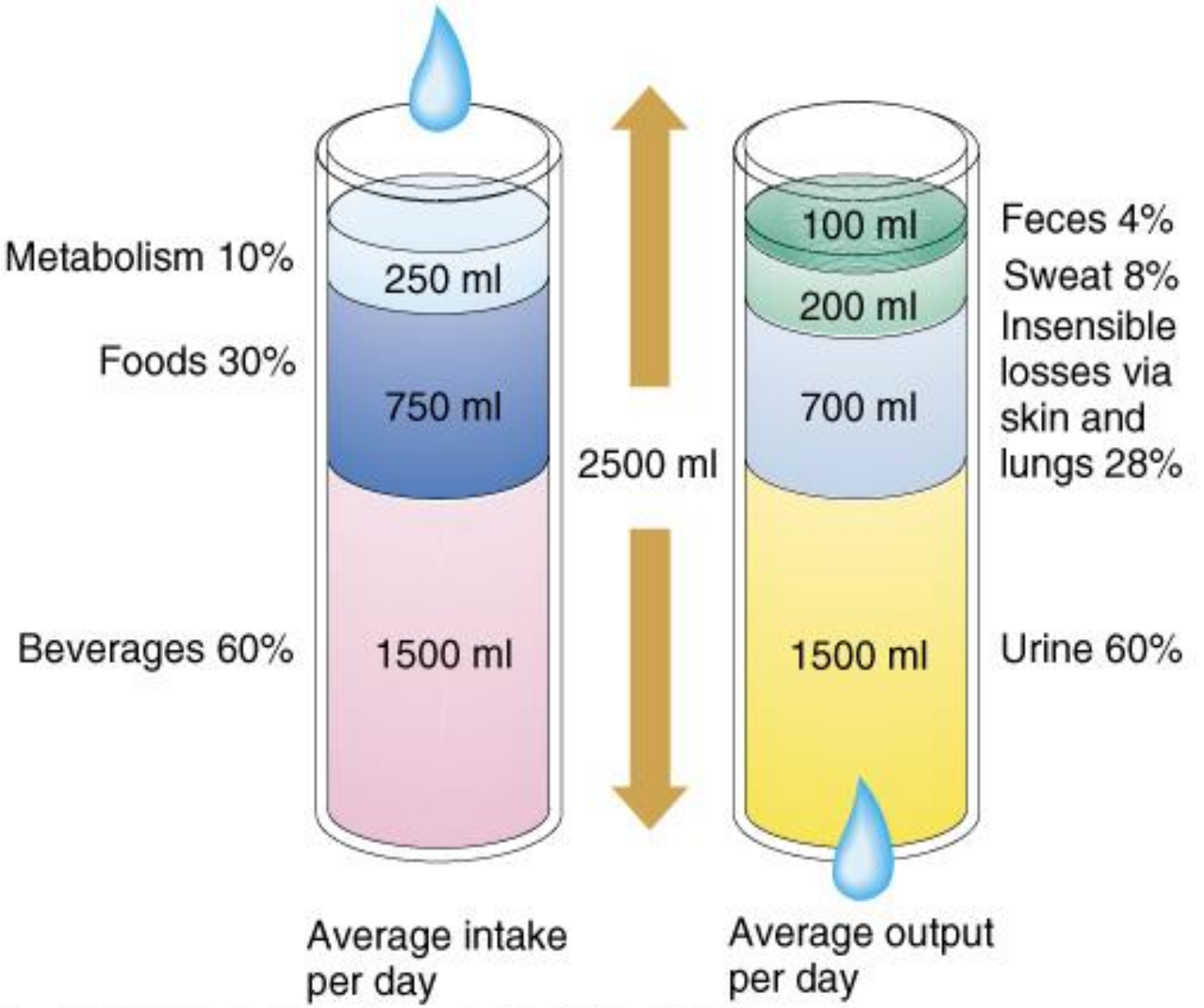

OUTPUT
•Kidneys
•Lungs
•Feces
•Sweat
•Skin
INTAKE
Intravascular plasma
3 L
Capillary membrane
Extracellular fluid (14 L)
Interstitial fluid
11 L
Lymphatics
Cell membrane
Intracellular fluid
28 L


CATIONS
ECF
ICF
200
150
100
50
0
Milliequivalents per liter (mEq/l)
Na+
K+
Ca2+
Na+
K+
Na+
K+
Mg2+
Plasma
Interstitial fluid
Intracellular fluid
ANIONS
ECF
ICF
200
150
100
50
0
HCO3−
Cl−
HPO4 2−
Org. acid
Proteins
HCO3−
Cl−
HPO4 2−
SO4 2−
HCO3−
Cl−
HPO4 2−
SO4 2−
Proteins
Plasma
Interstitial fluid
Intracellular fluid


Body Composition %
Water
Solids
70%-80%
20%-30%
Infant
50%-60%
40%-50%
Adult
45%-55%
45%-55%
Older adult

- Input and Output of the “Normal” Adult
  - Minimal Obligatory Daily input:
    - 500mL: Ingested water:
    - 800mL: Water content in food
    - 300mL : Water from oxidation :
    - TOTAL: 1600mL

- Minimal Obligatory Daily water output:
  - • 500mL : Urine
  - • 500mL: Skin
  - • 400mL: Respiratory tract
  - • 200mL: Stool
  - • TOTAL : 1600mL
  - On average, an adult input and output is 30-35mL/kg/day (about 2.4L/day)



- Water requirements increase:
  - Fever, Sweating ,Burns, Tachypnea, Surgical drain, Polyuria , and Gastrointestinal losses through Vomiting or diarrhea
  - Water requirements increase by 100 to 150 mL/day for each C degree of body temperature elevation.

Definitions

- ***Osmolality :***
  - number of moles of a chemical compound that contributes to the solution's osmotic pressure and is expressed as mOsm/kg of water
- ***Osmolarity :***
  - number of osmoles of solute particles per unit volume of solution (mosm/L)
- ***Osmotic pressure :***
  - pressure exerted by osmotically active particles in the fluid. depends on number of particles / unit vol

- ***Plasma osmolality :*** determined largely by sodium salts
  - Normal plasma osmolality = ***275-295 mosm/kg***
  - ***Plasma osmolality = 2*Na + glucose/18 + BUN/2.8***
- ***Effective plasma osmolality :***
  - determined by those solutes in plasma which do not permeate cell wall freely and act to hold water within ECF
  - ***Effective osmolality = 2*Na + glucose/18***

Types of IVF therapy

- Deficit
- Maintenance
- Ongoing loses

	Na^+ (mmol/l)	K^+ (mmol/l)	Cl^- (mmol/l)	HCO_3^- (mmol/l)	Ca^{2+} (mmol/l)	Mg^{2+} (mmol/l)	Oncotic pressure (mmH_2O)	Typical plasma half-life	pH
5% dextrose	–	–	–	–	–		0	–	4.0
0.9% NaCl	154	0	154	0	0		0	–	5.0
Ringer's lactate (Hartmann's solution)	131	5	112	29*	1	1	0	–	6.5
Haemaccel (succinylated gelatin)	145	5.1	145	0	6.25		370	5 hours	7.4
Gelofusine (polygeline gelatin)	154	0.4	125	0	0.4	0.4	465	4 hours	7.4
Hetastarch	154	0	154	0	0		310	17 days	5.5
Human albumin solution 4.5% (HAS)	150	0	120	0	0		275	–	7.4

*The lactate present in Ringer's lactate solution is rapidly metabolized in the liver. This generates bicarbonate ions. Bicarbonate cannot be directly added to the solutions because it is unstable (tends to precipitate).

Dextrose 5%

- *Composition : Glucose 50 gms*
- *Pharmacological basis :*
  - Corrects dehydration and supplies energy(170Kcal/L)
- *Indications :*
  - Prevention and treatment of dehydration
  - Pre and post op fluid replacement
  - IV administration of various drugs
  - Prevention of ketosis in starvation, vomiting, diarrhea
  - Adequate glucose infusion protects liver against toxic substances
  - Correction of hypernatremia

0.9% NS

- *Composition : Na 154 mEq, Cl 154 mEq*
  - *PH : 5.7*
- *Pharmacological basis : provide major EC electrolytes..*
  - corrects both water and electrolyte deficit.
  - increase the intravascular volume substantially
- *Contra indications*
  - Avoid in pre eclamptic patients, CHF, renal disease and cirrhosis
  - Large volume may lead to hyperchloremic acidosis

Indications for NS

- Water and salt depletion – diarrhoea, vomiting, excessive diuresis
- Hypovolemic shock
- Alkalosis with dehydration
- Severe salt depletion and hyponatremia
- Initial fluid therapy in DKA
- Hypercalcemia
- Fluid challenge in prerenal AKI
- Irrigation – washing of body fluids
- Vehicle for certain drugs

Ringer Lactate

- *Composition – Na, k , cl, lactate , ca*

- *Pharmacological basis :*
  - Most physiological fluid , rapidly expands the iv volume..
  - Lactate metabolized in liver to bicarbonate providing buffering capacity

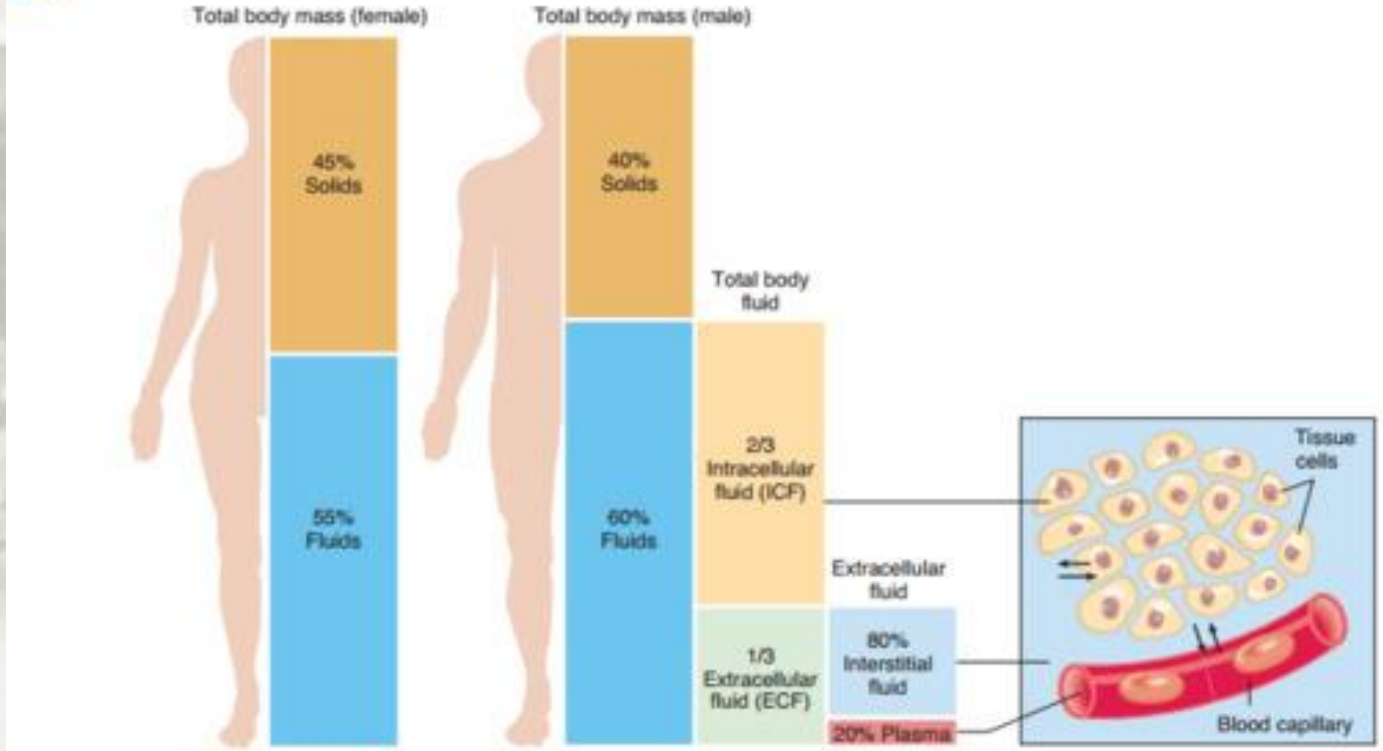
- *Indications*
  - Correction in severe hypovolemia
  - Replacing fluid in post op patients, burns
  - Diarrhoea induced hypokalemic metabolic acidosis
    - Fluid of choice in diarrhoea induced dehydration in paediatrics
  - DKA
    - provides water, correct metabolic acidosis and supplies potassium
  - Maintaining normal ECF fluid and electrolyte balance

Colloids

- *Colloids :*
  - *large molecular wt substances that* largely remains in the intravascular compartment thereby generating oncotic pressure
  - 3 times more potent
  - 1 ml blood loss = 1ml colloid = 3ml crystalloids

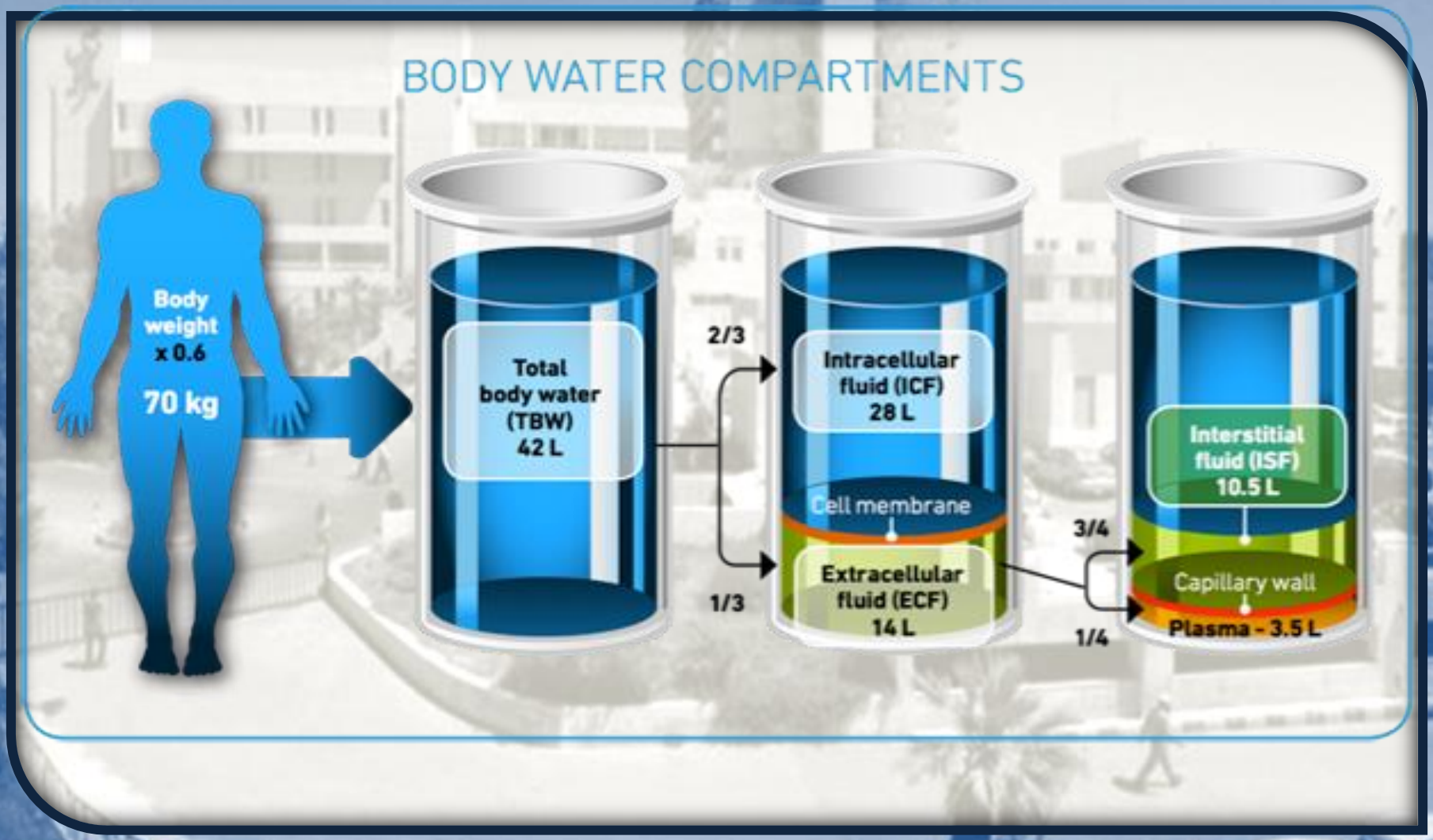
Figure 27.1 Body fluid compartments.

The term body fluid refers to body water and its dissolved substances.



(a) Distribution of body solids and fluids in average lean, adult female and male

(b) Exchange of water among body fluid compartments


BODY WATER COMPARTMENTS
Body weight x 0.6
70 kg
Total body water (TBW) 42 L
2/3
1/3
Intracellular fluid (ICF) 28 L
Cell membrane
Extracellular fluid (ECF) 14 L
3/4
1/4
Interstitial fluid (ISF) 10.5 L
Capillary wall
Plasma - 3.5 L

Albumin

- Maintain plasma oncotic pressure
- Heat treated preparation of albumin – 5%, 20% and 25% commercially available
- *Pharmacalogical basis :*
  - 25% albumin –expands plasma volume to 4-5 times the volume infused
- *Rate of infusion :*
  - 1 to 2 ml/min – 5% albumin
  - 1 ml/min - 25% albumin

Albumin

- *Indications :*
  - Plasma volume expansion in acute hypovolemic shock, burns, severe hypo albuminemia
  - Hypo proteinemia – liver disease, Diuretic resistant nephrotic syndrome
  - In therapeutic plasmapheresis , as an exchange fluid

- *Contra indications :*
  - Severe anaemia, cardiac failure
  - Hypersensitive reaction

Dextran

- Dextran are glucose polymers produced by bacteria
- 2 forms :
  - dextran 70(MW 70,000)
  - dextran 40(MW 40,000)
- *Pharmacological basis :*
  - Effectively expand intravacular volume
  - Dextran 40 as 10% sol …greater expansion , short duration(6hrs) – rapid renal excretion
  - Anti thrombotic , inhibits platelet aggregation
  - Improves micro circulatory flow

- *Indications :*
  - Hypovolemia correction
  - Prophylaxis of DVT and post operative thromboembolism
  - Improves blood flow and micro circulation in threatened vascular gangrene
  - Myocardial ischemia, cerebral ischemia, PVD and maintaining vacular graft patency
- *Adverse effects*
  - Acute renal failure
  - Interfere with blood grouping and cross matching
  - Hypersensitive reaction

- *Precautions/CI :*
  - Severe oligo-anuria
  - CHF, circulatory overload
  - Bleeding disorders like thrombocytopenia.
  - Severe dehydration
  - Anticoagulant effect of heparin enhanced
  - Hypersensitive to dextran
- *Administration :*
  - Adult patient in shock – rapid 500 ml iv infusion
  - First 24 hrs – dose should not exceed 20ml/kg
  - Next 5 days – 10 ml/kg/ day

Gelatin polymers (haemaccel)

- Sterile, pyrogen free 3.5 % solution
- Polymer of degraded gelatin with electrolytes

- 2 types
  - Succinylated gelatin (modified fluid gelatin)
  - Urea cross linked gelatin (polygeline)
- *Composition : Na Cl 145 mEq, Ca 12.5 mEq,* potassium 5.1 mEq
- *Indications :*
  - Rapid plasma volume expansion in hypovolemia
  - Volume pre loading in regional anesthesia
  - Priming of heart lung machines

Gelatin polymers (haemaccel)

- *Advantages :*
  - Does not interfere with coagulation, blood grouping
  - Remains in blood for 4 to 5 hrs
  - Infusion of 1000ml expands plasma volume by 300 to 350 ml

- *Side effects :*
  - Hypersensitivity reaction
  - Should not be mixed with citrated blood

Hydroxyethyl starch

- *Hetastarch :*
  - It is composed of more than 90% esterified amylopectine.
  - Esterification retards degradation leading to longer plasma expansion

- *Pharmacological basis :*
  - Osmolality – 310 mosm/L
  - Higher colloidal osmotic pressure
  - LMW substances excreted in urine in 24 hrs

- *Metabolism :*
  - Rapid amylase dependent breakdown and renal excretion up to 50% in 24 hrs

- *Advantages :*
  - Non antigenic
  - Does not interfere with blood grouping
  - Greater plasma volume expansion
  - Preserve intestinal micro vascular perfusion in endotoxaemia
  - Duration – 24 hrs
- *Disadvantages :*
  - Increase in *Serum amylase concentration up to 5 days after* discontinuation
  - Affects coagulation by prolonging PTT, PT and bleeding time by lowering fibrinogen
  - Decrease platelet aggregation , VWF , factor VIII

- *Contra indications :*
  - Bleeding disorders , CHF
  - Impaired renal function
- *Administration :*
  - Adult dose 6% solution – 500ml to 1 lit
  - Total daily dose should not exceed 20ml/kg

Pentastarch :

- LMW derivative (2,64,000) 3%, 6% and 10% solution
- Lower degree of esterification
- Lesser effect on coagulation
- 10% solution can increase plasma volume 1.5 times of infused volume

Crystalloid or Colloids ???

- Crystalloids – recommended as the initial fluid of choice in resuscitating patients from hemorrhagic shock
  - » *Svensen C, Ponzer S… Volume kinetics of Ringer solution after surgery for hip fracture. Canadian journal of anesthesia 1999 ; 46 : 133 - 141*

- COCHRANE Collaboration in critically ill patients –
  - *" No evidence from RCT that resuscitation with colloids reduces the risk of death, compared with crystalloids in patients with trauma or burns after surgery"*
    - » *Roberts I, Alderson P, Bunn F et al : Colloids versus crystalloids for fluid resuscitation in critically ill patients.. Cochrane Database Syst Rev(4) : CD,2004*


0 10 20 30 40 50 60 70 80 90 100
50 ml.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