

Final Med

# *Fluids and Electrolytes*

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## Overview

Fluids and electrolytes are very interesting

- Common important treatment of patients in hospital
- Common job for intern
- Common question for examiners to ask students

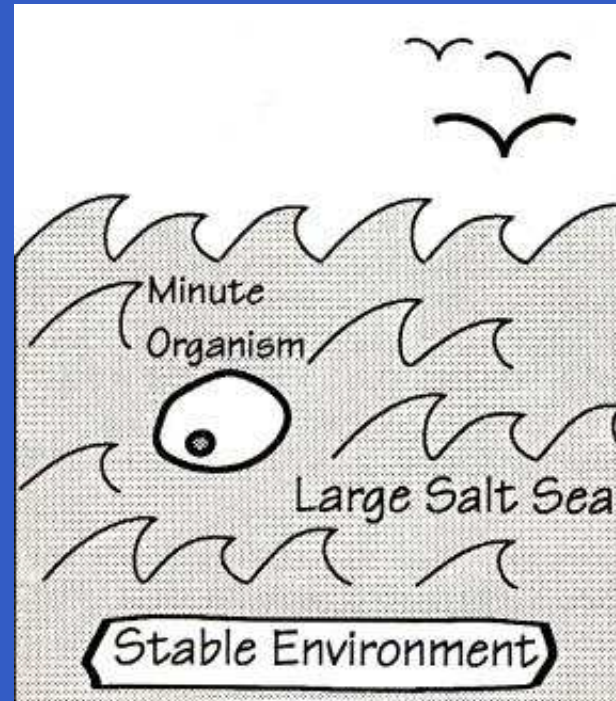
## Fluids and electrolytes

- Milieu Interieur
- Normal volumes, fluid compartments
- Normal compositions
- Volume of secretions into the gastrointestinal tract
- Composition of secretions into the gastrointestinal tract
- Clinical assesement of fluid status
- Types of fluids available for administration
- Normal fluid and electrolyte requirements

## Milieu Interieur... Amoeba

Simple unicellular organism in sea

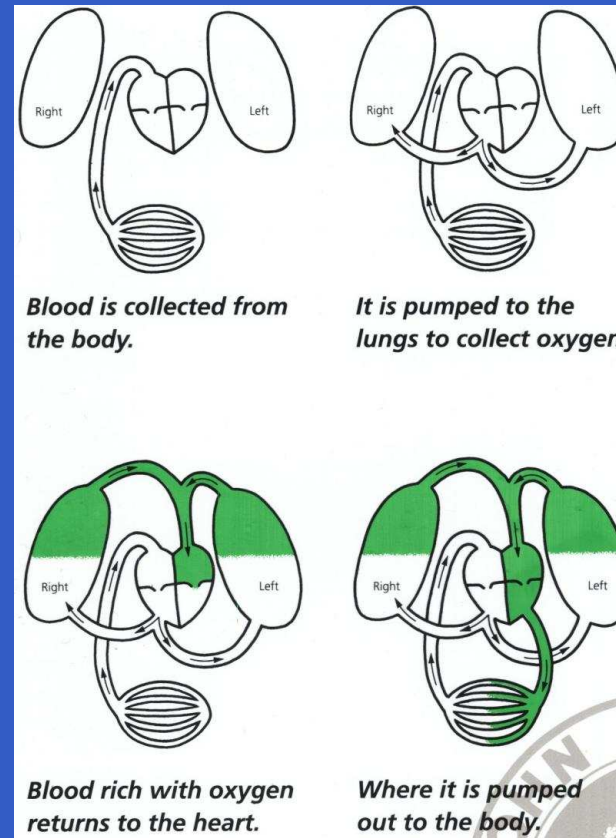
- Nutritional needs supplied
- Waste products removed



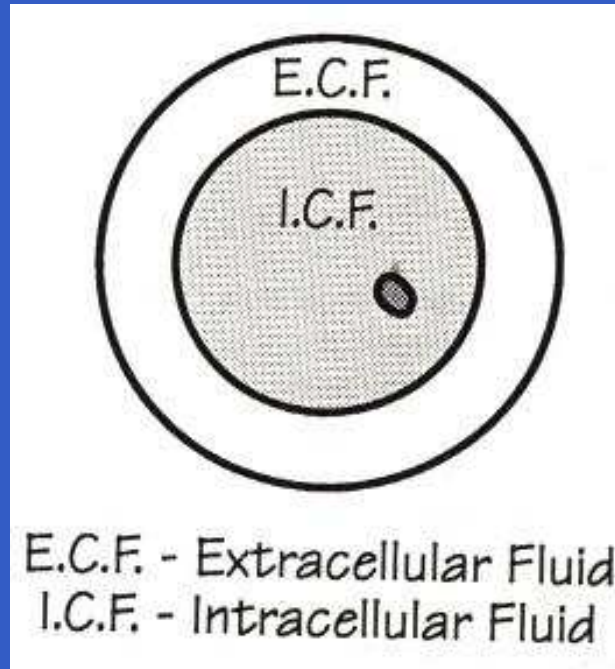
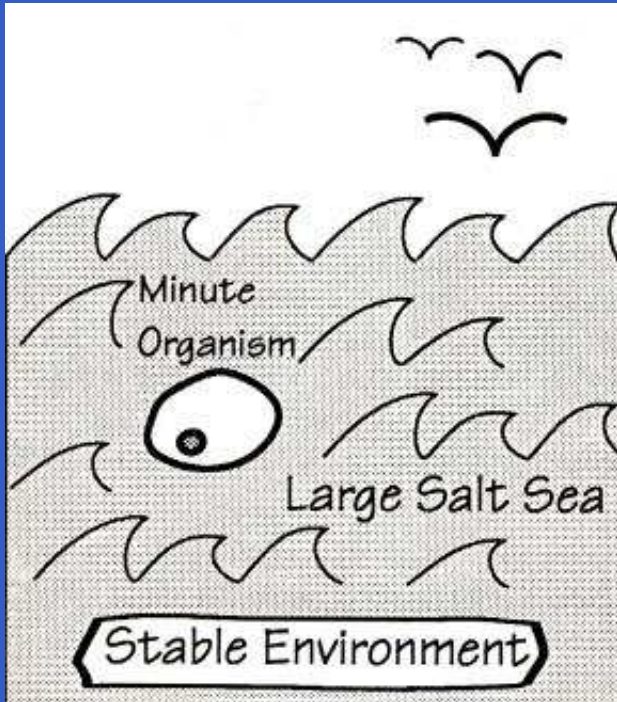
# Milieu Interieur... Humans

Complex multicellular organism

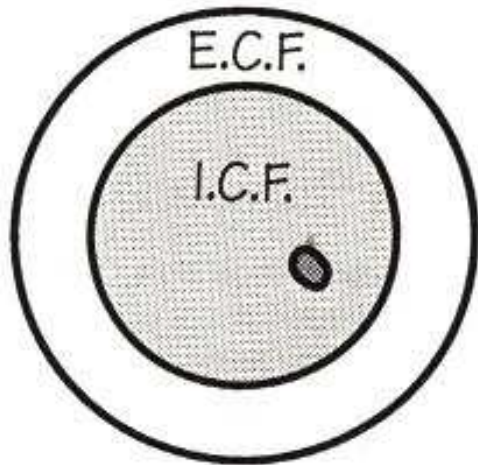
- Needs circulatory system
- Needs special organs



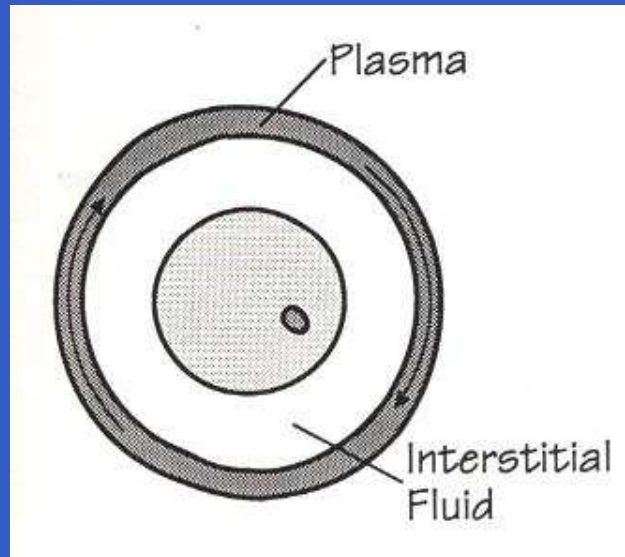
# Fluid compartments . . . Amoeba



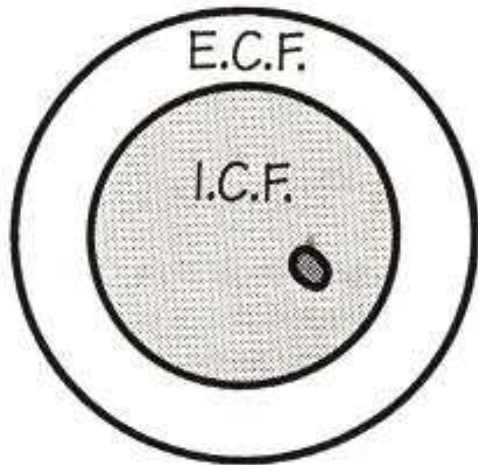
# Fluid compartments . . . Humans



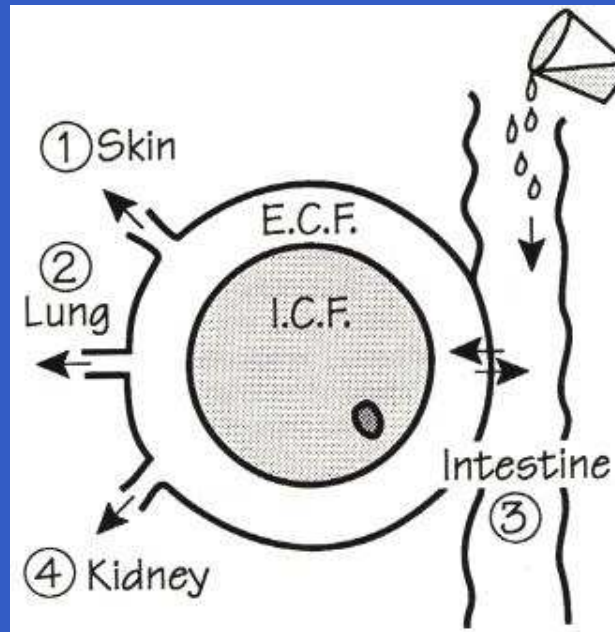
E.C.F. - Extracellular Fluid  
I.C.F. - Intracellular Fluid



# Fluid compartments . . . In-Out



E.C.F. - Extracellular Fluid  
I.C.F. - Intracellular Fluid





## Fluid compartments

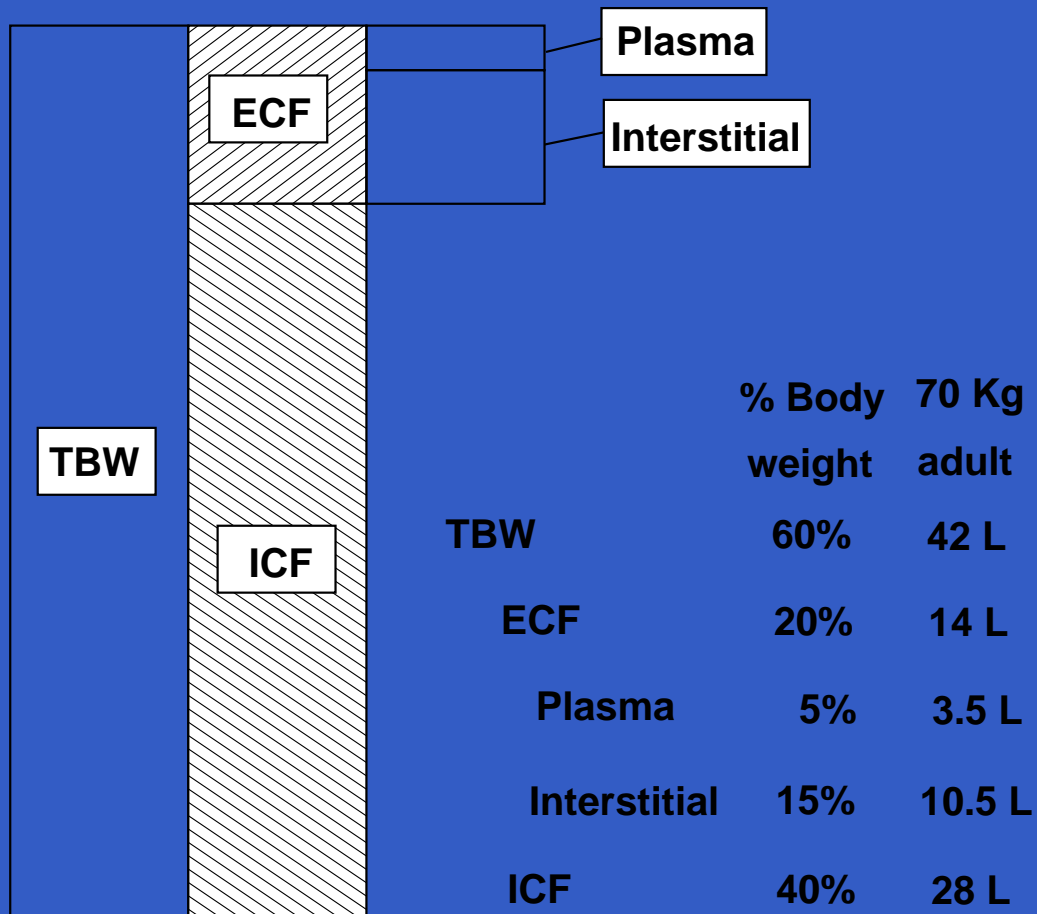
$$70 \times 0.6 = 42 \text{ Litres} \dots \text{Total body water}$$

$$42 \times 0.66 = 28 \text{ Litres} \dots \text{ICF}$$

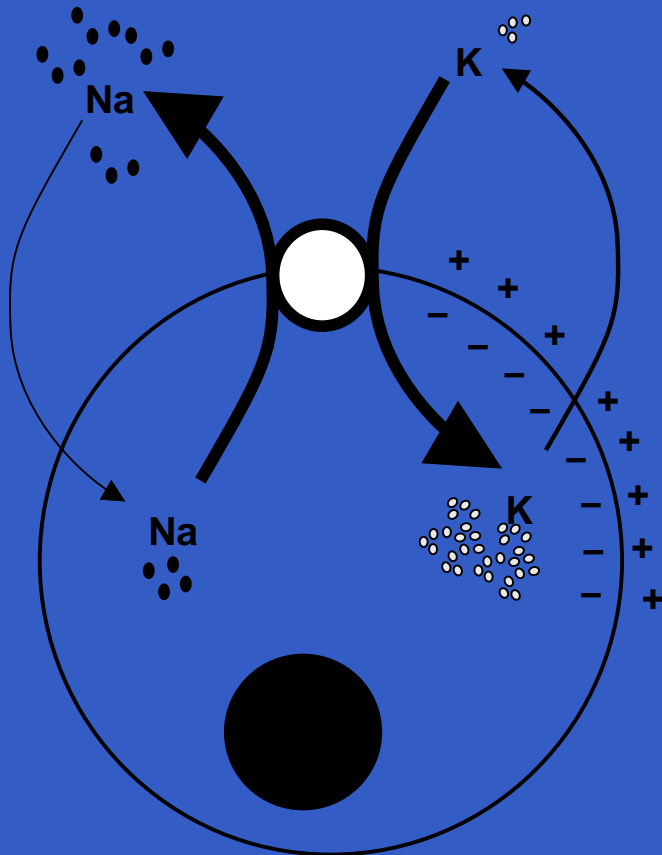
$$42 - 28 = 14 \text{ Litres} \dots \text{ECF}$$

$$14 \times 0.25 = 3.5 \text{ Litres} \dots \text{Plasma}$$

# Normal volumes



# The pump



- Na out K in
- ATP dependent
- Gradient of 140 mmol
- K leaks out faster than Na leaks in

# Normal composition

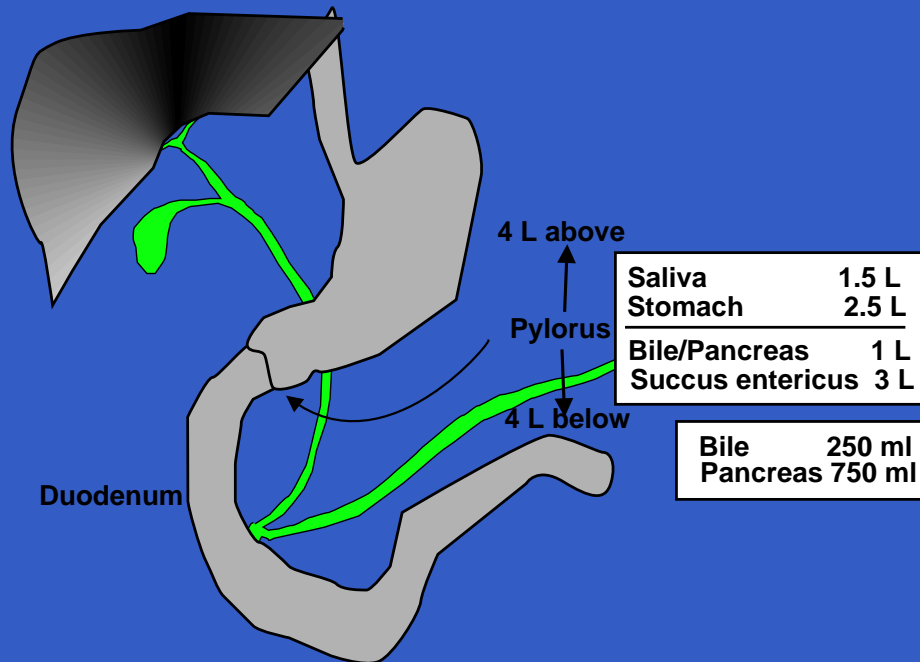
ECF (154)		ICF (200)	
cations (+ve)	anions (-ve)	cations (+ve)	anions (-ve)
Na (142)	Cl (103)	K (150)	HPO <sub>4</sub> SO <sub>4</sub> (150)
	HCO(27)		
	AGap		
K (4)	Protein (16)		
Ca (5)		Mg (40)	Protein (40)
Mg (3)		Na (10)	HCO(10)

- Anode is positive
- Anions go to the anode
- Negative ions are anions
- Positive balanced by negative

## Anion gap: sodium - (chloride + bicarbonate)

- Unmeasured anion contribution of phosphate and sulphate
- Calculated as  
sodium - (chloride + bicarbonate)
- If AG is increased - more acid in blood
- If normal then - bicarbonate loss, renal tubule dysfunction or acid loading

# Secretions into GI tract

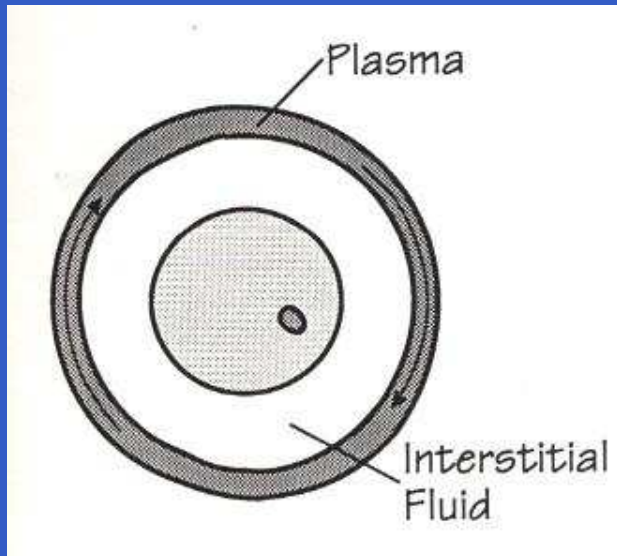


- 4 L above 4 L below
- Spit is 1.5 L
- Succus entericus is 3 L
- Bile 250 ml

## Composition of GI secretions

	<b>Plasma</b>	<b>Saliva</b>	<b>Stomach</b>	<b>Pancreas</b>	<b>Bile</b>
$\text{Na}^+$	140	10	<b>60</b>	140	145
$\text{K}^+$	4	<b>26</b>	10	5	5
$\text{Cl}^-$	110	10	130	75	100
$\text{HCO}_3^-$	30	30	<b>0</b>	<b>115</b>	<b>35</b>

## Clinical assessment of fluid status



- Body water up or down
- Which compartments
- Changes in ICF hardest to detect (hidden by the ECF)
- In ECF changes in plasma easier to detect than changes in interstitium



## Symptoms of low body water

- Thirst
- Confusion
- Altered level of consciousness

## Signs of low body water

- Dry mucous membranes
- Decreased skin elasticity
- Decreased intraocular pressure
- Cardiovascular decompensation

## Dehydration

Symptom or sign	Deficit	Volume (70Kg man)
Thirst	3%	1.5 L
Dry Mucosae	5%	2 L
Decreased skin elasticity	8%	3.5 L
Fall in intraocular pressure	10%	4.5 L
Tachycardia Hypotension	> 15 %	6.5 L

## Changes in plasma volume

### Forward compartment

- Pulse (ECG)
- Blood pressure (Arterial Line)
- Tissue perfusion (Urinary output, ABG)

### Backward compartment

- Change in venous pressure (CVP)

# ATLS Classes of Haemorrhage

	<b>Class I</b>	<b>Class II</b>	<b>Class III</b>	<b>Class IV</b>
Blood loss (ml)	Up to 750	750-1500	1500-2000	>2000
Blood loss (% blood volume)	Up to 15%	15-30%	30-40%	>40%
Pulse Rate (beats per minute)	<100	>100	>120	>140
Blood Pressure	Normal	Normal	Decreased	Decreased
Pulse Pressure	Normal or ↑	Decreased	Decreased	Decreased
Respiratory Rate (breaths per minute)	14-20	20-30	30-40	>35
Urine Output (ml/hr)	>30	20-30	5-15	Negligible
CNS/Mental Status	Slightly anxious	Mildly anxious	Anxious confused	Confused, lethargic
Fluid Replacement (3:1 rule)	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and blood

## Changes in interstitium

- Expansion - oedema (check dependent part, auscultate lungs, CXR)
- Contraction - dry mucosae, decreased skin elasticity, decreased intra-ocular pressure

## Changes in ICF

- Difficult to assess
- Brain is main organ affected
- Headaches and confusion due to contraction or expansion of ICF
- Expansion dangerous due to limited space in skull
- Contraction dangerous as it may cause bleeding

## Examine patients fluid status

- History - thirst, losses, confusion
- Examination - pulse, blood pressure, central venous pressure, mucosae, skin elasticity, intraocular pressure, gallop rhythm, mitral incompetence, cardiomegally, fine bibasal creps, oedema of dependent parts
- Inspect input - output chart, weights



# Oedema



## Fluids available for therapy

- Crystalloids
- Colloids
- Crystalloids are in solution
- Colloids are in suspension
- Tindal effect

# Crystalloids

Name	Na <sup>+</sup>	K <sup>+</sup>	Cl <sup>-</sup>	HCO <sub>3</sub> <sup>-</sup>	Ca <sup>2+</sup>	Glucose
Normal Saline	150	0	150	0	0	0
Hartman's	131	5	111	29	2	0
Dextrose Saline	30	0	30	0	0	43 g/L
Dextrose 5%	0	0	0	0	0	50 g/L

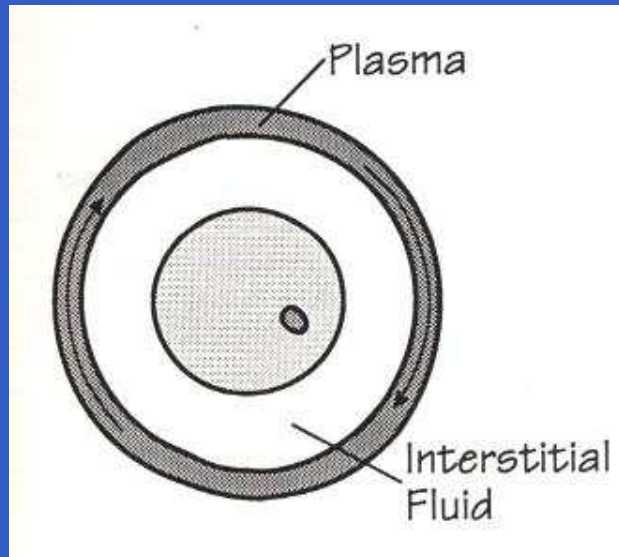
## Colloids in common use

- Gelofusin
- Whole blood
- Packed red blood cells
- Fresh frozen plasma

## Why these fluids?

- Must not be toxic
- Must not cause haemolysis (to much water)
- Must not damage vein too much (too little water)

## Where do the fluids go?



- Colloids into plasma
- Saline and Hartmans into ECF
- Dextrose 5% into total body water

## Normal volume requirements - Holliday-Segar regimen

Volume of fluid (ml) /(kg body weight) per hour	
Up to 10 kg	4 mls/kg
From 10 – 20 kg	2 mls/kg
In excess of 20 kg	1 ml/kg for every kg after

$$10 \text{ kg} @ 4 \text{ mls/kg} = 40 \text{ ml/hr}$$

$$10 \text{ kg} @ 2 \text{ mls/kg} = 20 \text{ ml/hr}$$

$$50 \text{ kg} @ 1 \text{ ml/kg} = 50 \text{ ml/hr}$$





## Electrolyte requirements

Sodium ( $\text{Na}^+$ )	1 mmol/kg/24 hours
Potassium ( $\text{K}^+$ )	0.5 mmol/kg/24hours

## Normal fluid and volume requirements

- 3 litre H<sub>2</sub>O / 24 hr
- 80-100 mmol Na<sup>+</sup> / 24hr
- 60 mmol K<sup>+</sup> / 24hr

eg. 1L Soln 18 with 20mmol K<sup>+</sup> over 8 hours (repeat times 3)

## Fluid prescription

- Existing deficit (Based upon your clinical assessment)
- Maintenance (See above)
- Ongoing loss, (Fluid for fluid, eg NaCl 0.9% for NG loss)

Monitor clinical status, weight, input output and urea and electrolytes