SR1502 Applied Exercise Physiology

Water Balance & Hydration

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Course info and some Powerpoint files can be found at www.abdn.ac.uk/sms

Click on “Course Guides” and select “SR1502”

Homeostasis

- The body continually strives to maintain a constant internal environment despite external perturbations.
- This constant balancing act is the basis of most of our physiology, and is termed HOMEOSTASIS.
- Every process in our body is constantly changing from second to second and we keep trying to correct any changes from normal.

The Need for Water

- Most important nutrient
- No energy
- Main constituent of the body
- Body temperature regulation - important to the normal person and the athlete

Water Intake

Fluids 1,250 ml

Food 1000ml

Metabolism 350 ml

Total 2,600 ml

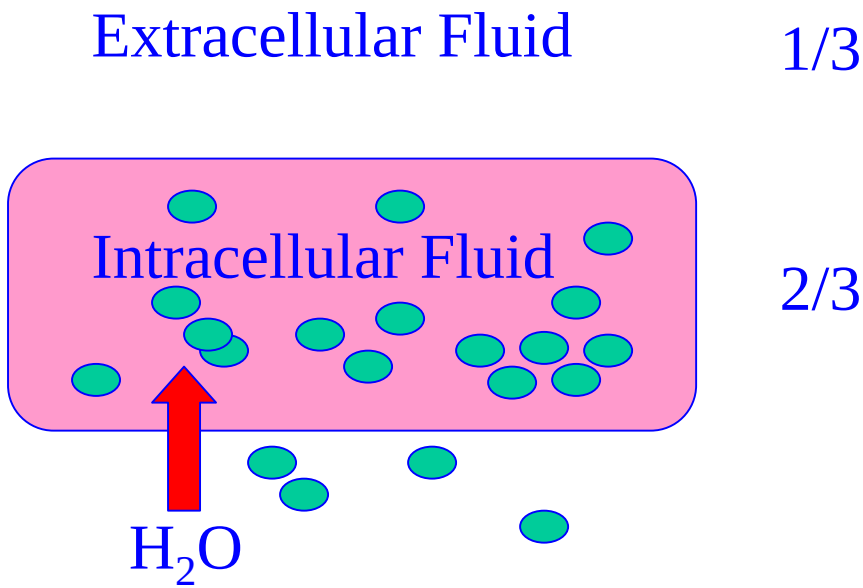
Water Output

Urine -	1500 ml
Faeces -	100 ml
Lungs & skin -	900 ml
Sweat -	100 ml
Total -	2600 ml

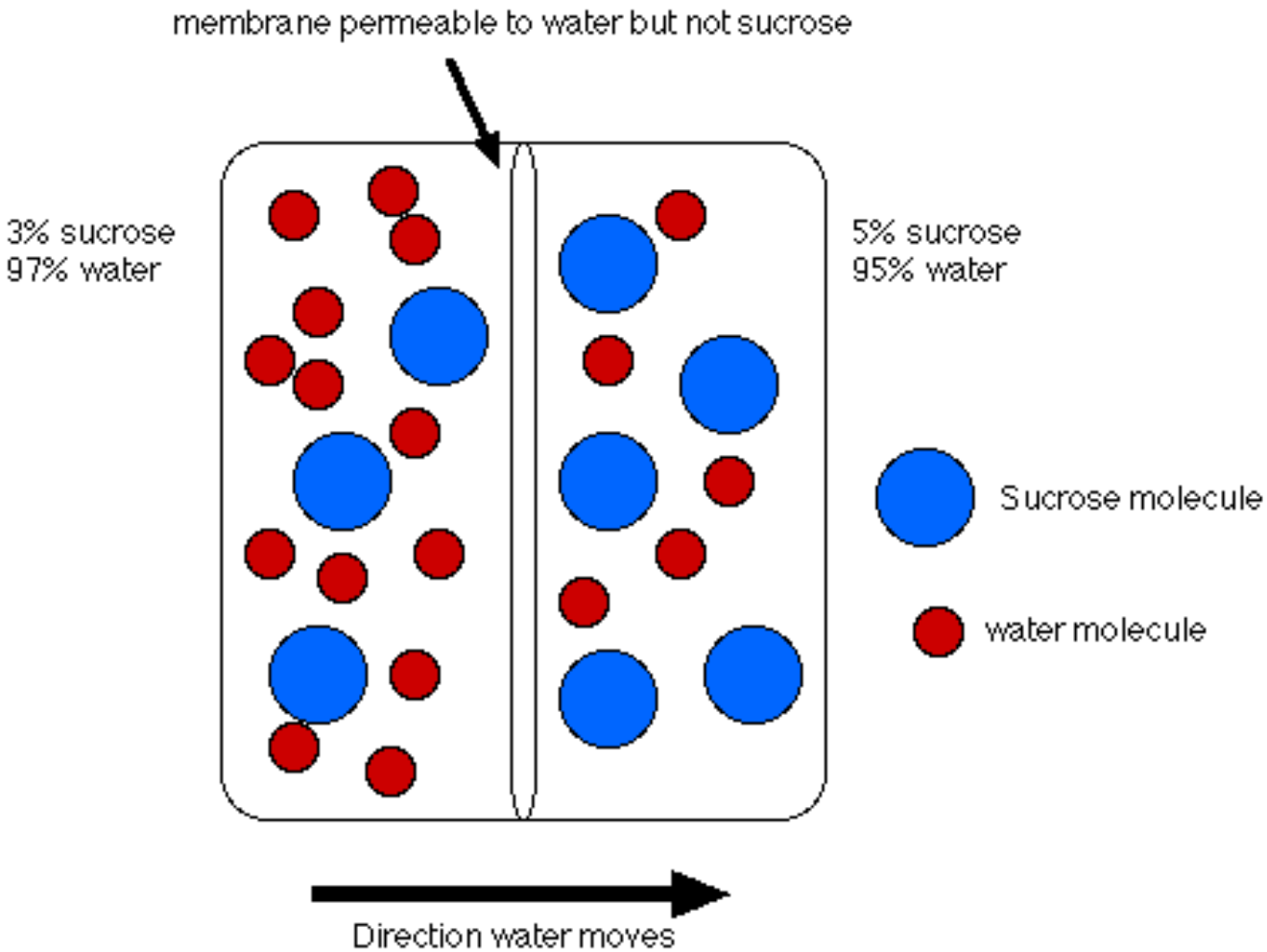
Fluid balance

Why is most water inside the cell?

- Most molecules (proteins) are inside the cell
- Water follows by osmosis



Osmosis



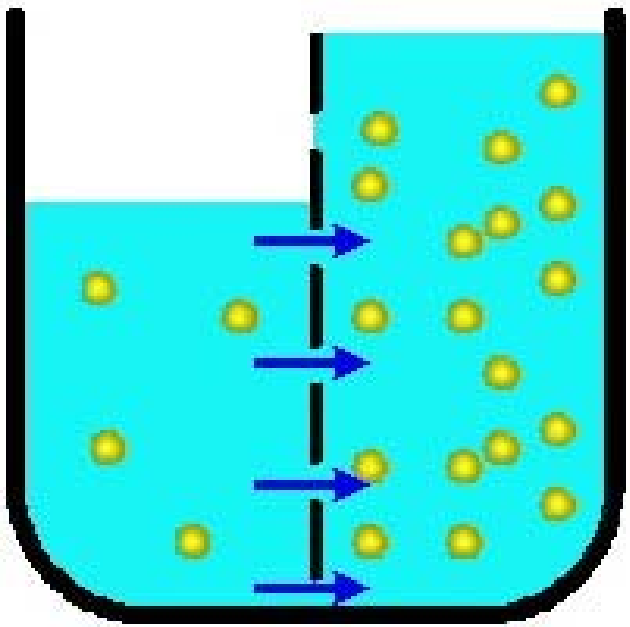
Rules: water moves from:

i) higher water concentration to lower water concentration

or

ii) lower solute (e.g., sucrose) concentration to higher solute concentration.

Osmosis



Osmosis

(Water moves by concentration gradient)

Total Body Fluid

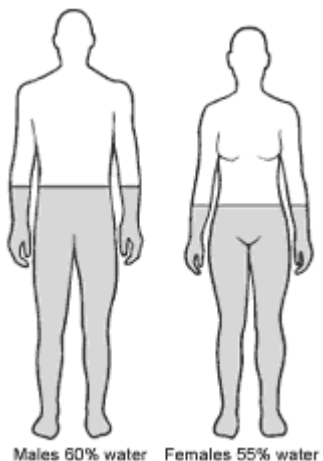
Most abundant component of the human body (40-80%)

% Water per tissue	
Plasma	90%
Skin, Muscle	70-80%
Skeleton	22%
Fat	10%

Total Body Fluid

60% in males

50% in females



Extracellular Fluid (surrounding cells)	1/3
Intracellular Fluid (inside cells)	2/3

Body Fluid Compartments

Compartment	*Fluid Vol. (l)*	*% Body Fluid*	*% Bodymass*
Total Body Fluid	42	100	60
Intracellular Fluid (ICF)	28	67	40
Extracellular Fluid (ECF)	14	33	20
Plasma	2.8	6.6 (20% ECF)	4
Interstitial Fluid	11.2	26.4 (80% ECF)	16
Lymph & Transcellular Fluid	Neg.	Neg.	Neg.

Ionic Composition of Major Fluid Compartments

Ion	*Plasma*	Interstitial	*Intracellular*
Na^{+}	140	145	10
K^{+}	4	4	160
Ca^{2+}	2	2	$1*10^{-4}$
Cl^{-}	100	115	3
HCO^{3-}	28	30	10
$PO4^{3-}$	Neg.	Neg.	120
Protein	16	10	55

The Need for Salt

- Sodium Chloride (NaCl)
- Fluid balance
- Muscle contraction
- Nerve conduction
- Hedonistic (i.e. more to do with pleasure or satisfaction) rather than regulatory appetite
- 0.5-2.5g/day

Salt Intake

Salt Output

Ingestion 10.5g

Obligatory loss in:

Sweat

Faeces
0.5 g

Urine -
10 g

Salt balance

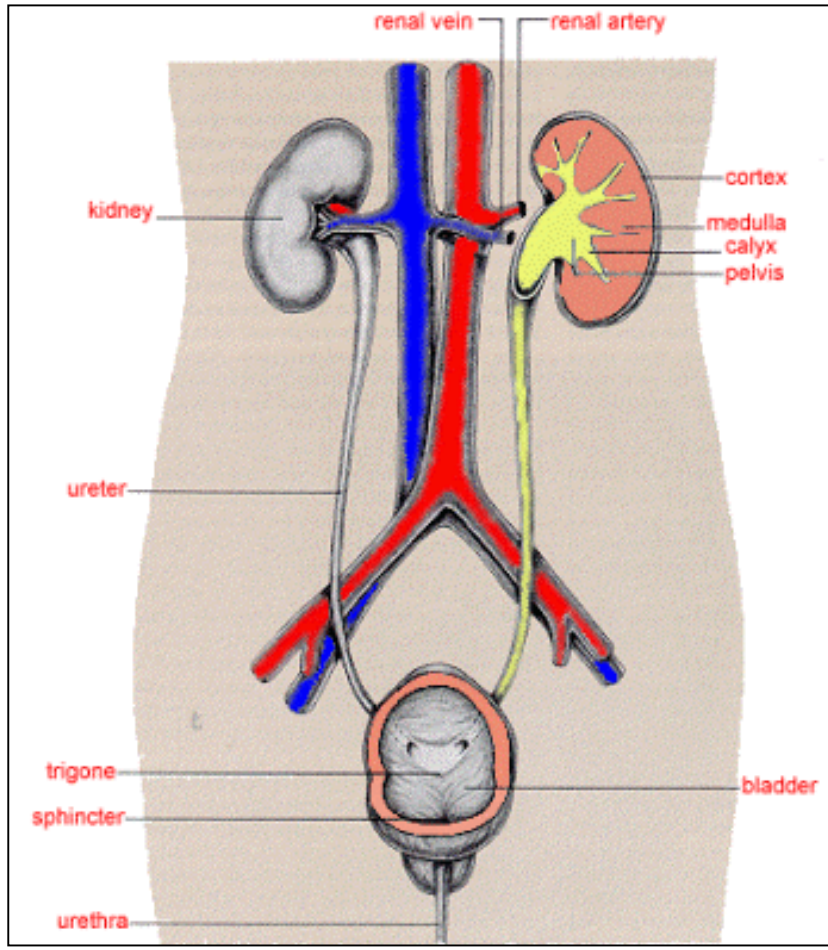
Functions of the Kidney

Regulation of

(A) fluid balance

(B) electrolyte balance

Primary route for elimination of potentially toxic metabolic wastes and foreign compounds



Water Regulation

- 80% of water is absorbed in proximal tubules (1st part of nephron – Renal lecture)
- However, further reabsorption is required to prevent dehydration.
- Controlled by the hormone, Vasopressin (ADH) – renders distal portion of tubules permeable to water & creates concentration gradients through pumping out Na^+ and Cl^-.
- Detected by ion concentration in blood near hypothalamus (Na^+).
- Also stimulates thirst so you increase your water intake.

Control of Water and Salt Balance

Ionic & Osmotic homeostasis

Neural/Endocrine (hormones)

(1) Control of kidney filtration rate

(2) Control of salt reabsorption (reabsorb at least 90% NaCl)

(3) Control of water reabsorption

Volume of urine produced

(1) Hydrostatic pressure (pressure due to fluid in nephron that allows you to filter the blood)

(2) Solute concentration

(3) Vasopressin (ADH) - hormone

(4) Water loss by other systems e.g. sweating

Medical applications – Diuretics and treatment of hypertension – you urinate out the excess fluid that causes high blood pressure

Sweat production

- Why do we produce sweat?
- How much can we sweat?
- What effect will this have on exercise performance?

Dehydration in team sports

Sport	*Sweat Loss (ml)*	*Fluid Intake (ml)*	*Dehydration (% BM)*
Soccer	1935	825	1.4
Soccer	1585	530	1.4
Soccer (F)	1505	810	1.2
Rugby union	2160	751	1.6
Rugby union	2100	150	2.5
Basketball	2310	1515	0.9
Basketball (F)	1420	930	0.7
Basketball (F)	1320	810	0.7
Water Polo	595	285	0.4

10-25 °C

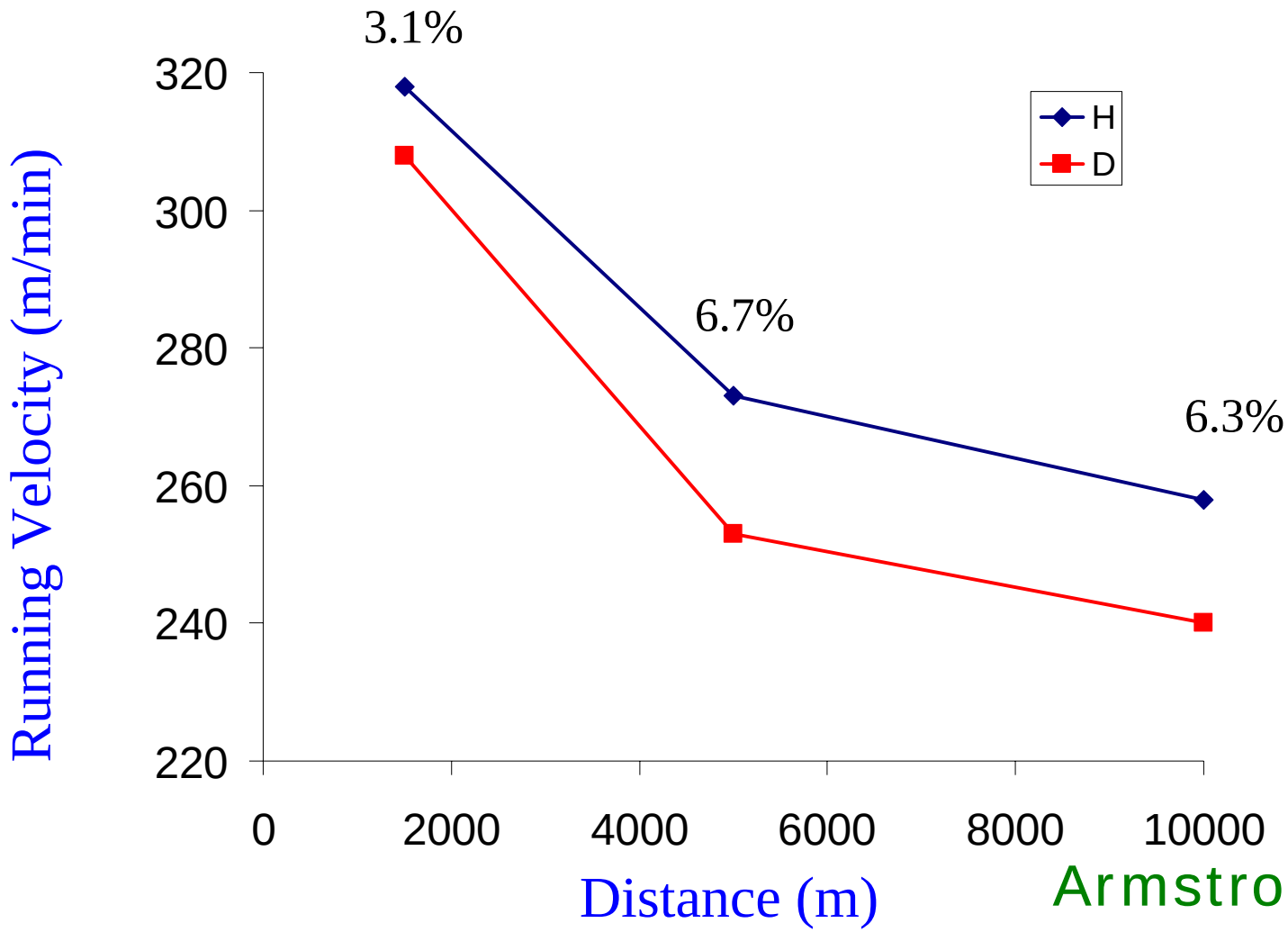
Dehydration and exercise

Blood supply to muscles and skin is reduced

Lessens sweat losses + skin blood flow decreases

Single, High Power exertion, (a few seconds)	4-5% body mass dehydration?
High Intensity (< a few minutes)	2-3 body mass dehydration %
Endurance Performance	>1.5 body mass dehydration %

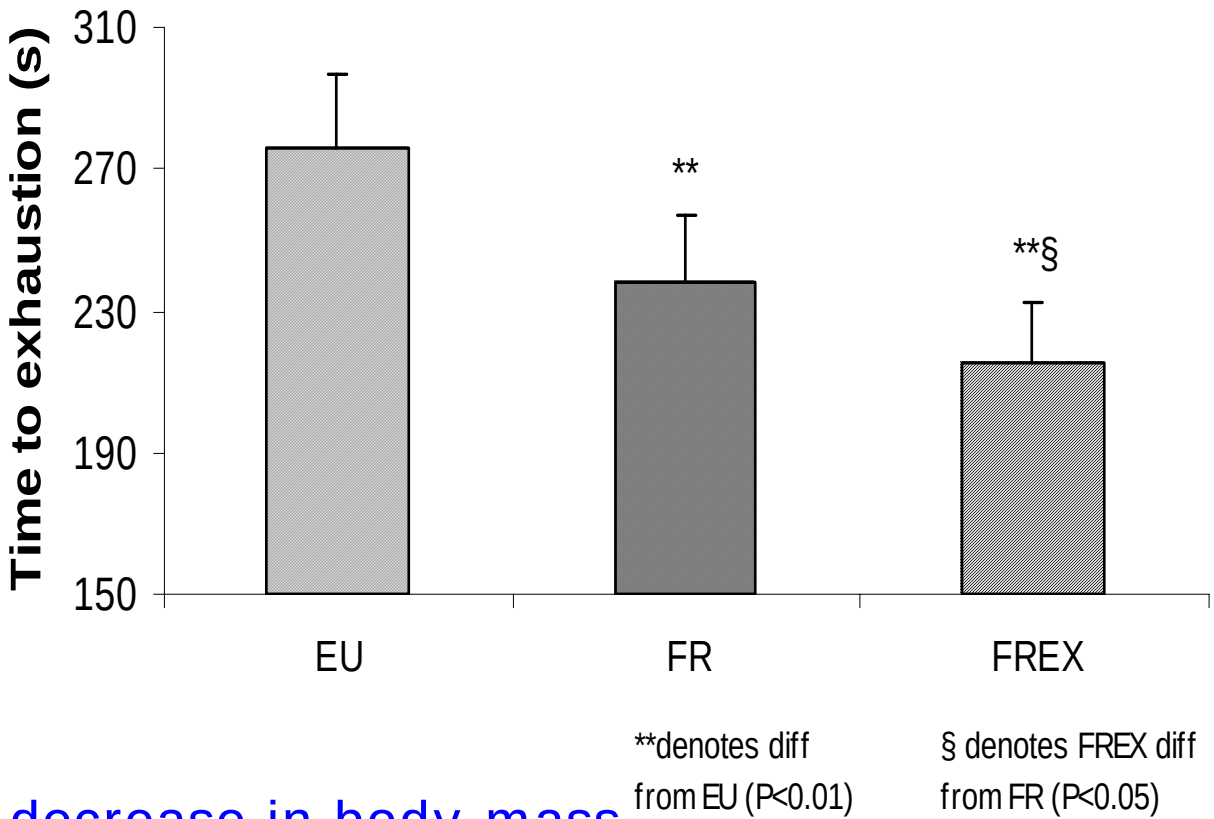
Dehydration & Performance



Armstrong *et al.* *1985*

Dehydration of ~2% body mass

Dehydration and Exercise Capacity



- 2% decrease in body mass
- 95% VO_2 max to exhaustion
- Dehydration causes elevated HR and perceived exertion