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Fluid Therapy

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DISTRIBUTION OF FLUID WITHIN THE BODY

3 main ‘compartments’, separated by semi-permeable membranes that allow water to move freely.

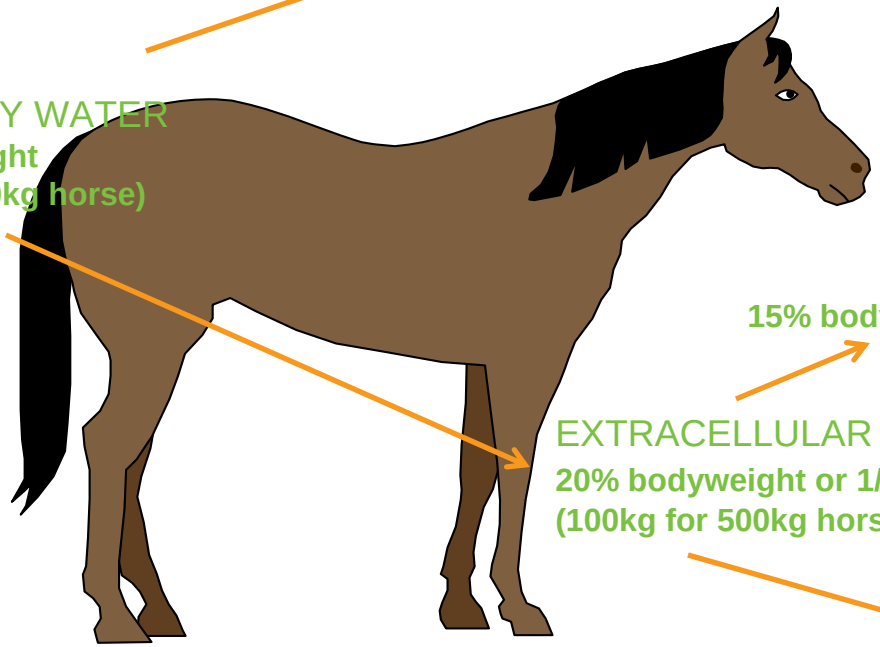
- *Intracellular compartment*
- *Interstitial compartment*
- Intravascular compartment

In all mammals, water makes up a significant part of the total bodyweight totalling ~60% or 2/3 of total bodyweight.

Distribution of fluid

INTRACELLULAR FLUID
40% Bodyweight or 2/3 total body water
(2OOKG for a 500KG horse)

TOTAL BODY WATER
60% bodyweight
(300kg for 500kg horse)



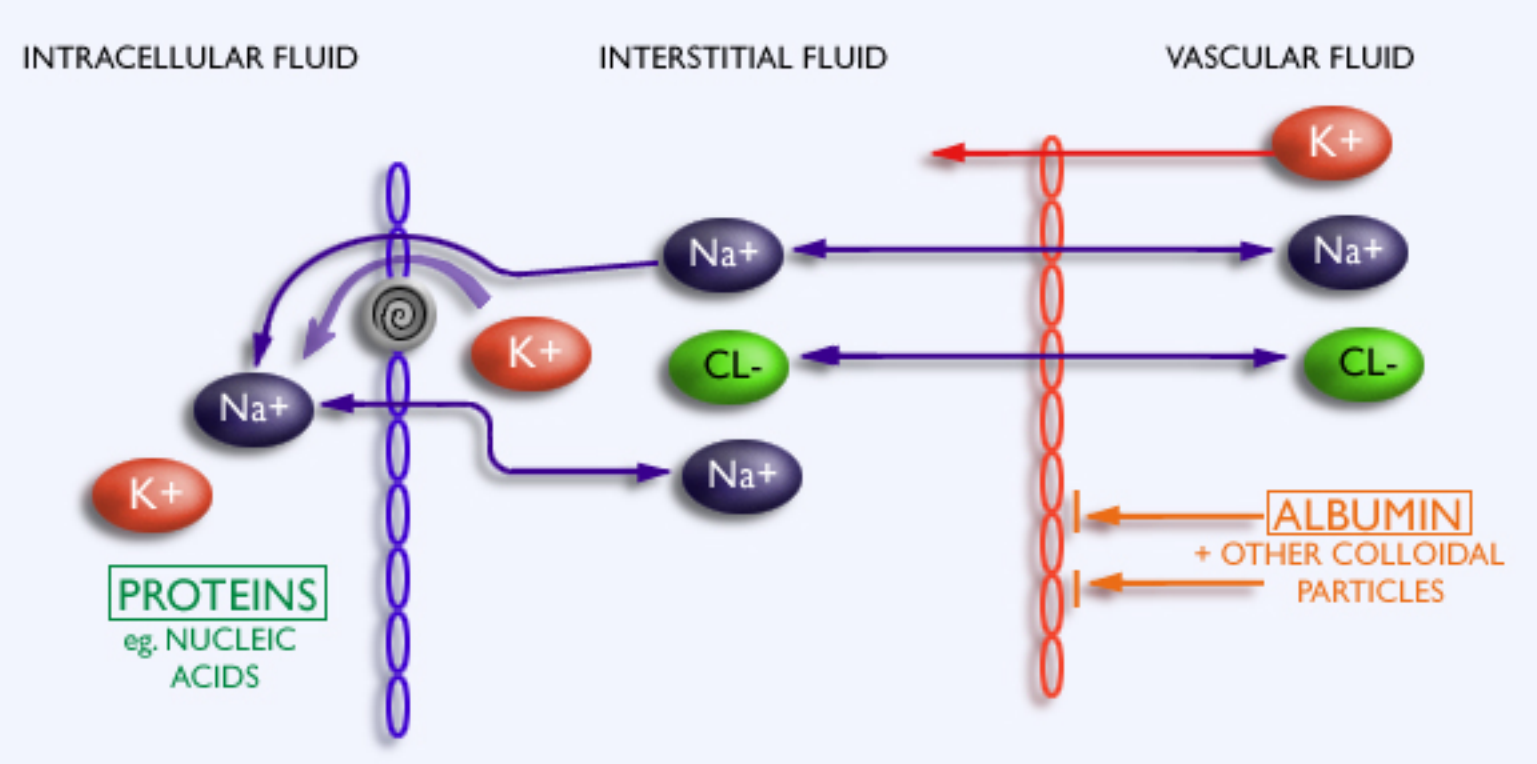
INTERSTITIALFLUID
15% bodyweight or 1/4 total body water
(75kg for a 500kg horse)

EXTRACELLULAR FLUID
20% bodyweight or 1/3 total body water
(100kg for 500kg horse)

INTRAVASCULAR FLUID
5% bodyweight or 1/12 total
(25kg for 500kg horse)

	INTRACELLULAR	EXTRACELLULAR	INTERSTITIAL	INTRAVASCULAR
500kg horse	200 litres	100 litres	75 litres	25 litres
20kg dog	8 litres	4 litres	3 litres	1 litre
5kg dog	2 litres	1 litre	0.75 litres	0.25 litre

Important osmotic particles



TYPES OF FLUID LOSS

- WHOLE BLOOD LOSS
- EXTRACELLULAR FLUID LOSS
- PROTEIN RICH EXTRACELLULAR FLUID LOSS
- PURE WATER LOSS

Whole Blood Loss

- E.g. artery rupture, splenic tear
- Blood loss exclusively from the intravascular compartment
- First 4- 6 hours the PCV and TP will not change
- No alteration in osmotic gradients
- PCV falls 4-12 hours post haemorrhage
- Some small proteins (albumin) restored to the plasma
- New red blood cells made in bone marrow which takes 3-5 days

Extracellular Fluid Loss

- E.g. diarrhoea, sweating
- MOST COMMON TYPE OF FLUID LOSS
- Components lost include Na+, Cl- and water
- Osmotic potential of the extracellular fluid does not change very much if losses in normal ratio
- Intravascular hypovolaemia stimulates increased sodium and water retention
- If water is lost in excess of electrolytes, ECF becomes hypertonic so water moves from intracellular compartment to ECF

Protein Rich Extracellular Fluid Loss

- E.g pleural /peritoneal effusions, GI sequestration, protein losing enteropathies, burns
- Extracellular fluid loss → interstitial compartment and intravascular compartment
- Components in fluid lost are Na^+, Cl^-, water and *proteins*
- Due to inflammation there is leakage / effusion of plasma proteins into the fluid
- If total protein in the blood falls below 30g/l then oedema will occur as water isn't easily retained in the intravascular space

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Pure water loss

- E.g. high respiratory rate or water deprivation
- Pure water loss → all three compartments!
- Components in fluid lost =water!
- The osmotic potentials all increase equally but the osmotic gradients remain the same, so that the remaining water distributes between the compartments in the 'normal' ratios.
- All compartments show reduction in volume and an increase in tonicity
- Thirst and ADH are released

Response of the body to fluid loss

- Hypovolaemia is a reduction of fluid in the intravascular compartment (or a reduced circulating volume).
- Clinical signs reflect the increase in sympathetic tone:

tachycardia

weak pulse quality

pale mucous membranes

prolonged capillary refill time

cool extremities

Hypovolaemia

Four laboratory/clinical tests that would help to confirm hypovolaemia:

1)PCV/TP in conjunction

2)High urine specific gravity/reduced urine production (1-1.5ml/kg/hr)

3)Low arterial blood pressure

4)Low central venous pressure

Vascular volume deficits are present in *all* types of fluid deficits.

Response of the body to fluid loss

- Dehydration is a reduced amount of fluid in the interstitial compartment.
- Animals that are dehydrated must also be hypovolaemic.
- Clinical signs of dehydration include
  - reduced skin pliability.
  - Thirst
  - Oliguria
  - Dry mucous membranes
  - Sunken eyes
  - Depressed mentation
  - Neuromuscular derangements
- Interstitial fluid is lost in all cases of fluid loss except whole blood loss.

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Intracellular Fluid Loss

- Largest fluid compartment but clinical signs associated with intracellular fluid loss are often vague.
- In general the main clinical sign is depressed mentation.
- Laboratory test to help confirm intracellular fluid loss:

High plasma Na^+

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Types of Fluids

- Crystalloids versus colloids?
- Isotonic/ hypotonic/ hypertonic?
- Which one??

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Types of Fluids

- Extracellular fluid replacers
- Fluids which have a similar composition to ECF e.g.
- Normal Saline
- Hartmann's Solution
- HARTMANN'S ~131mmol Na^+, 5mmol K^+, 111mmol Cl^-, 29mmol LACTATE
- For each litre of Hartmann's administered only ~250ml remains in the intravascular space.
- To restore blood volume quickly infusion rates of 90ml/kg/hr are needed.

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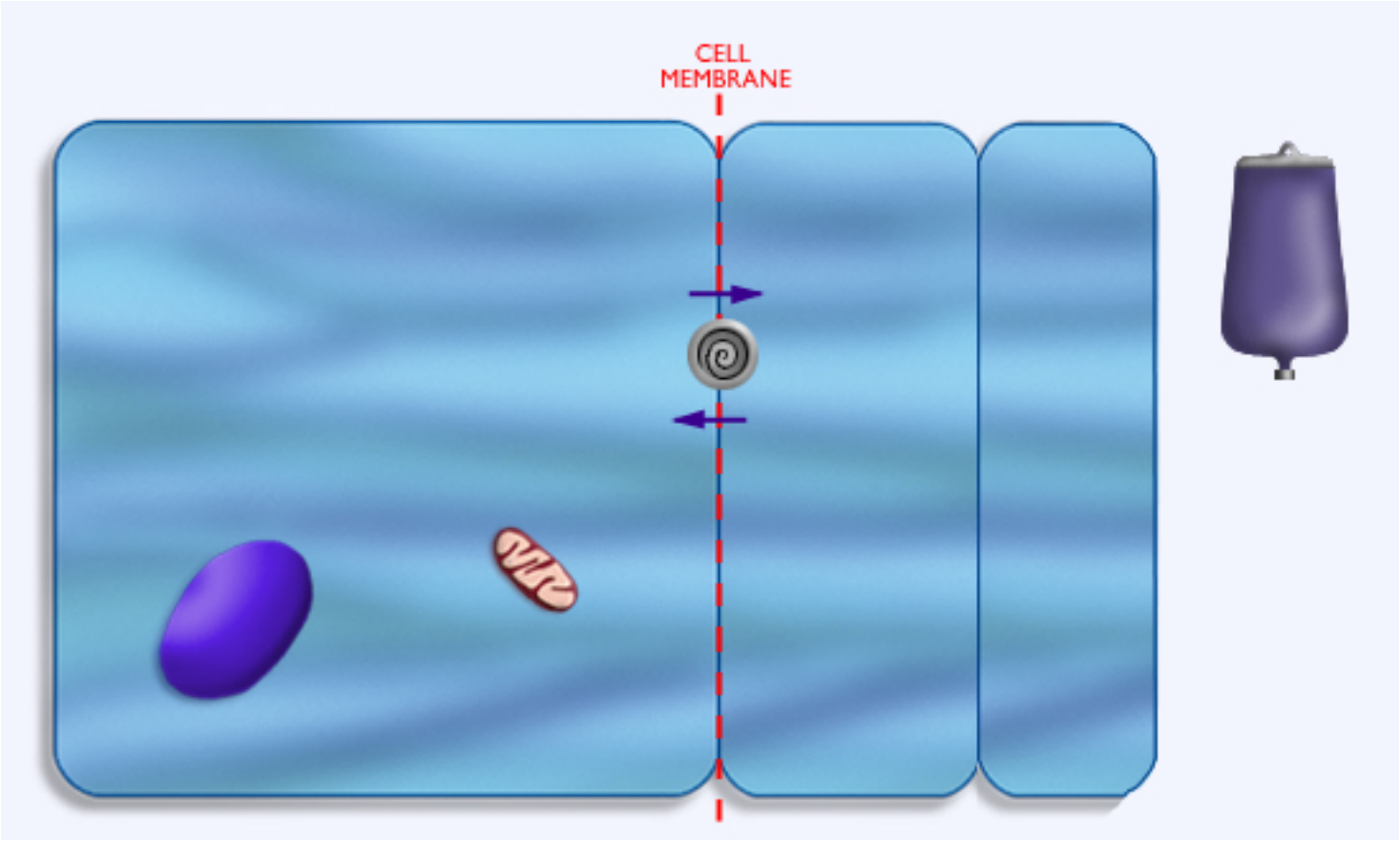
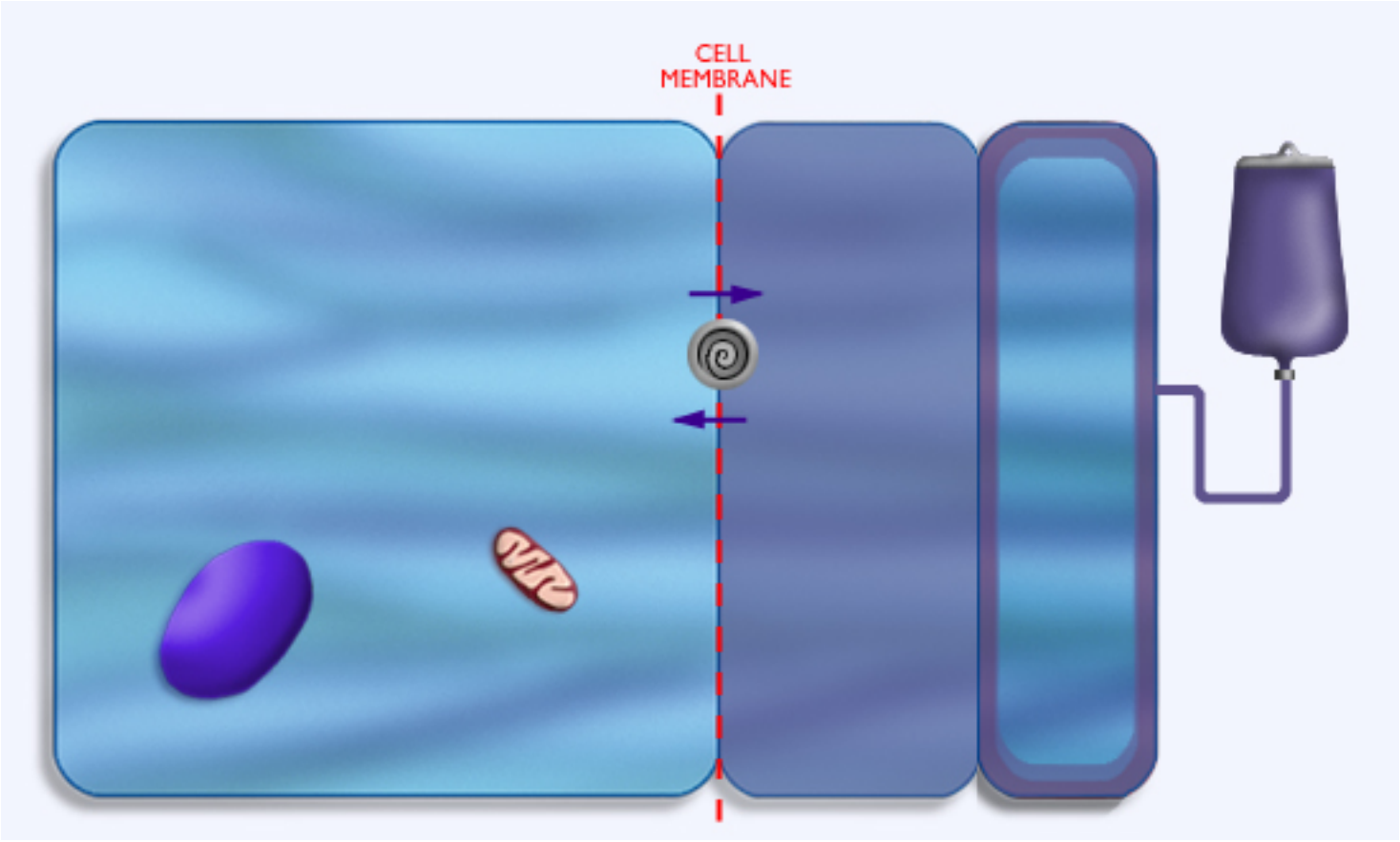
Types of Fluids

- Normal saline
- Not as closely matched to ECF as Hartmann's solution
- Does not contain lactate
- Too much chloride given for the body's requirements
- Hypokalaemia encouraged
- Good for treating hyponatraemia and hyperkalaemia

ECF volume replacers



ECF volume replacers



Types of Fluids

- Maintenance solutions/ water replacers
- Maintenance requirement for water is 50ml/kg/day or 2ml/kg/hour. Maintenance fluid should replace water and electrolytes. (see later)
- Normal fluid losses are hypotonic to the extracellular fluid, but contain more potassium. But can't put a solution into the vascular space that is too hypotonic, otherwise the blood cells would swell and burst

Maintenance solutions/ water replacers

- Aquapharm 18- 4% glucose with 0.18% sodium chloride, (supplemented with 20-30mEq/l of potassium for maintenance).
- This is physiologically the best solution as it contains some sodium to replace that which is lost during metabolism.
- 5% dextrose solution
- Recipe for horses is **1 part Hartmann's to 2 parts 5% dextrose with 5 - 10 mEq/l KCl added.**

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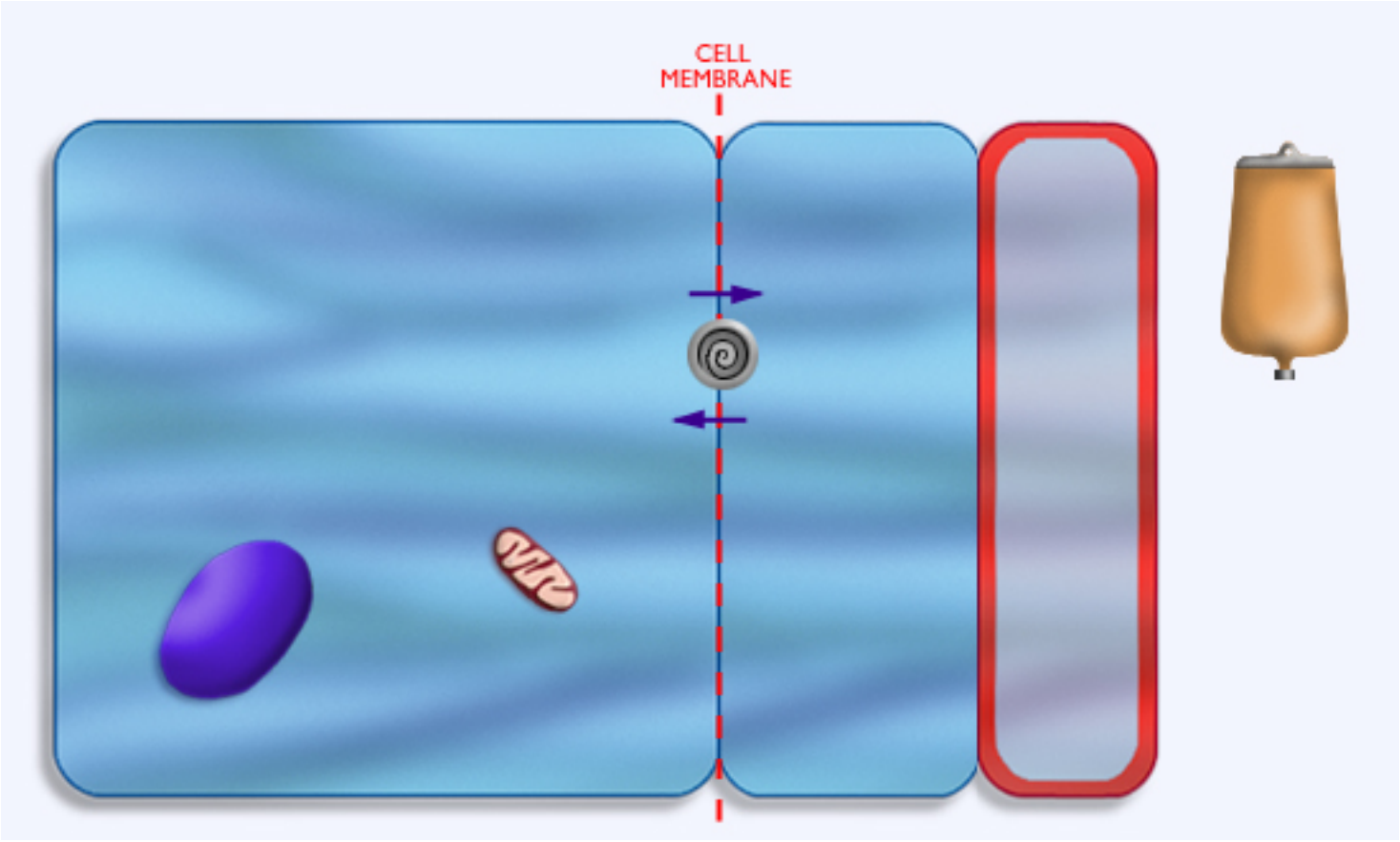
Maintenance solutions/ water replacers



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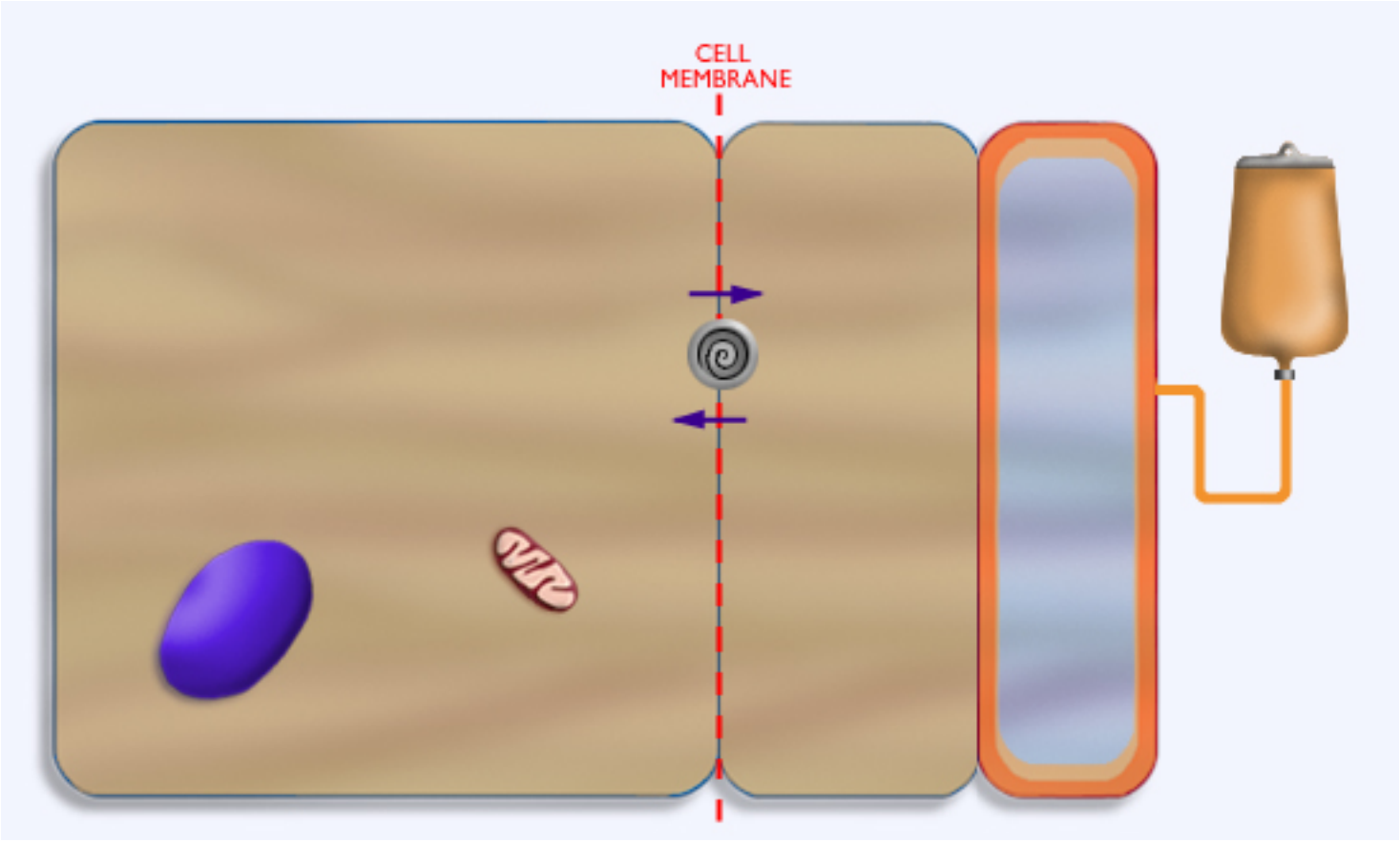
Maintenance solutions/ water replacers



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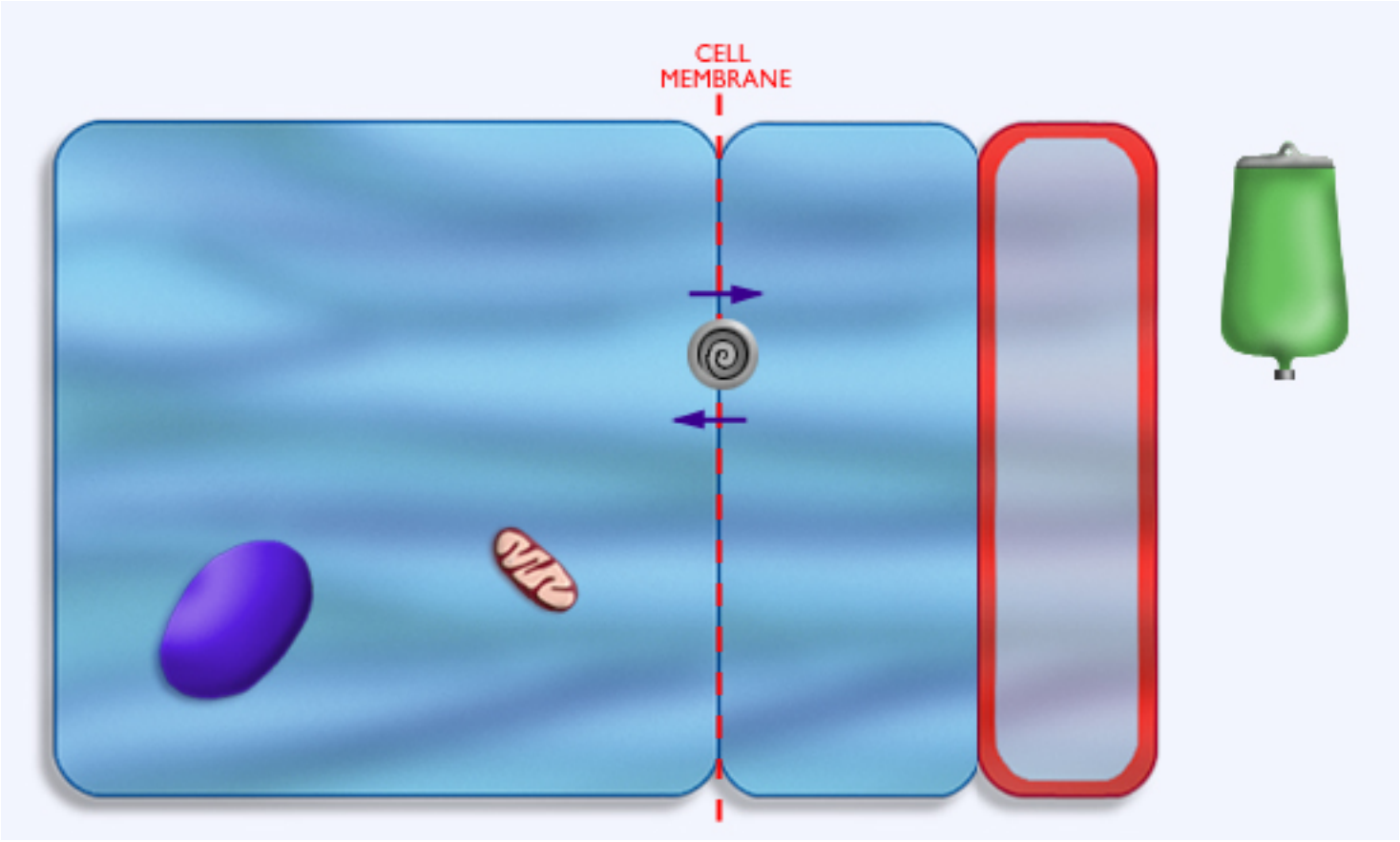
Types of Fluids

- Plasma volume expanders
  - Colloids and hypertonic saline

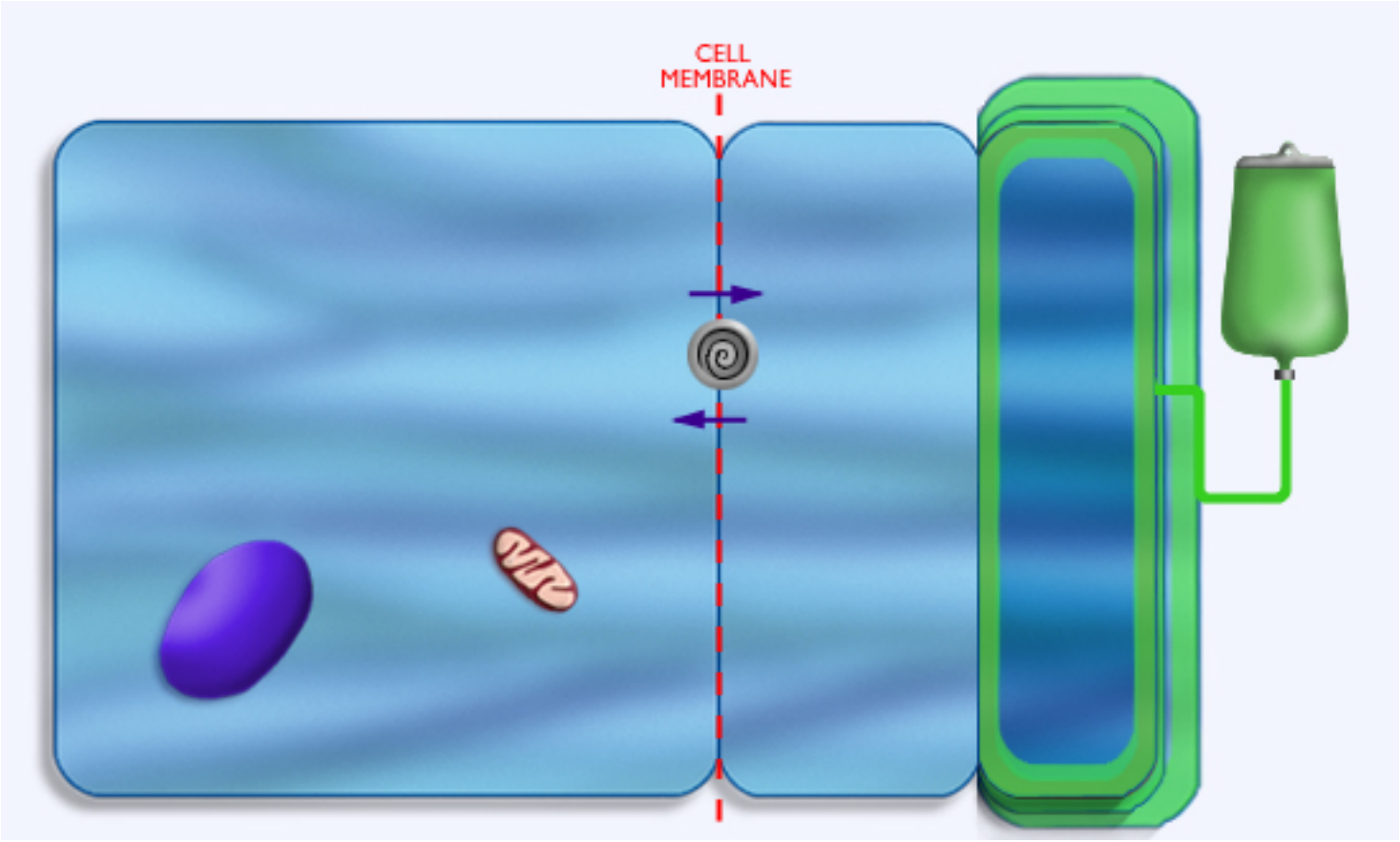
Colloids

- Colloids contain large molecules 5- 1000 kDa that cannot pass through the vascular endothelium.
- They increase the colloidal osmotic pressure of the plasma and ‘pull’ water from the interstitial space into the intravascular space. I.e. they are ‘PLASMA VOLUME EXPANDERS’
- ECF replacers should be used concurrently or soon after colloid administration in order to ‘payback’ the fluid taken from the interstitial space.
- Colloids should be used in any case where rapid improvement of circulating volume is necessary.
- However due to the large volumes required to have an impact on the circulating volume of an adult horse and the resulting cost, their use is restricted.

Colloids



Colloids



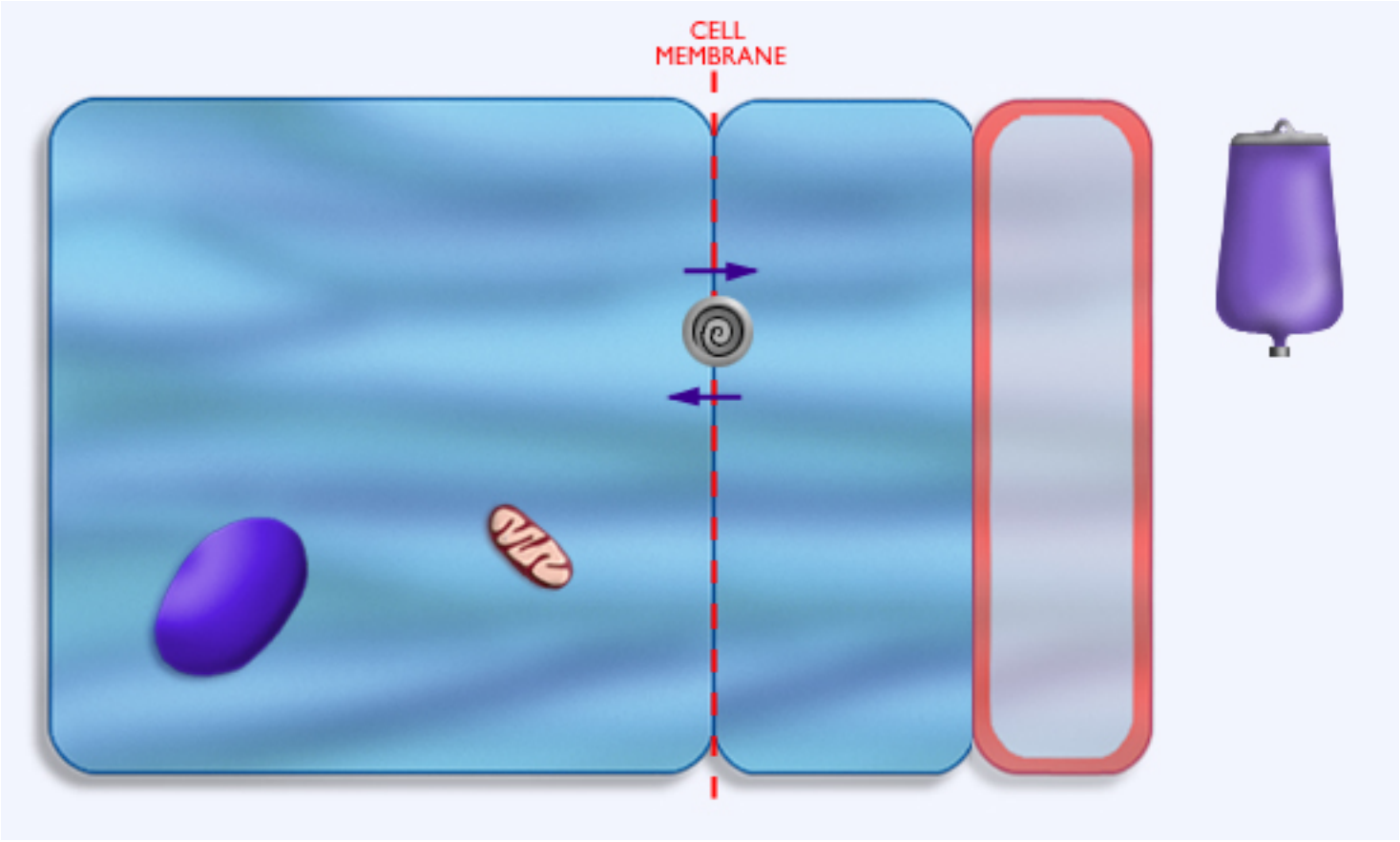
HYPERTONIC SALINE (7.2% NaCl)

Increases blood pressure by two mechanisms:

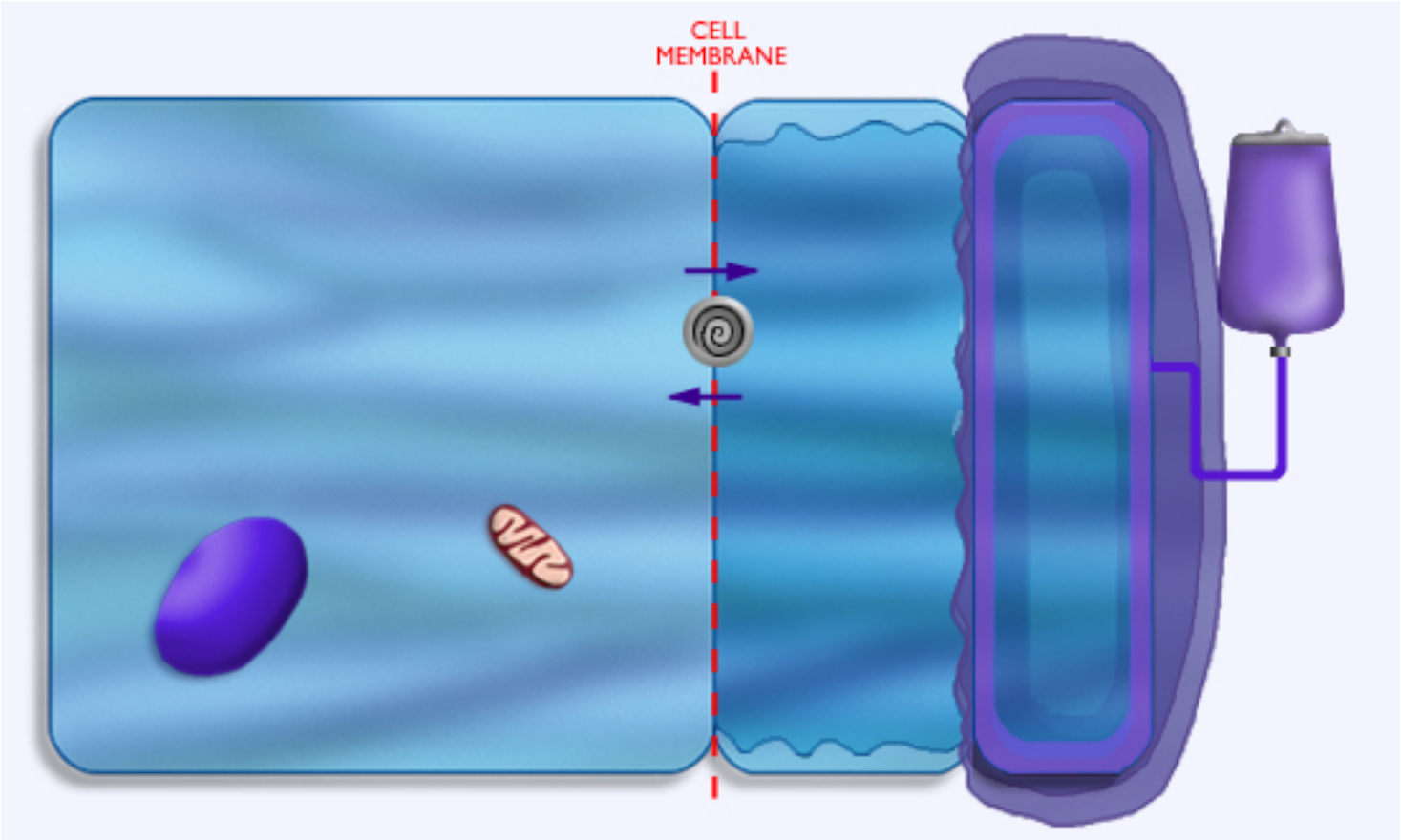
- it draws water from the interstitial space
- it causes a pulmonary-vagal reflex which leads to haemodynamic effects such as venoconstrction and a bypass of pulmonary circulation

Any effect is only transient (10-15 mins). Its use must be followed by the administration of isotonic crystalloids.

Hypertonic saline



Hypertonic saline



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Hypertonic saline

- Guideline dose is 4ml/kg over 10 mins (2L for a 500kg horse).

- Potential side effects include; hypernatraemia/hypokalaemia, haemolysis, thrombosis and the potential for re-haemorrhage.

- Repeated doses of hypertonic saline are contra indicated.

Fluid Therapy Plan

1. Restore circulating volume.

2. Then replace the fluid deficit

3. Then consider maintenance requirements

Fluid Therapy Plan

DEFICIT REPLACEMENT

3 MAIN QUESTIONS:

- How much fluid has been lost?
- What sort of fluid has been lost?
- How long will it take to replace that fluid?

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How much fluid has been lost????

- Monitoring PCV/TP, skin pliability and urine specific gravity can give a reasonable indication of how well fluid therapy regime is working.
- Often imprecise

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How long will it take to repair the deficit??

- Aim to replace intravascular deficit as quickly as possible
- Then any remaining deficit can be replaced over 24-36 hours

Maintenance fluids

- All animals lose water through sensible (e.g. urinary losses) and insensible (e.g. cellular metabolism, respiration) losses.
- Maintenance requirement for a healthy adult animal is 2-3ml/kg/hr or 50-75ml/kg/day.
- The best maintenance fluids are different from the best replacement fluids.
- This is because in maintenance we are mostly dealing with pure water loss (and K^+ losses) that freely moves between the 3 body compartments.

Maintenance fluids

- Thus, during a 24hr period, if a horse has no water intake it will have lost ~24L water. 2/3 (16L) is lost from intracellular fluid, 1/3 (8L) is lost from extracellular fluid.
- Need to maintain all 3 compartments- intracellular compartment is the most significant.
- Intracellular fluid is very different to extracellular fluid in terms of its Na^+ and K^+ concentrations.
- Urine is also different to extracellular fluid at Na^+ 40mmol/L and K^+ 20mmol/L

Putting the theory into Clinical Practice

- HISTORY – Very important in every case

Comprehensive history taking can be invaluable to the clinician in determining the nature and degree of fluid loss.

- VASOMOTOR TONE
  - mucous membrane colour
  - peripheral pulse
  - warmth of extremities
  - (C.V.P./arterial blood pressure)

Putting the theory into Clinical Practice

- SKIN PLIABILITY

Slow return → ~5% dehydration

Skin stands in a fold → ~10 -12% dehydration

- PCV/TP

PCV tends to increase with extracellular fluid loss and water loss. It tends to decrease after whole blood loss but not immediately.

TP tends to increase with extracellular fluid loss and water loss.

Urine Production and Specific Gravity

- Urine production is decreased in cases of hypovolaemia. The volume of urine decreases whilst its concentration increases.

- If you can obtain a urine sample, then measuring the specific gravity of the urine (using a refractometer) will give an indication of fluid status. The normal range for equine urine is 1.020-1.060.

- The rate of urine of urine production can also be measured. Normal urine production is 2ml/kg/hr or 50ml/kg/day. Practical?

Putting the theory into Clinical Practice

- How do you monitor your fluid therapy?
  - Urine production/ specific gravity
  - Pulse quality
  - Skin tent
  - PCV/TP etc.
- Equipment?
- Amount of supervision?

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