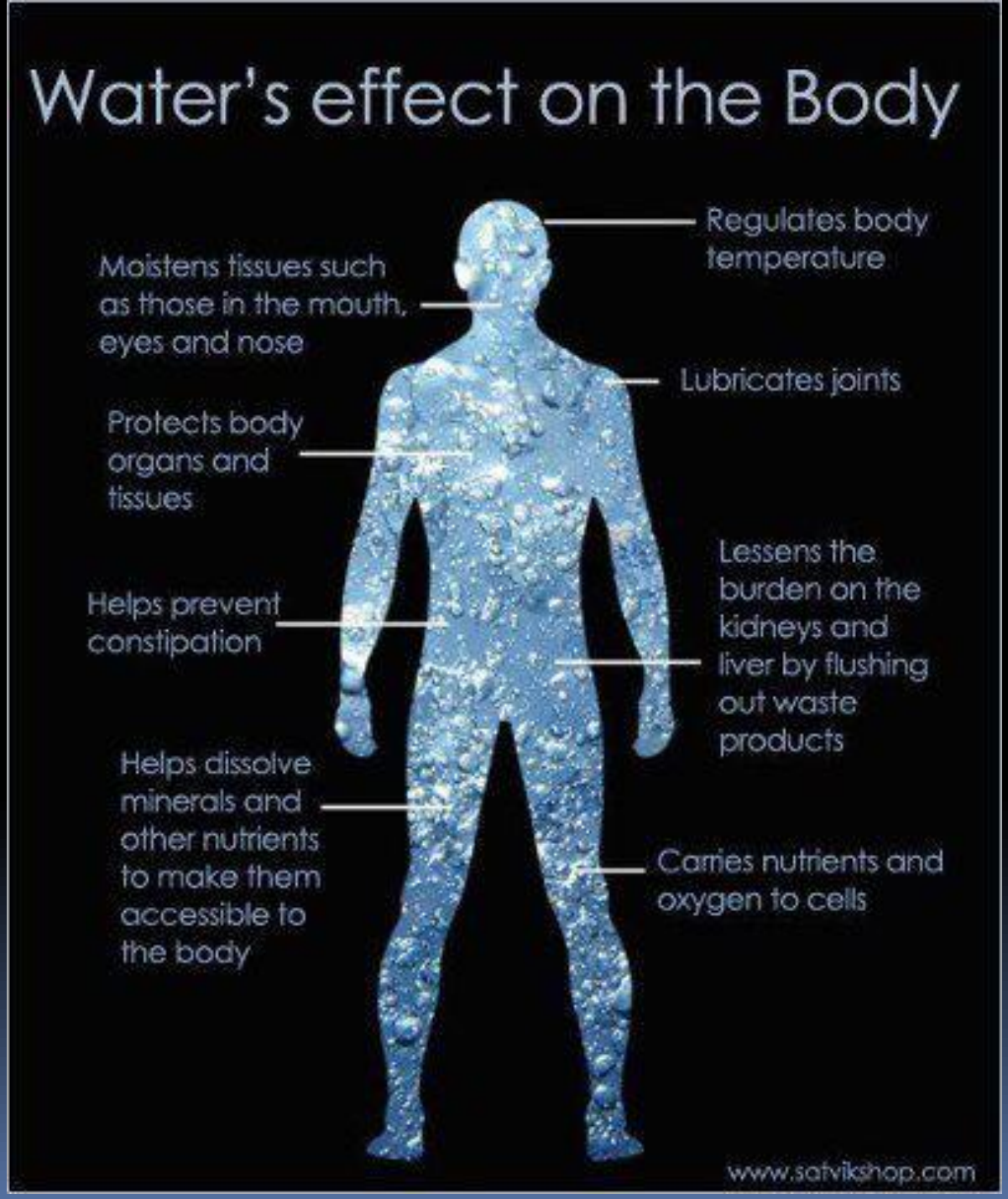
Amjad Bani Hani
Ass.Prof. of Cardiac Surgery
& Intensive Care

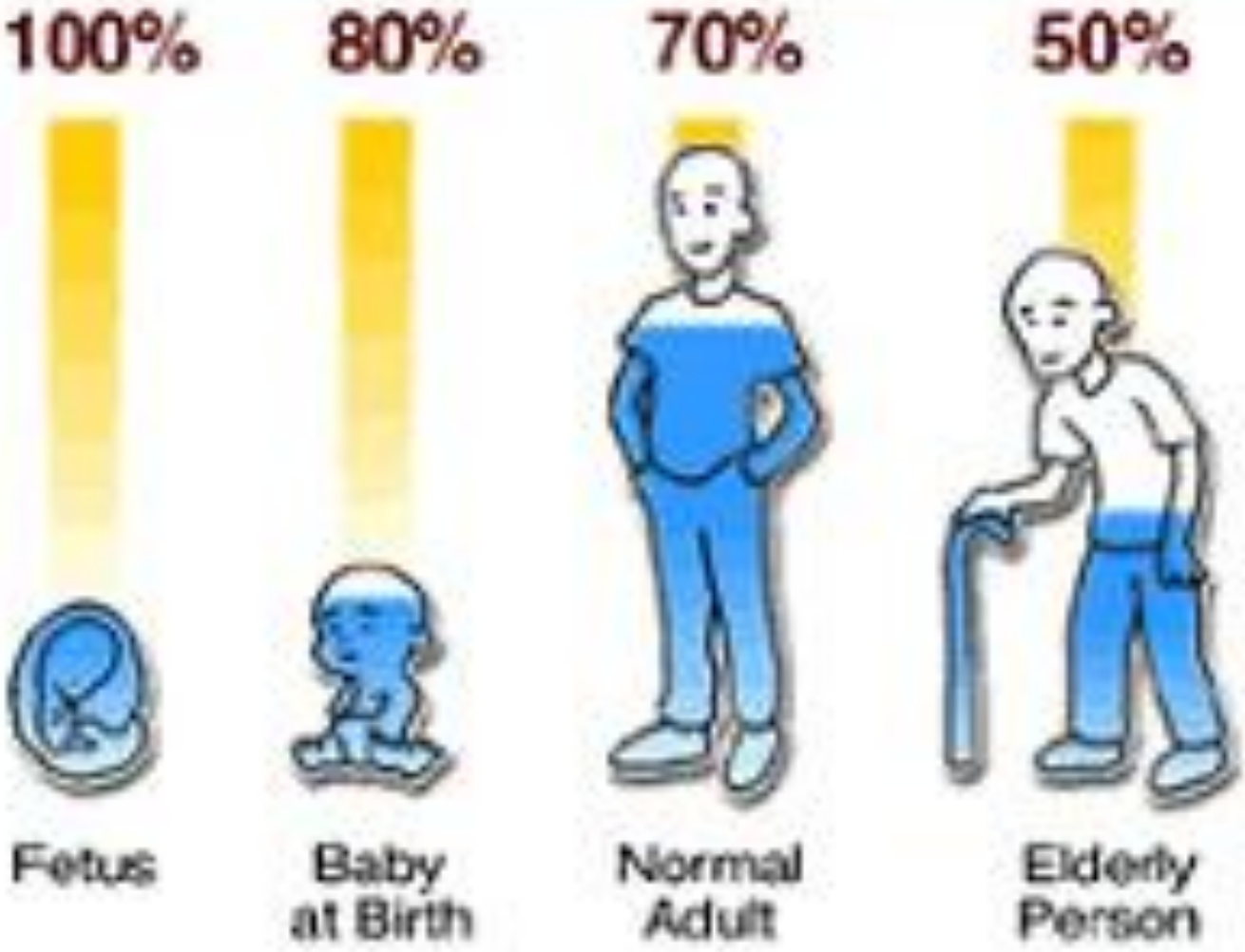
FLUIDS AND ELECTROLYTES

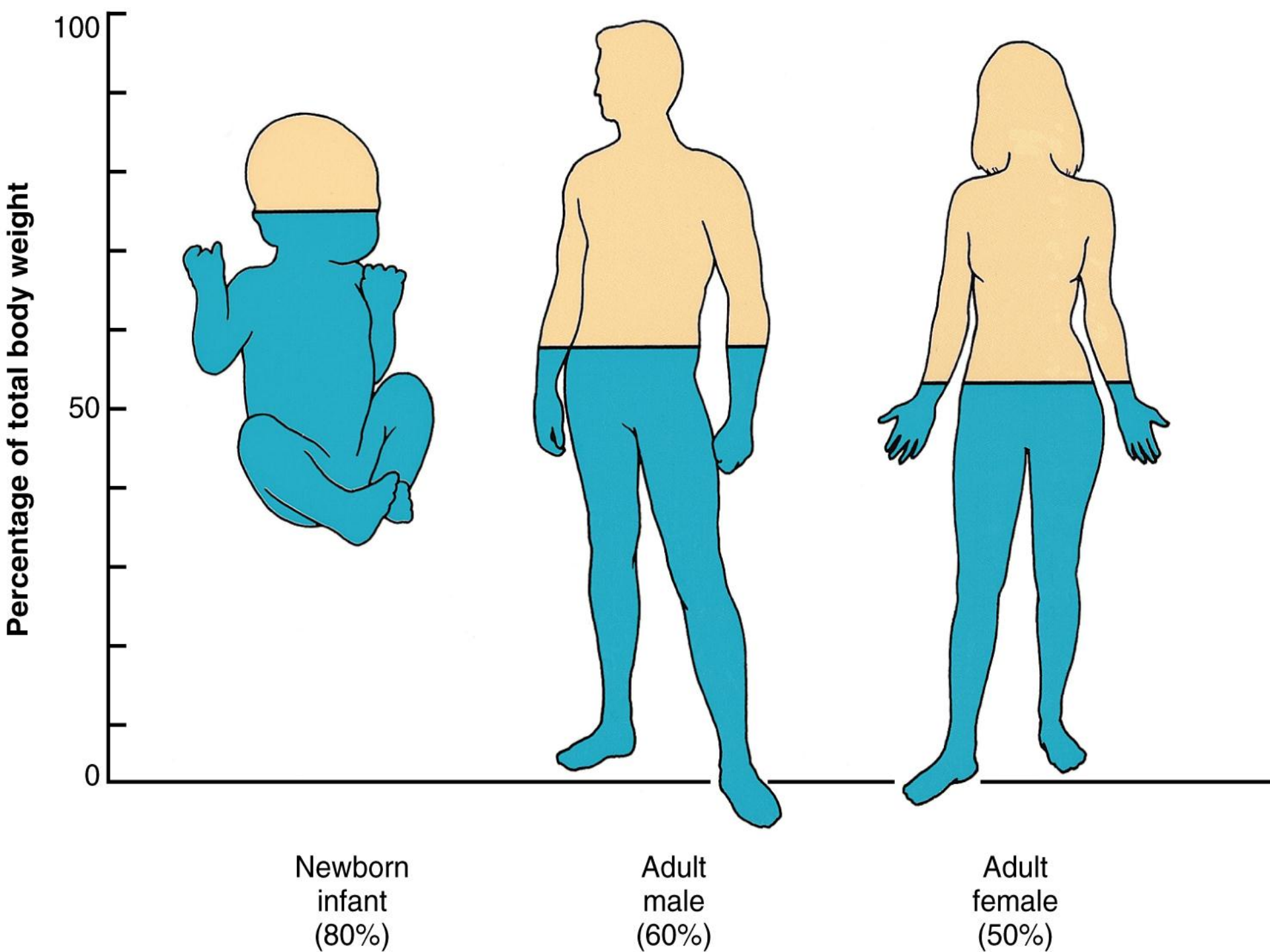

Water's effect on the Body
Regulates body temperature
Moistens tissues such as those in the mouth, eyes and nose
Lubricates joints
Protects body organs and tissues
Lessens the burden on the kidneys and liver by flushing out waste products
Helps prevent constipation
Helps dissolve minerals and other nutrients to make them accessible to the body
Carries nutrients and oxygen to cells
www.satvikshop.com

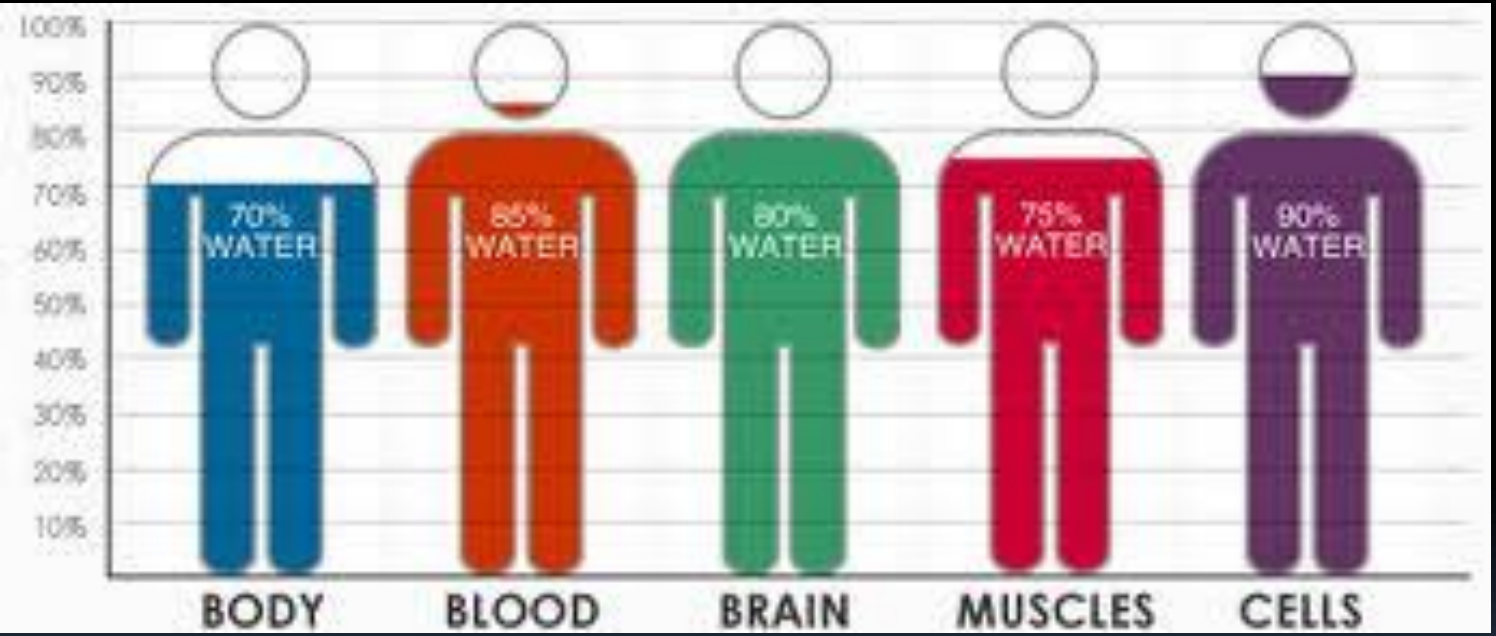
Body Water Content


CONTAIN
70%
H_2O

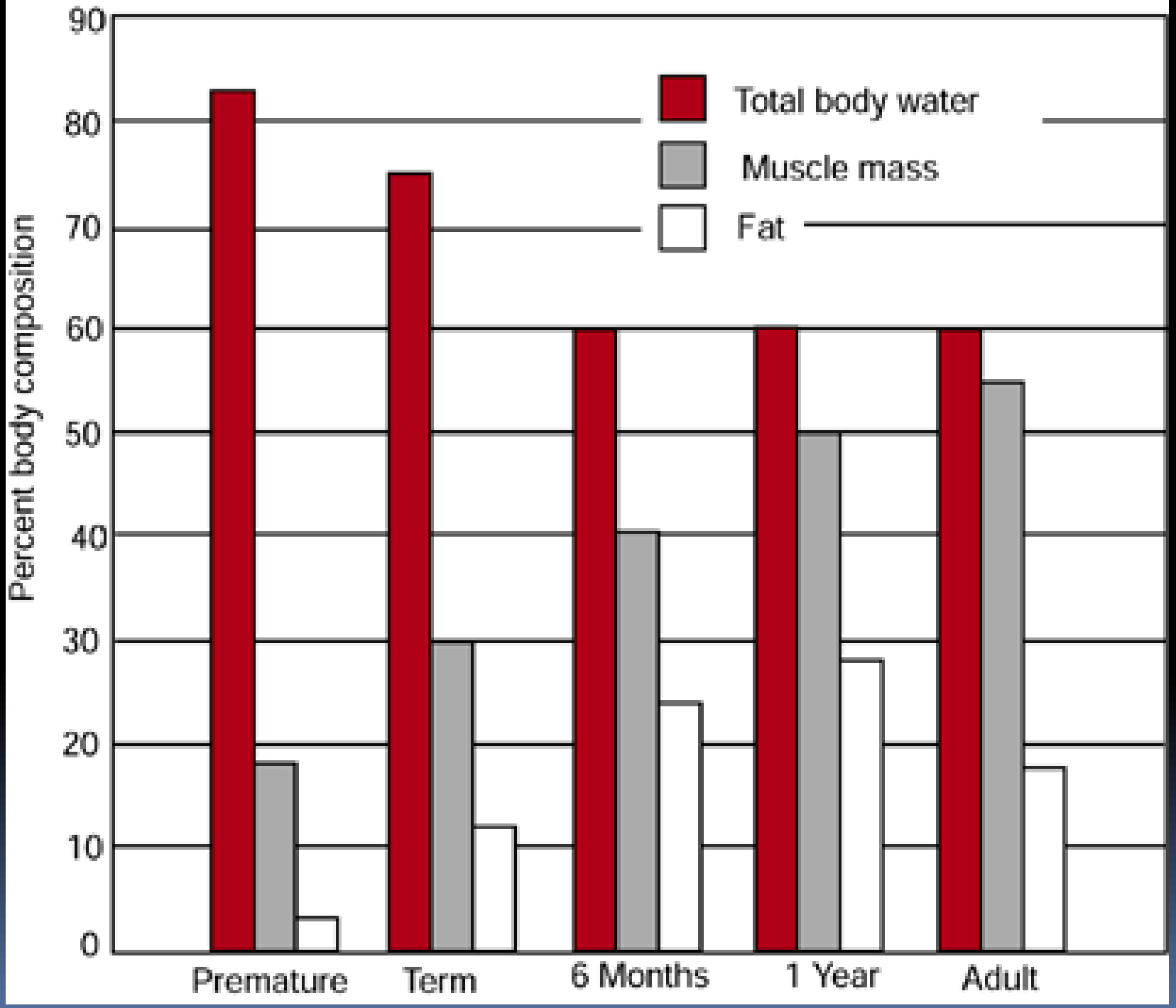
Percent of Water in the Human Body

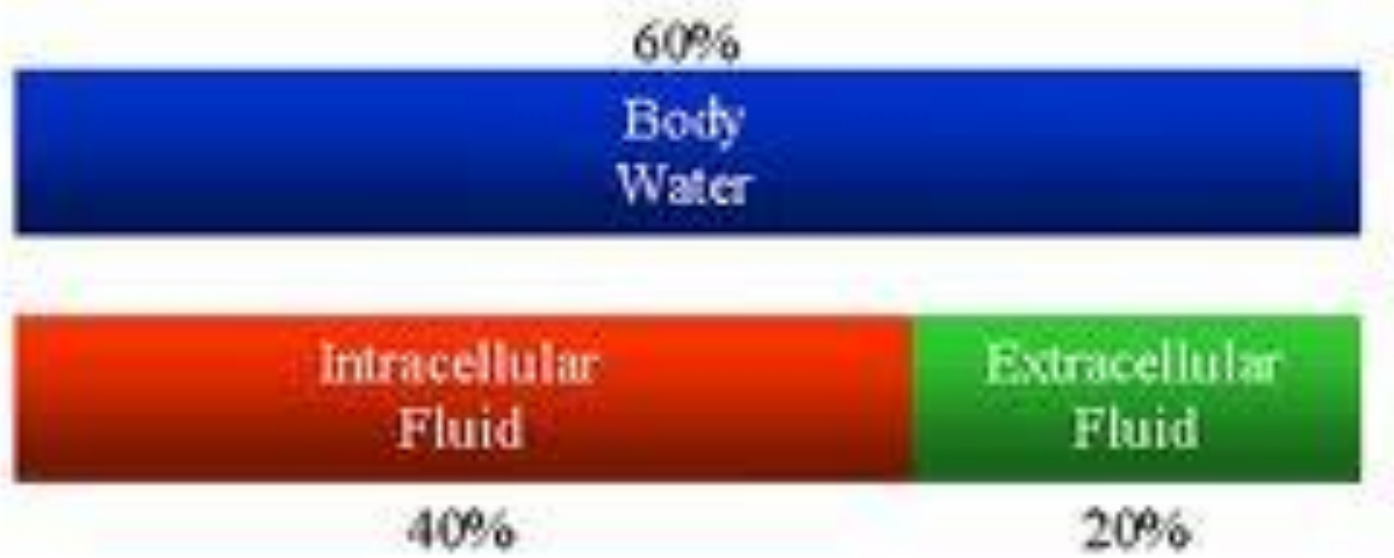


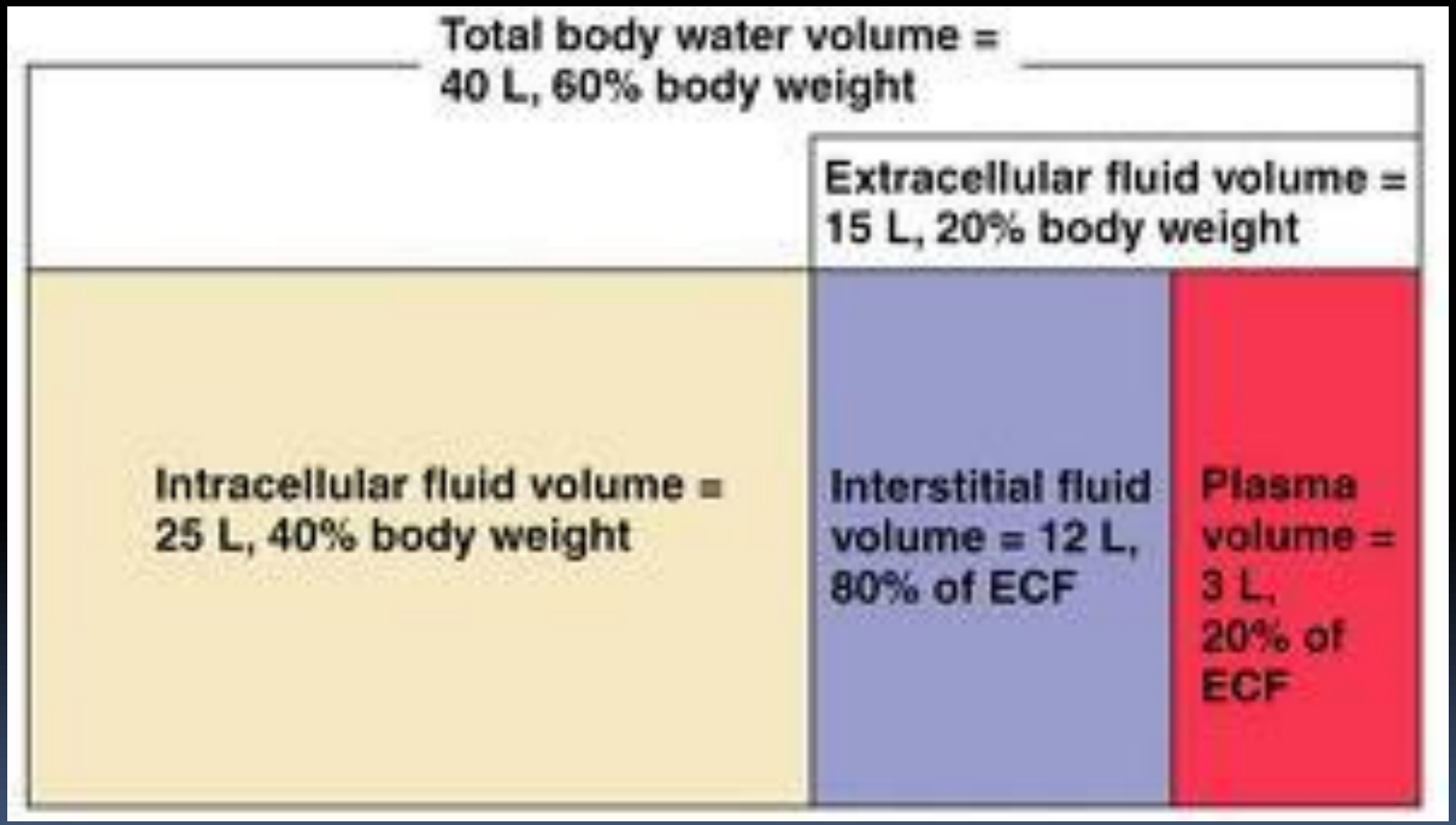

Percentage of total body weight
100
50
0
Newborn infant (80%)
Adult male (60%)
Adult female (50%)


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
70% WATER
85% WATER
80% WATER
75% WATER
90% WATER
BODY
BLOOD
BRAIN
MUSCLES
CELLS

Tissue	% water
Blood	83.0
Kidney	82.7
Muscle	75.6
Brain	74.8
Skin	72.0
Skeleton (bone)	22.0
Adipose tissue	10.0


Percent body composition
90
80
70
60
50
40
30
20
10
0
Total body water
Muscle mass
Fat
Premature
Term
6 Months
1 Year
Adult

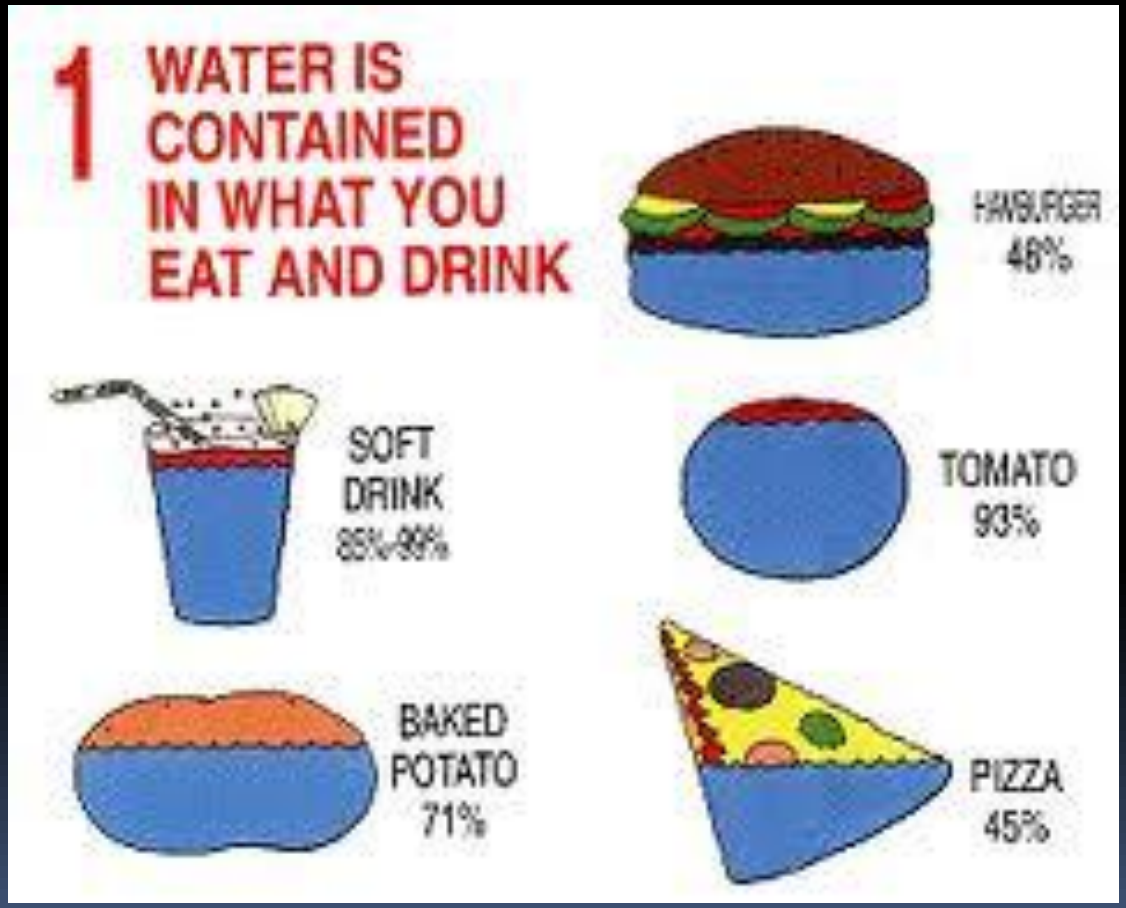

60%
Body
Water
Intracellular
Fluid
Extracellular
Fluid
40%
20%

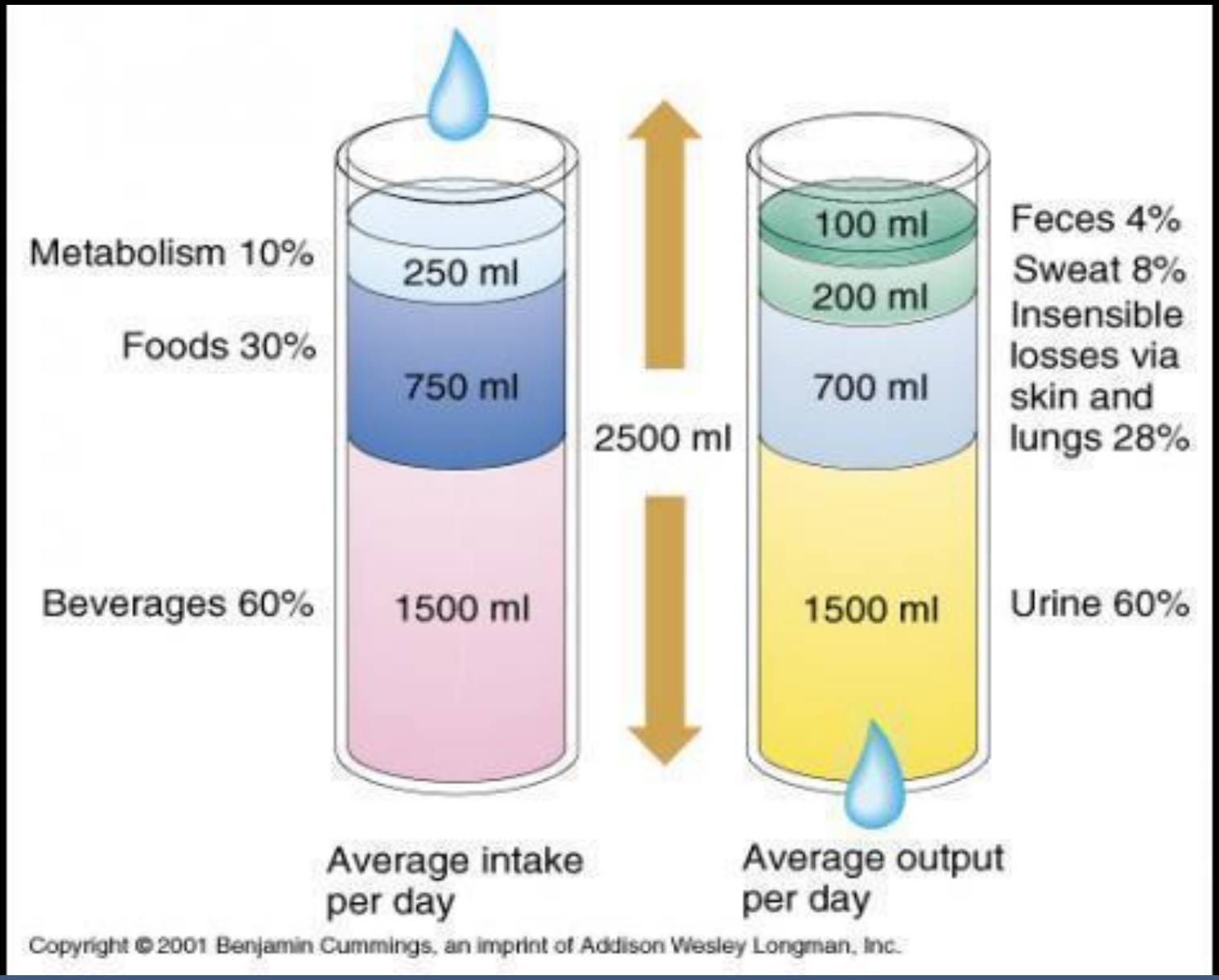

Total body water volume = 40 L, 60% body weight
Extracellular fluid volume = 15 L, 20% body weight
Intracellular fluid volume = 25 L, 40% body weight
Interstitial fluid volume = 12 L, 80% of ECF
Plasma volume = 3 L, 20% of ECF

Minimum Daily Requirements for Water

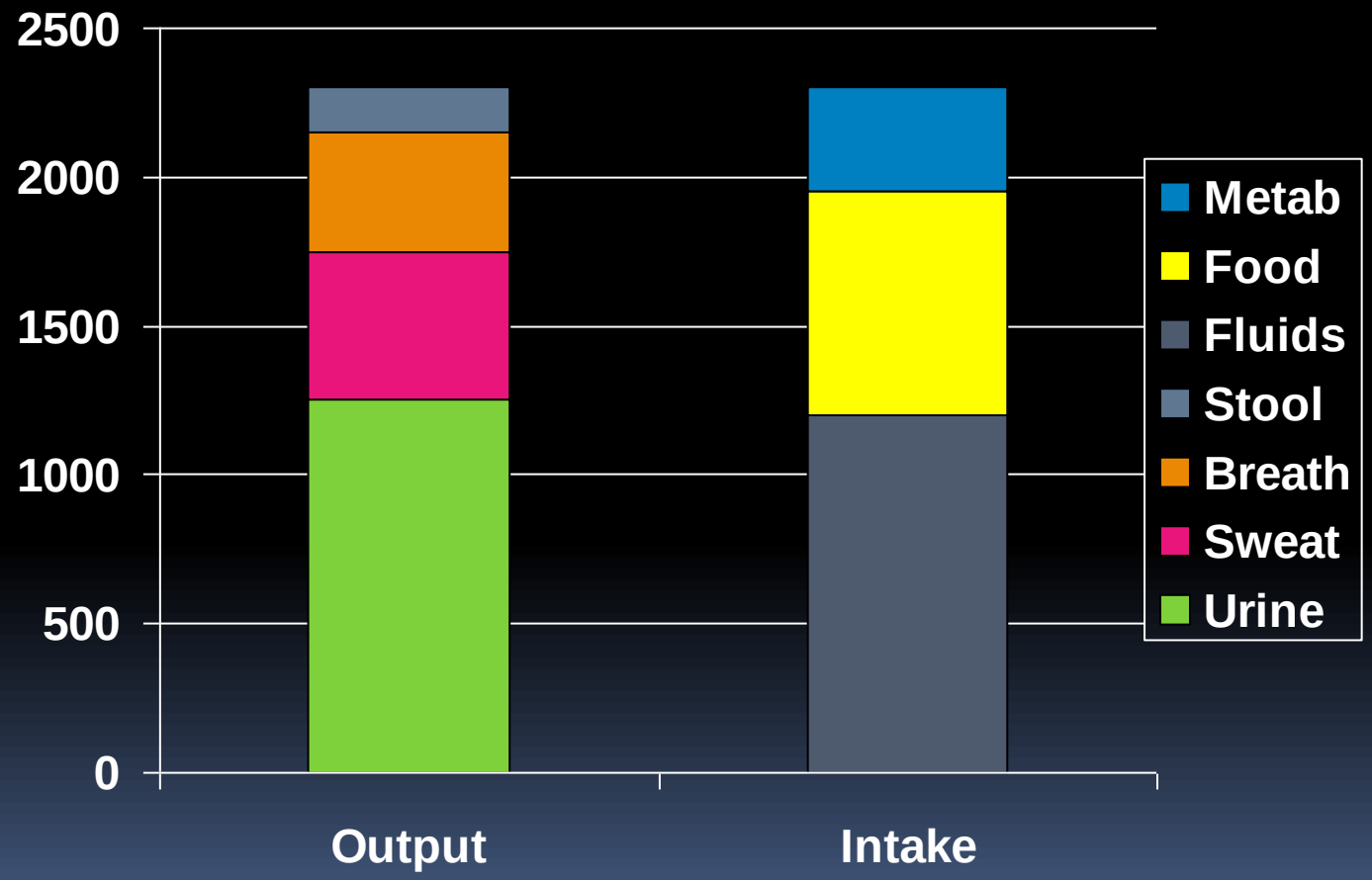
Population Group	Minimum Daily Requirements
Infants	
Birth to less than 6 months	800 ml
6 to 12 months	1000 ml
Children (1-18 y)	
Wt (kg)	
10-20	1000 ml + 50 ml/kg for each excess kg
>20	1500 ml + 20 ml/kg for each excess kg
Adults, 18+	2500 ml
Older persons, 65 and above	1500 ml
Pregnant Women	Additional 300 ml
Lactation Women , 1st 6 months	Additional 750 to 1000 ml

FNRI 2002 data, ppt table created by foodrecap.net

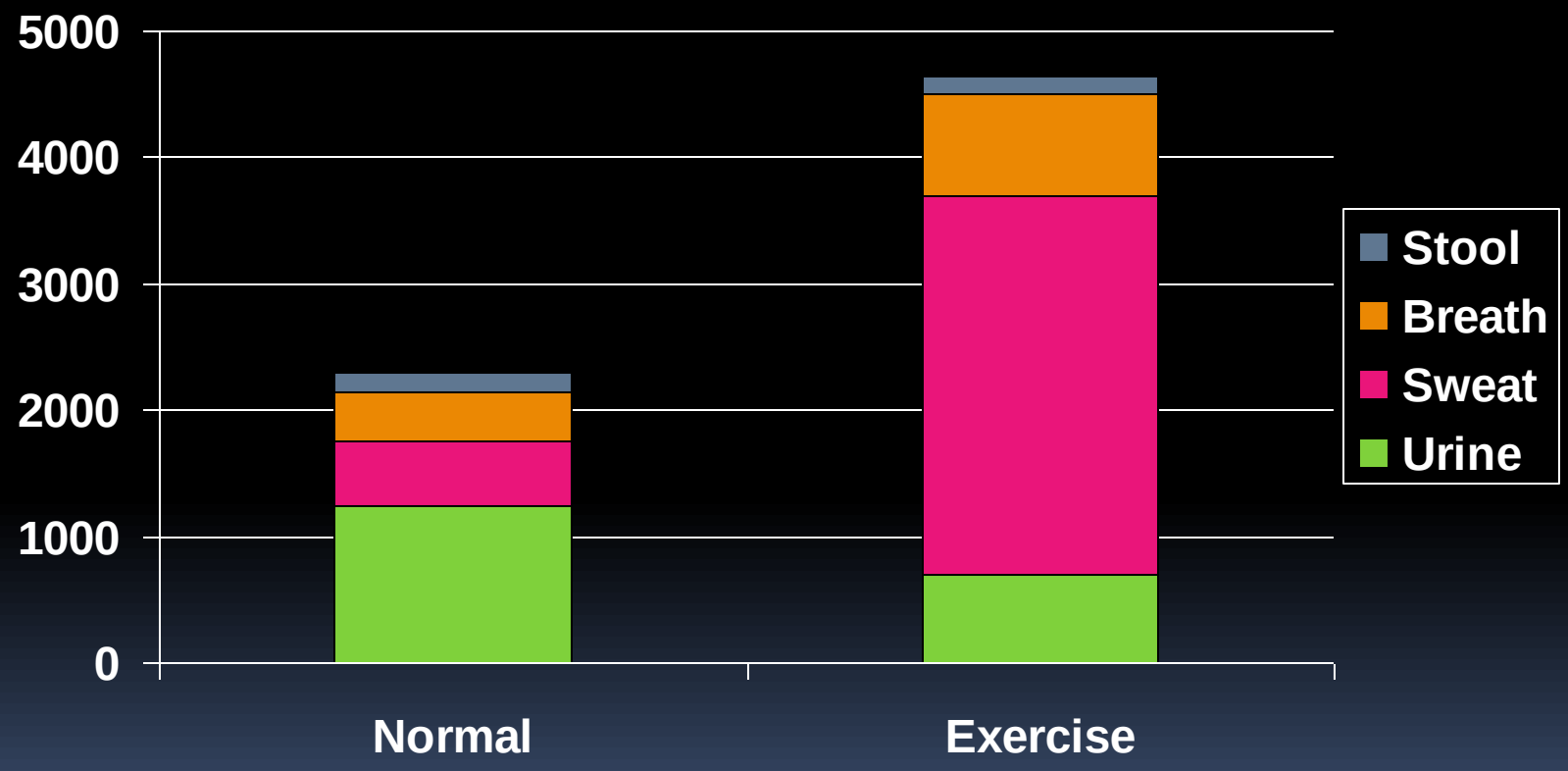

1 WATER IS CONTAINED IN WHAT YOU EAT AND DRINK
HAMBURGER 48%
SOFT DRINK 85%-99%
TOMATO 93%
BAKED POTATO 71%
PIZZA 45%



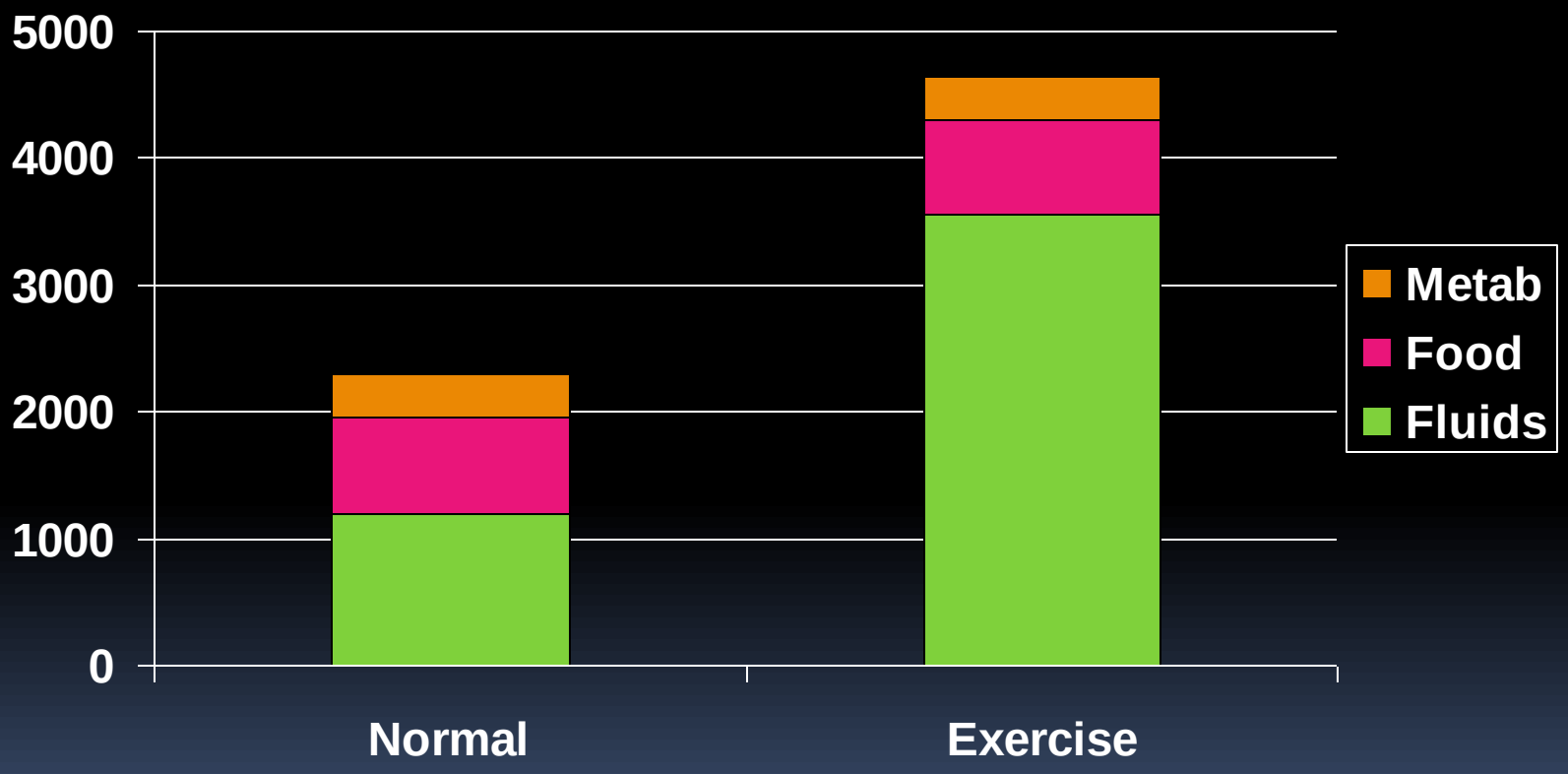
Water Balance: Normal



Water Output: Normal vs.Exercise

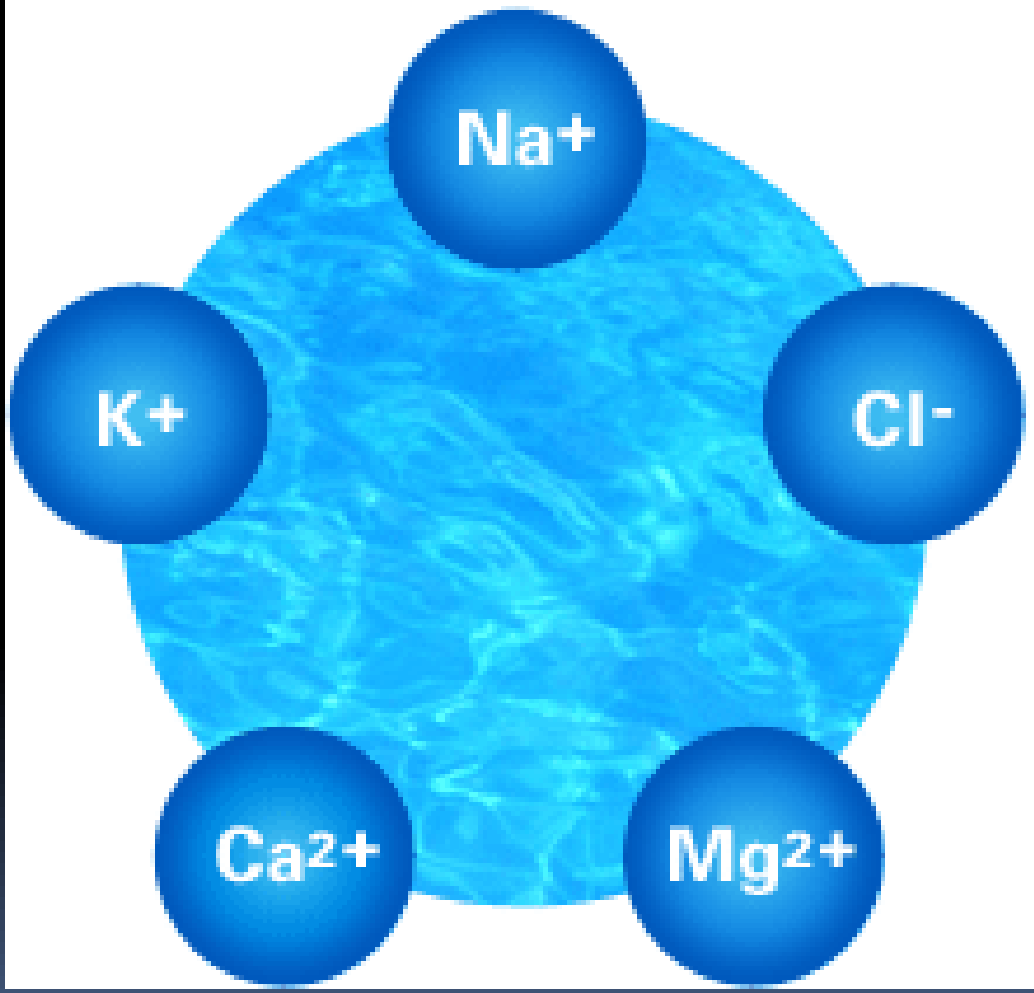


Water Intake: Normal vs Exercise



Electrolytes

The main electrolytes in Body Fluid.



Na^+	Sodium Ion
Cl^-	Chloride Ion
Mg^{2+}	Magnesium Ion
Ca^{2+}	Calcium Ion
K^+	Potassium Ion

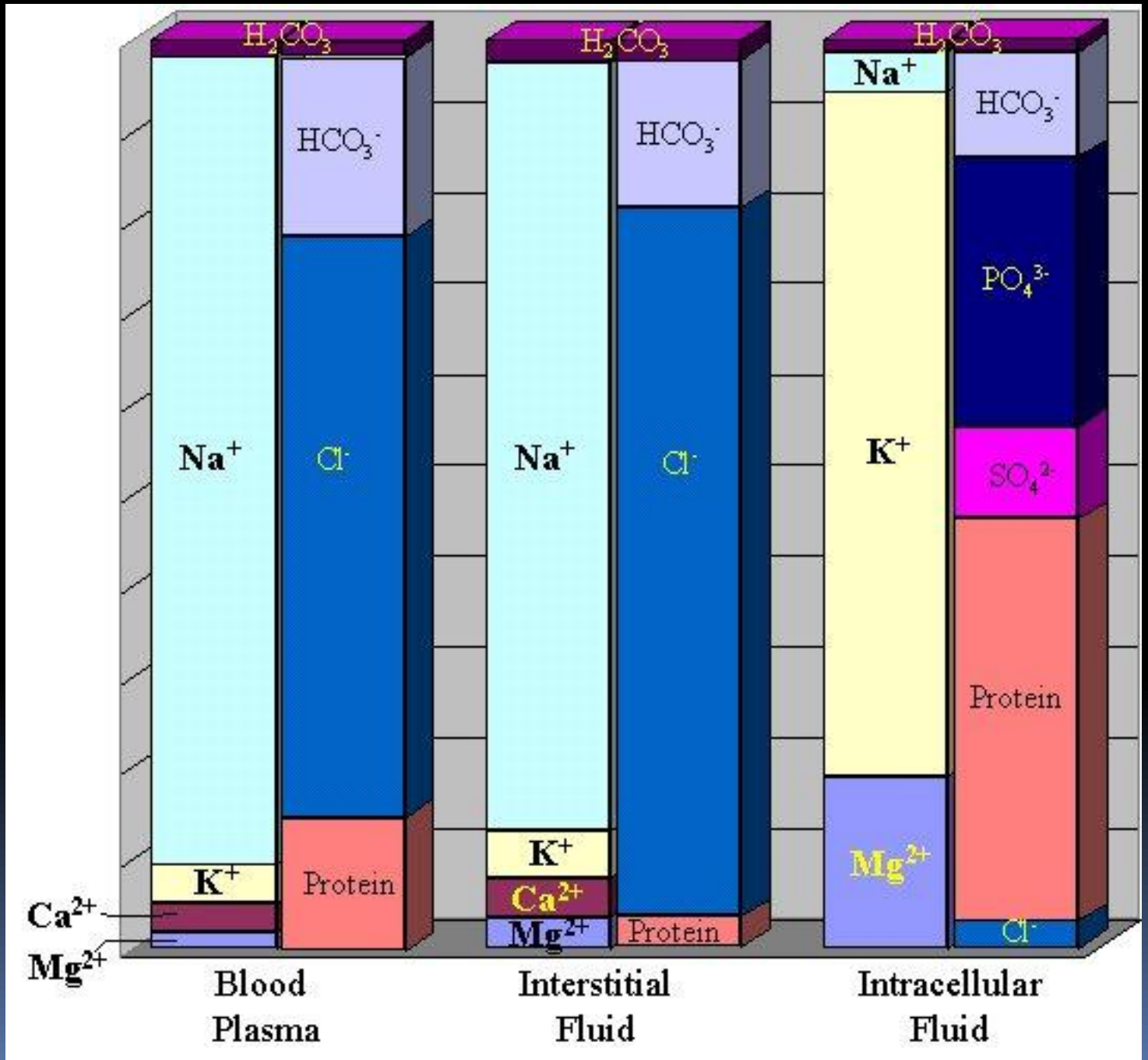
Each ion has its own rules, and body movement is a result of the function of these ions.

Electrolytes

- Solutes that form ions (electrical charge)
  - Cation (+)
  - Anion (-)
- Major body electrolytes:
  - Na+, K+, Ca++, Mg++
  - Cl-, HCO_3-, HPO_4--, SO_4-

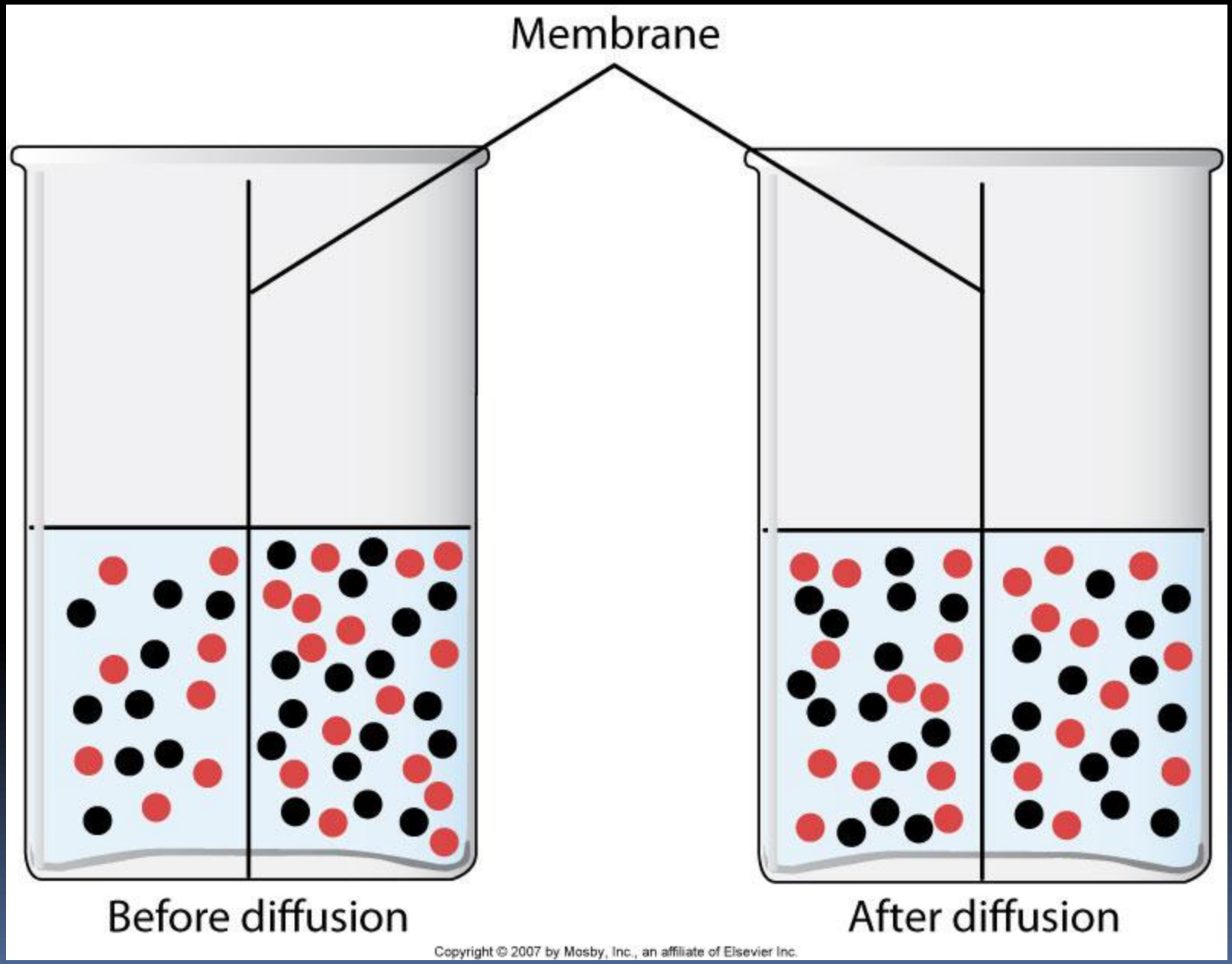
Electrolyte Distribution

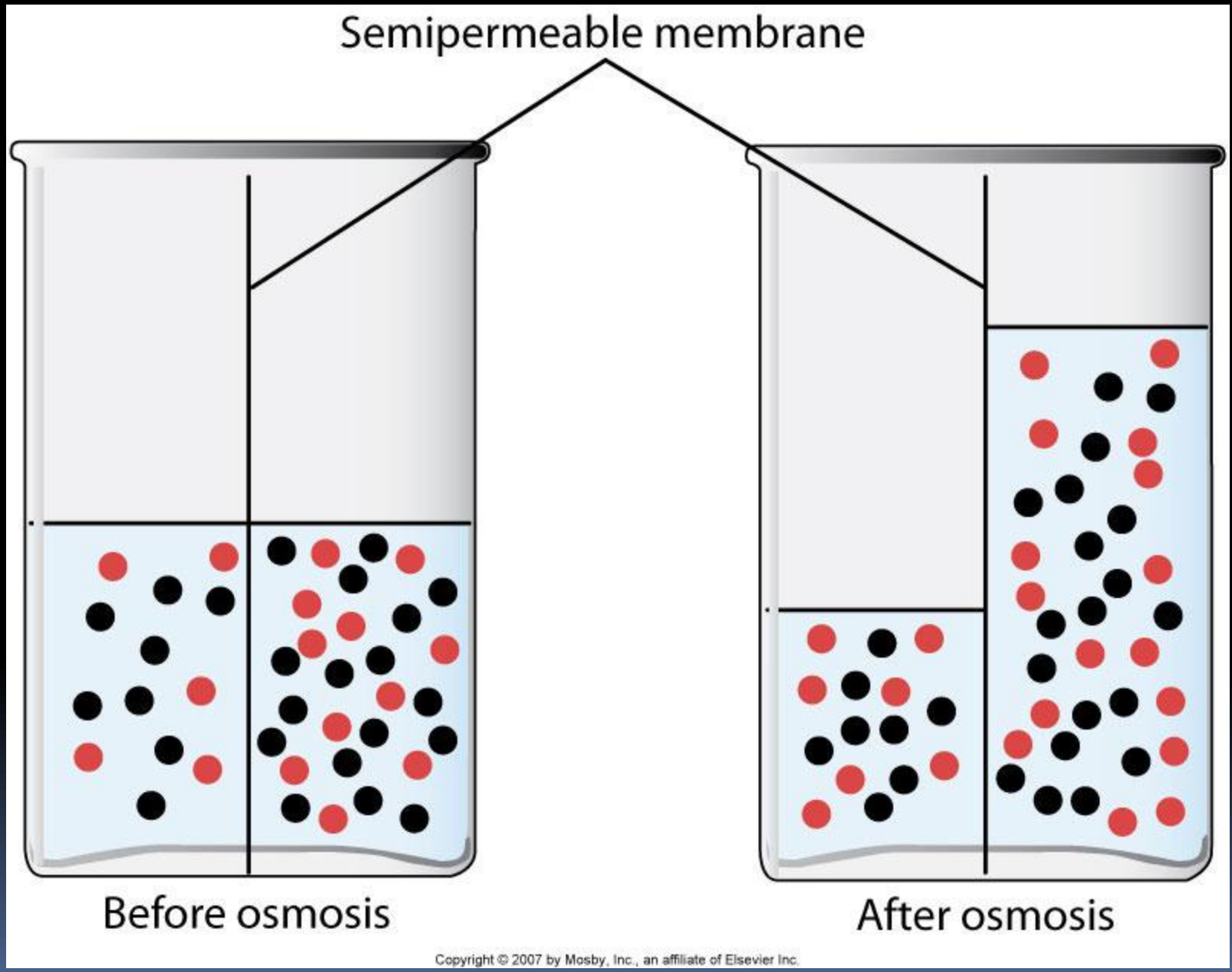
- Major ICF ions
  - K+
  - HPO_4--
- Major ECF ions
  - Na+
  - CL-, HCO_3-
- Intravascular (IVF) vs Interstitial (ISF)
  - Similar electrolytes, but IVF has proteins

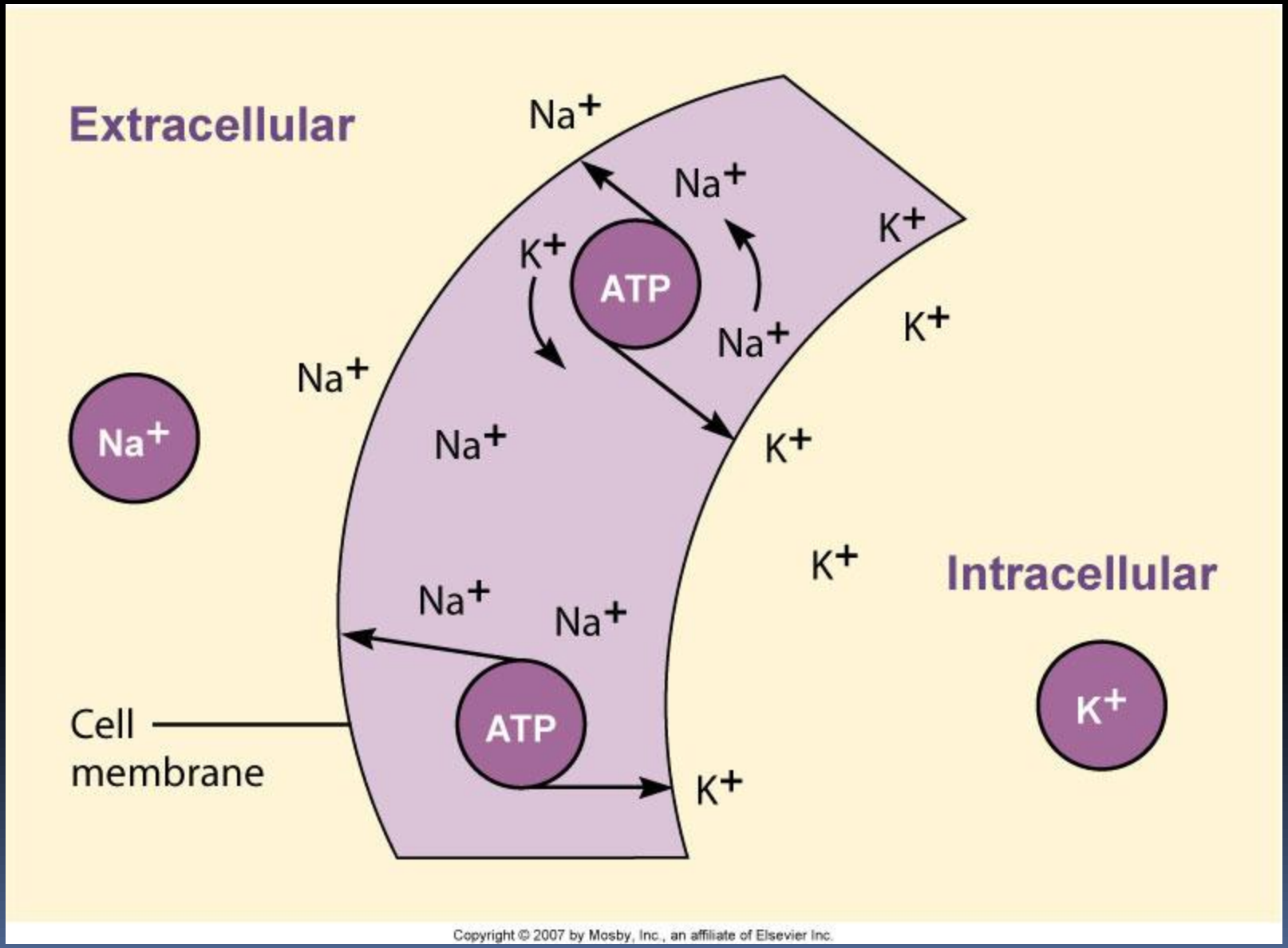

H_2CO_3
HCO_3^-
Na^+
Cl^-
K^+
Protein
Ca^{2+}
Mg^{2+}
Blood Plasma
Interstitial Fluid
PO_4^{3-}
SO_4^{2-}
Intracellular Fluid

Mechanisms Controlling Fluid and Electrolyte Movement

- Diffusion
- Selective Permeability
- Facilitated diffusion
- Active transport
- Osmosis
  - 2*Na + BUN + Glucose/18
- Hydrostatic pressure
- Oncotic pressure






Extracellular
Na+
Na+
K+
K+
ATP
Na+
K+
Na+
Na+
Na+
K+
K+
Intracellular
Na+
Na+
Cell membrane
ATP
K+
K+
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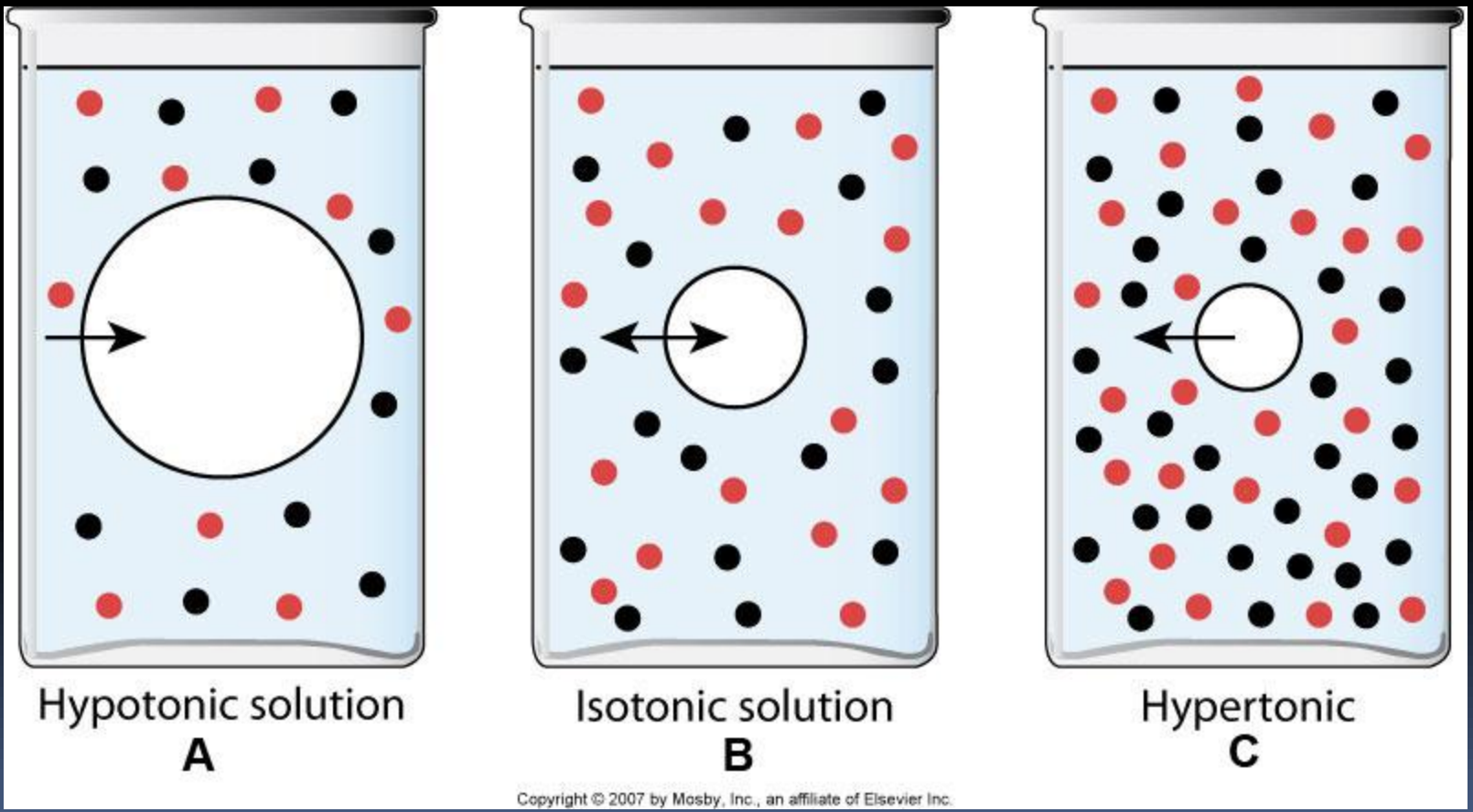
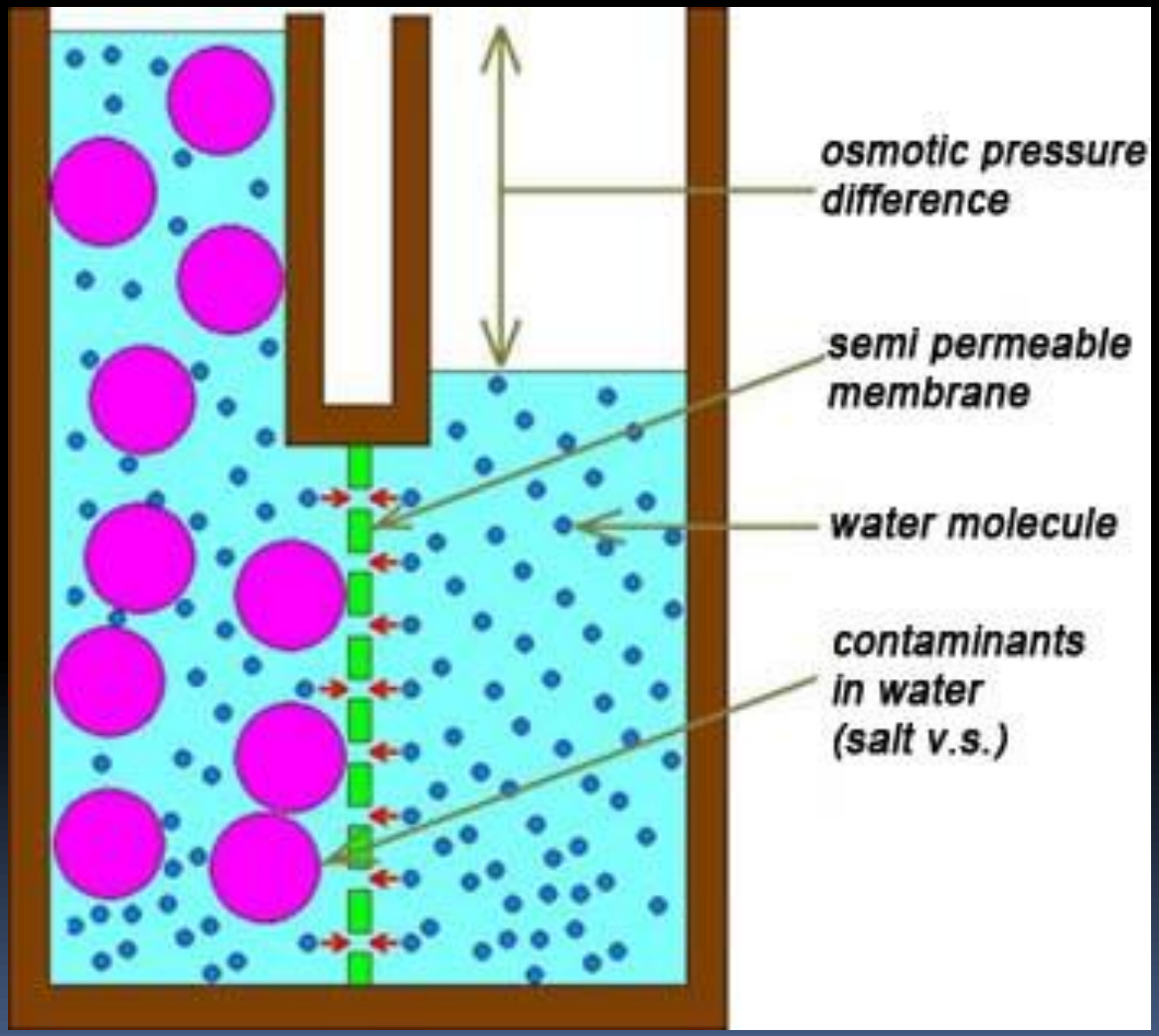
Cells are selectively permeable



Sodium is the largest Determinant of Osmolality

- Na+: 135 – 145 mEq/L
- Ca+: 8.5 – 10.5 mEq/L
- K+: 3.5 – 5 mEq/L
- Osmolality~ 2*(Na+) = 2*(135 - 145 mEq/L)
  - Normal (Isotonic) 280 – 300
  - Low (hypotonic) < 280
  - High (hypertonic) > 300


osmotic pressure difference
semi permeable membrane
water molecule
contaminants in water (salt v.s.)

Fluid Exchange Between Capillary and Tissue: Sum of Pressures

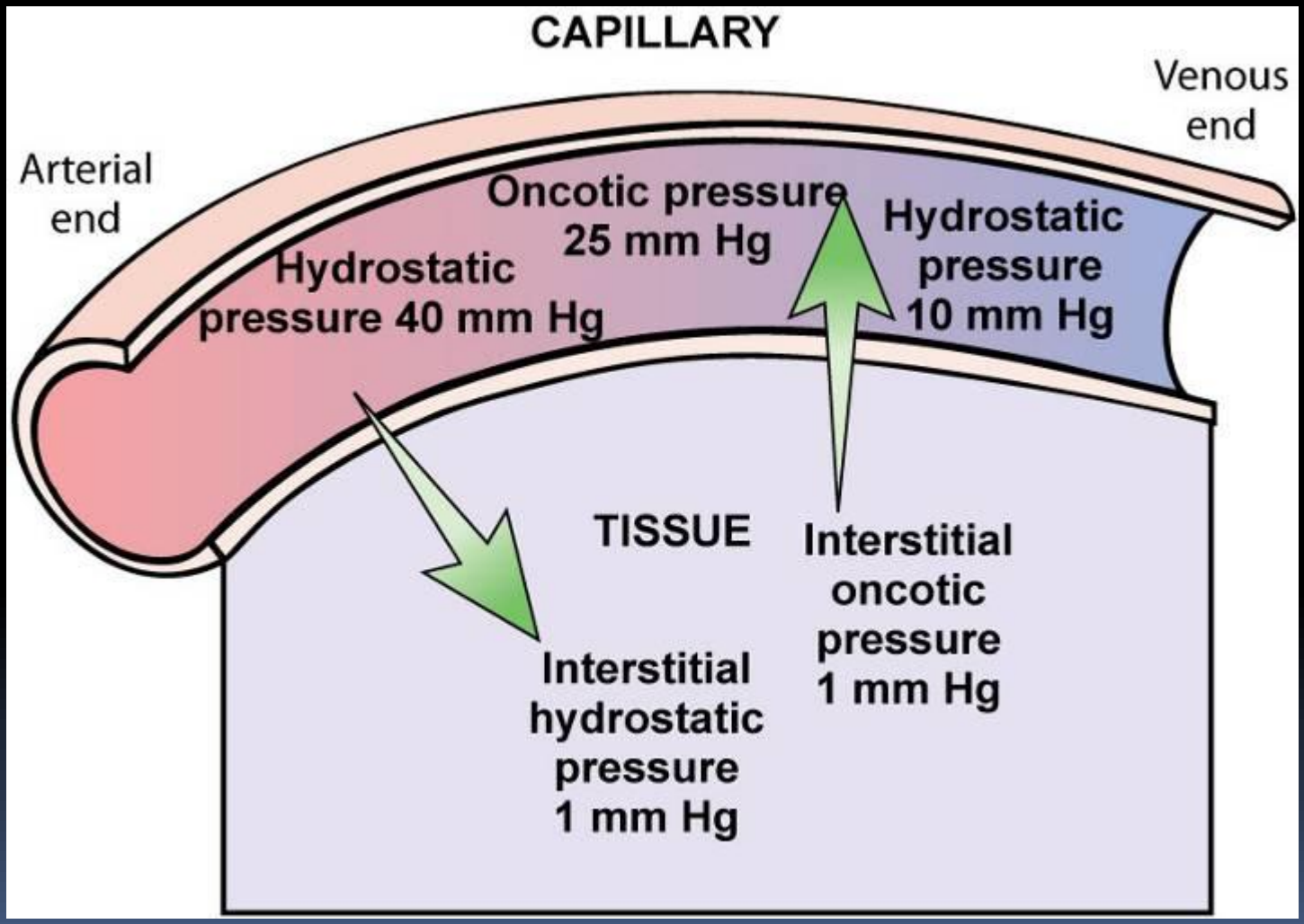
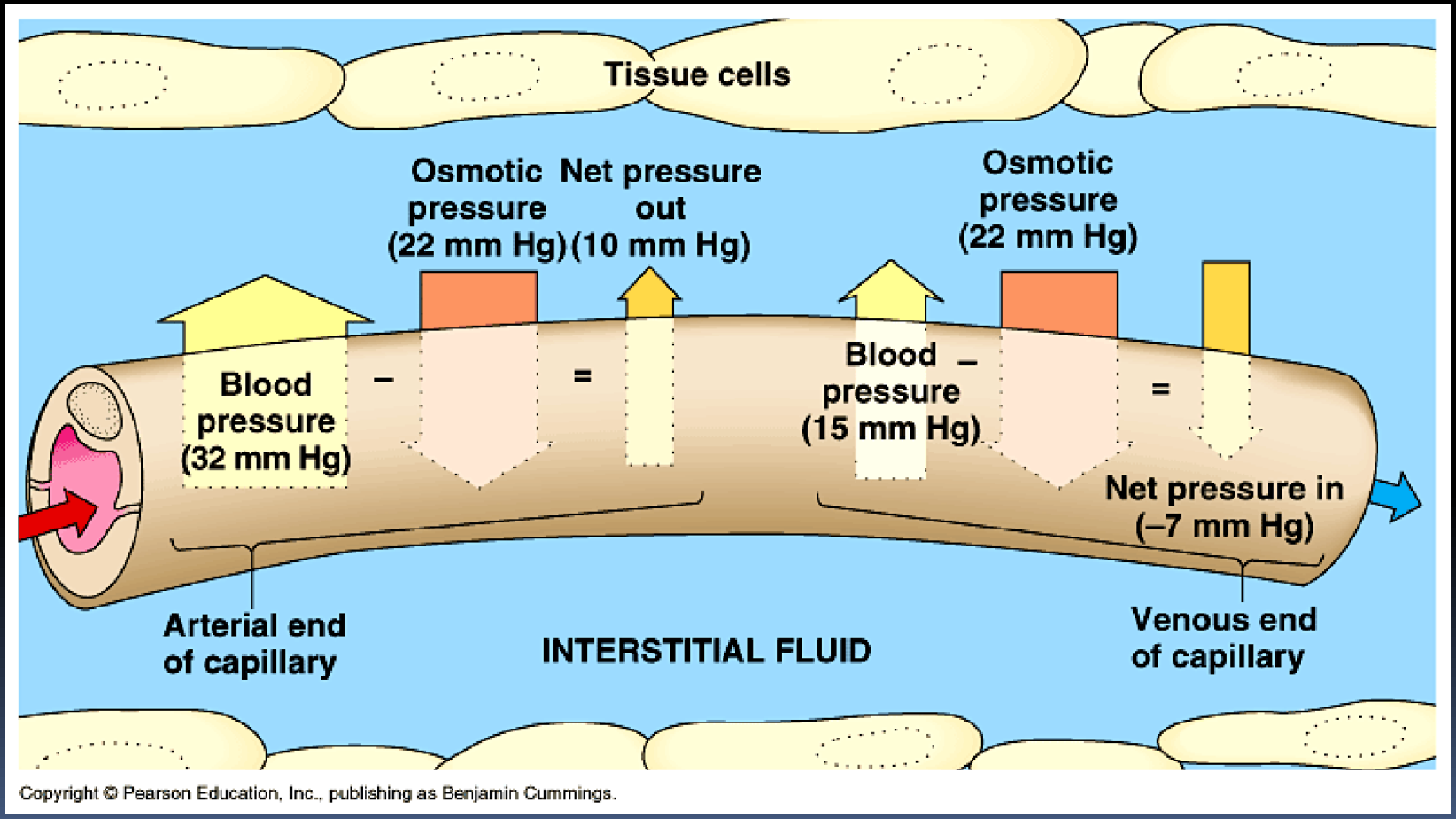
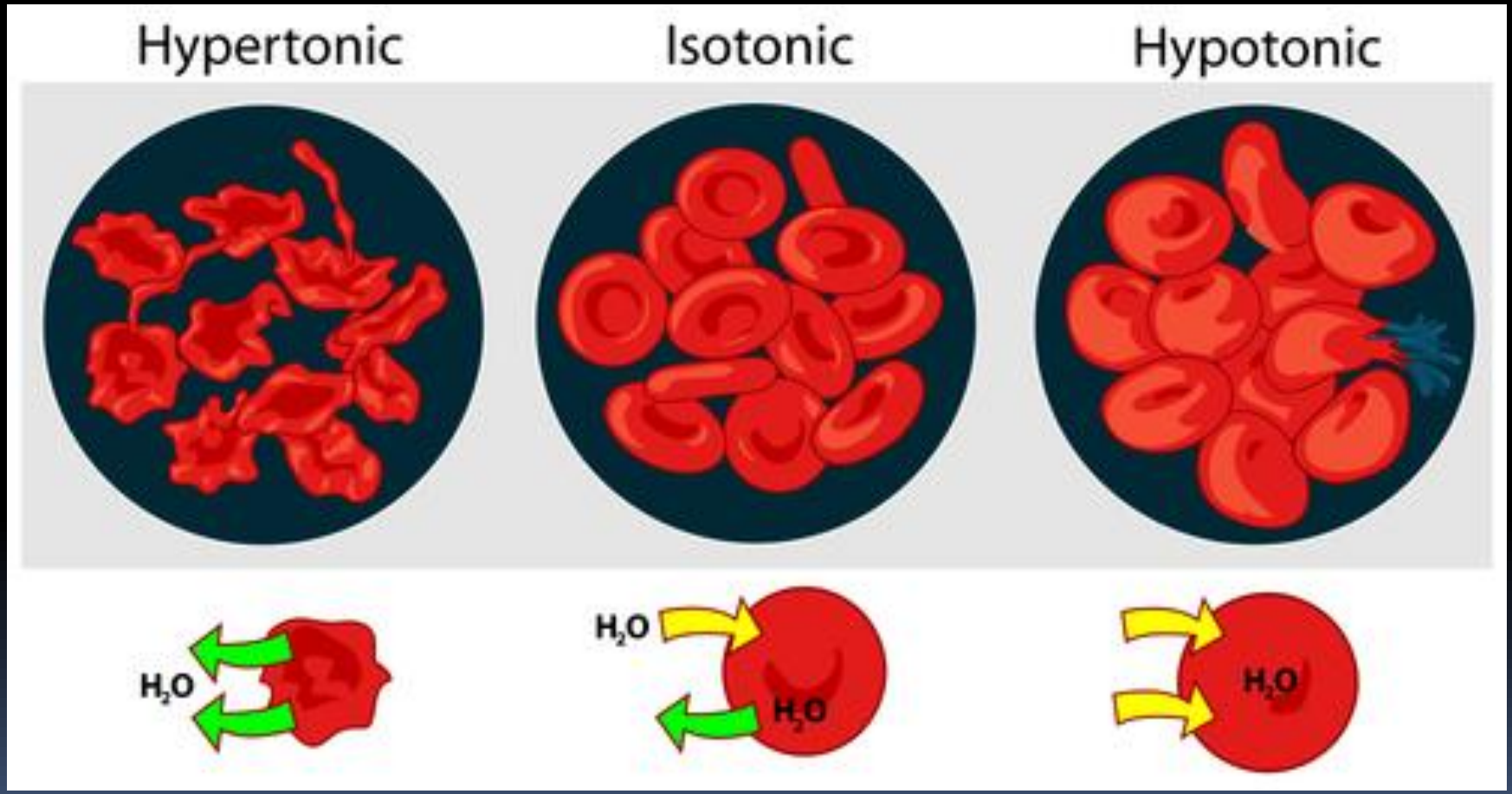


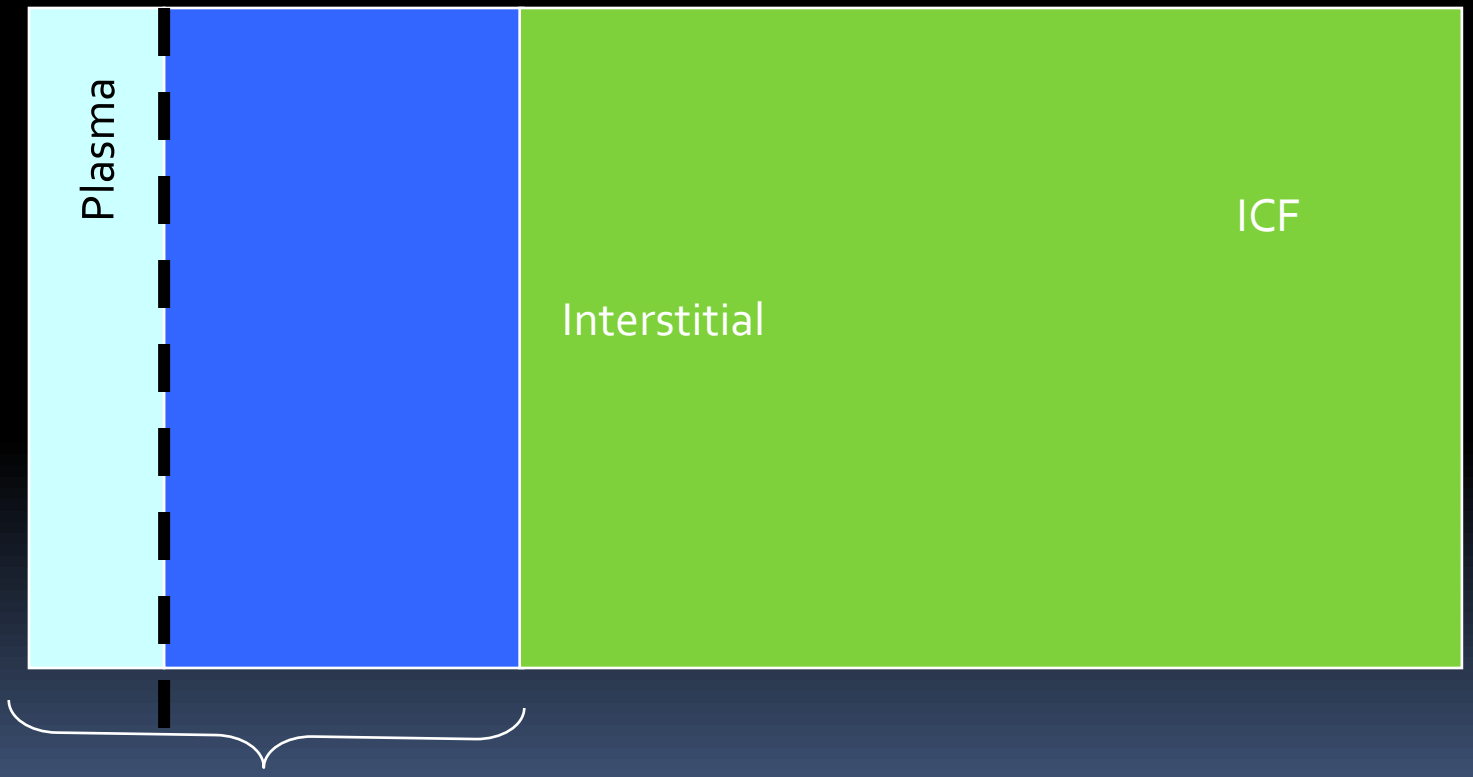
Fig. 17-8



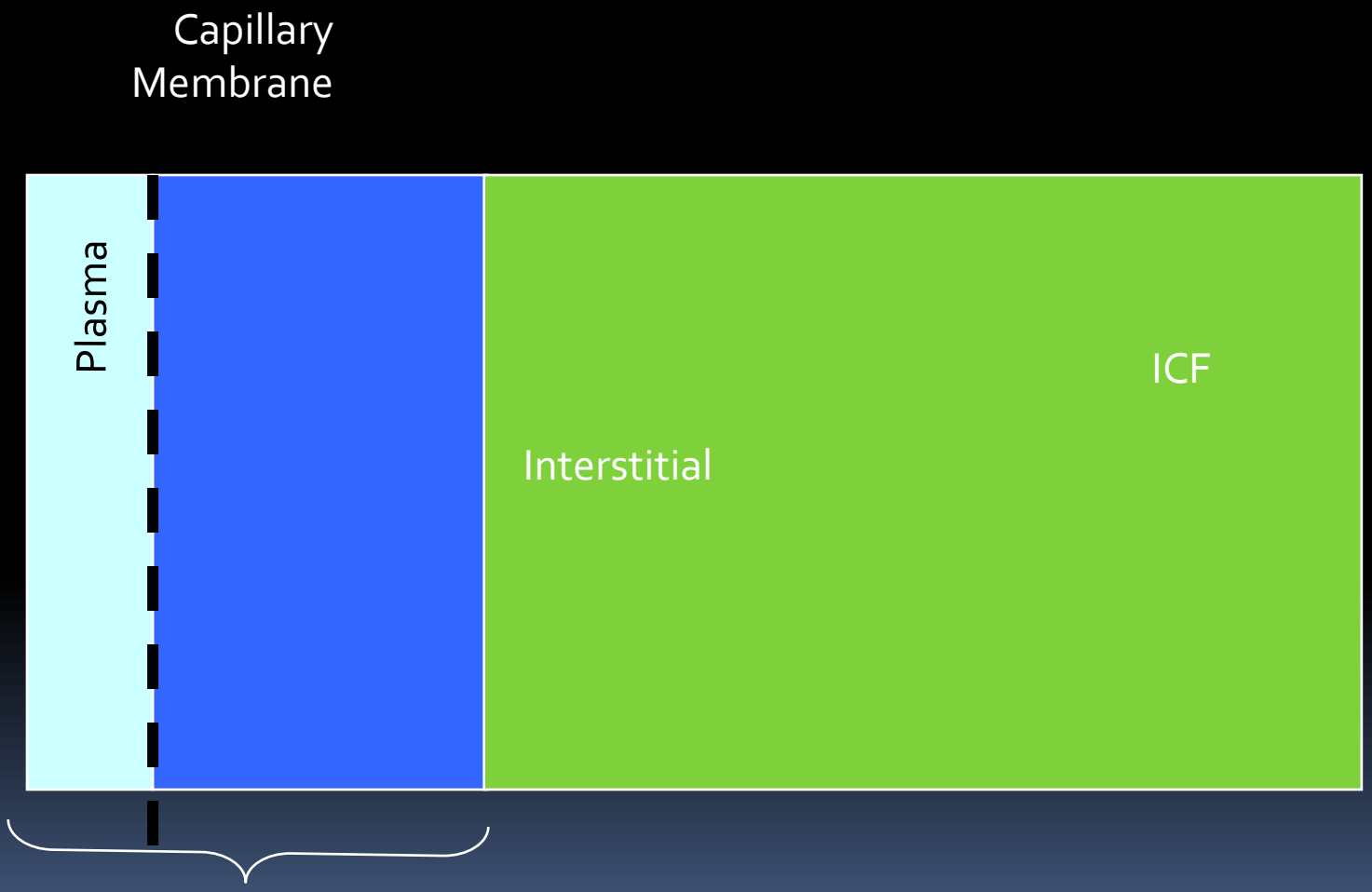

Hypertonic
Isotonic
Hypotonic
H_2O
H_2O
H_2O
H_2O

Fluid compartments

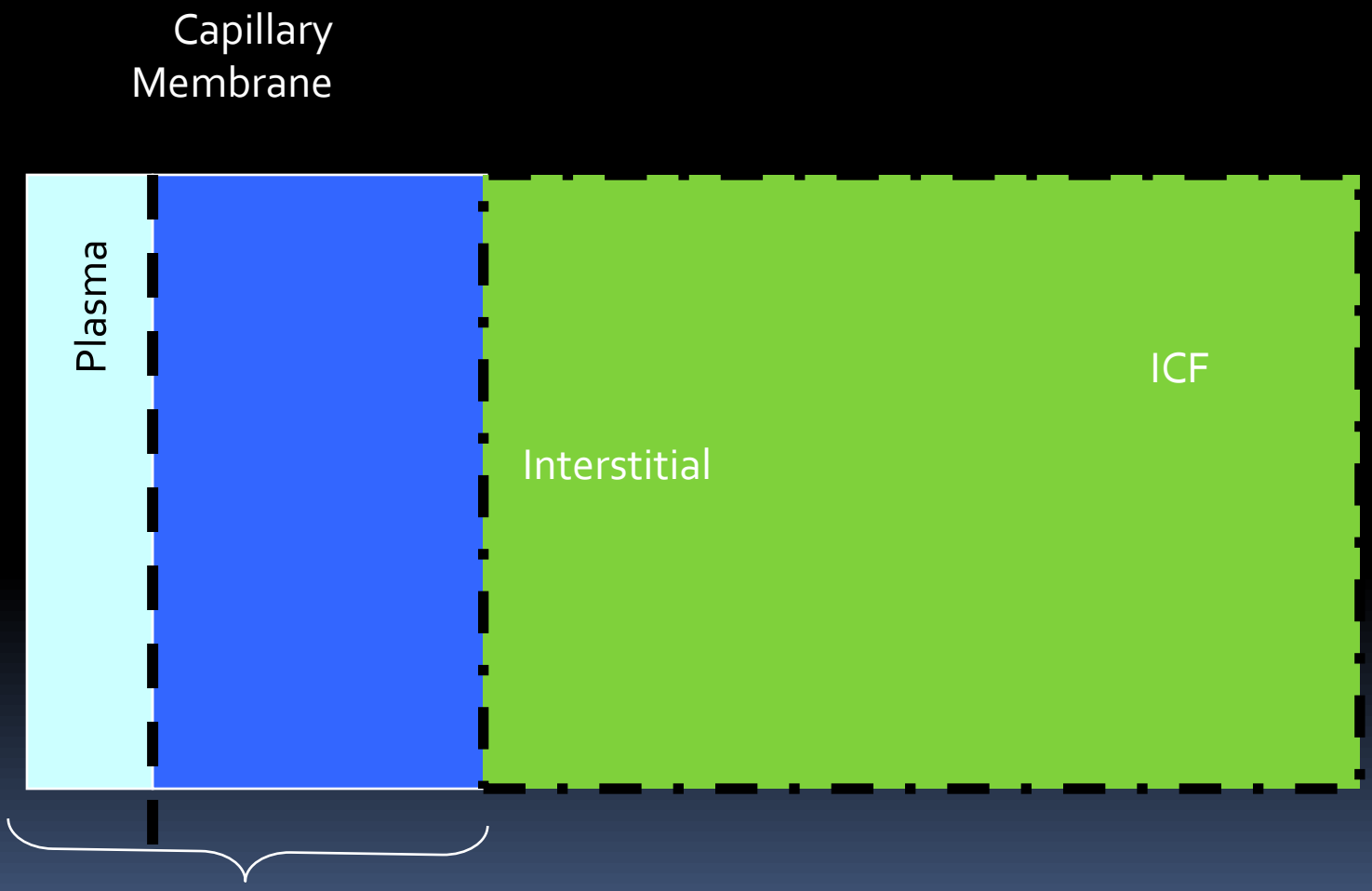
Fluid compartments



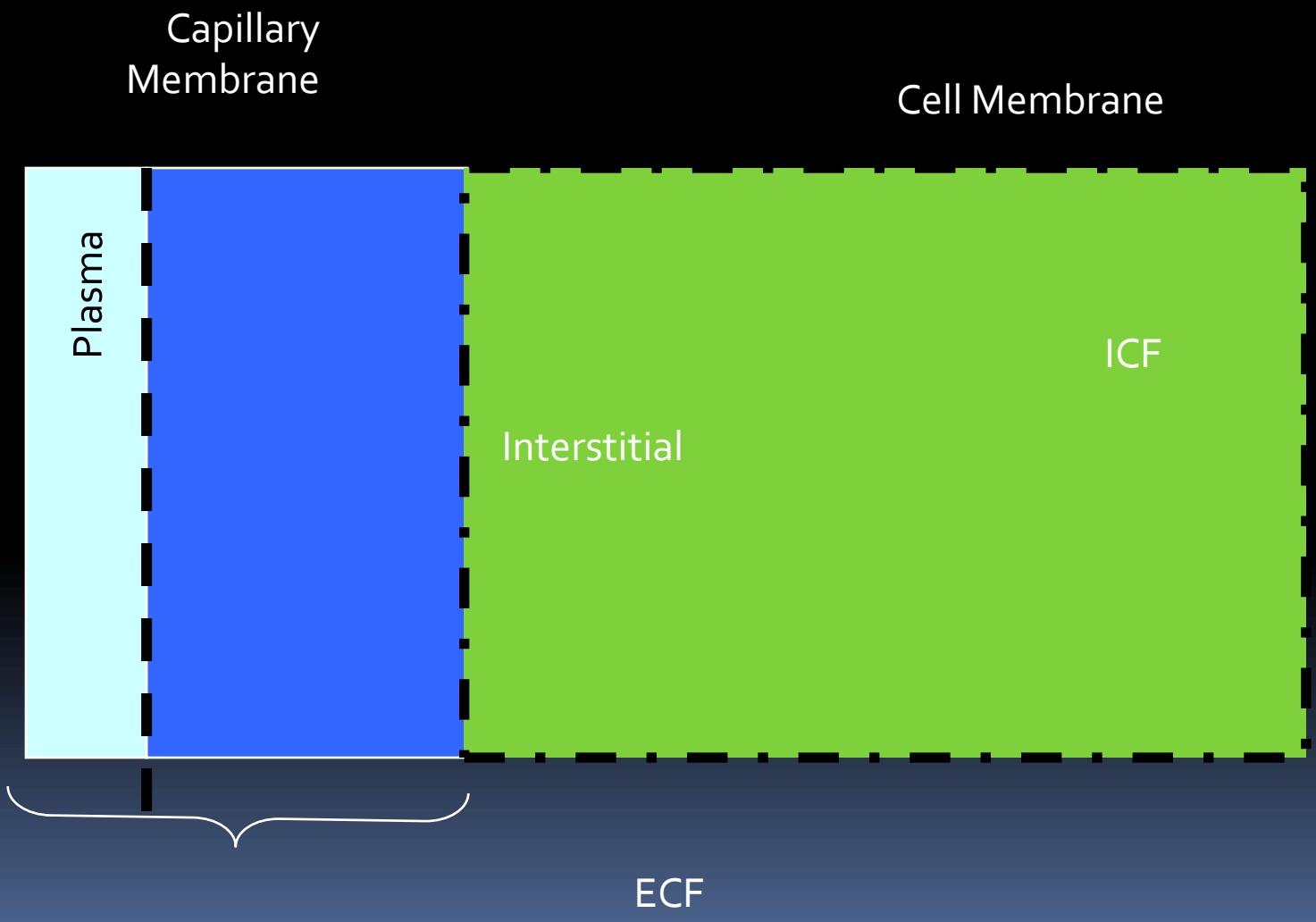
Fluid compartments



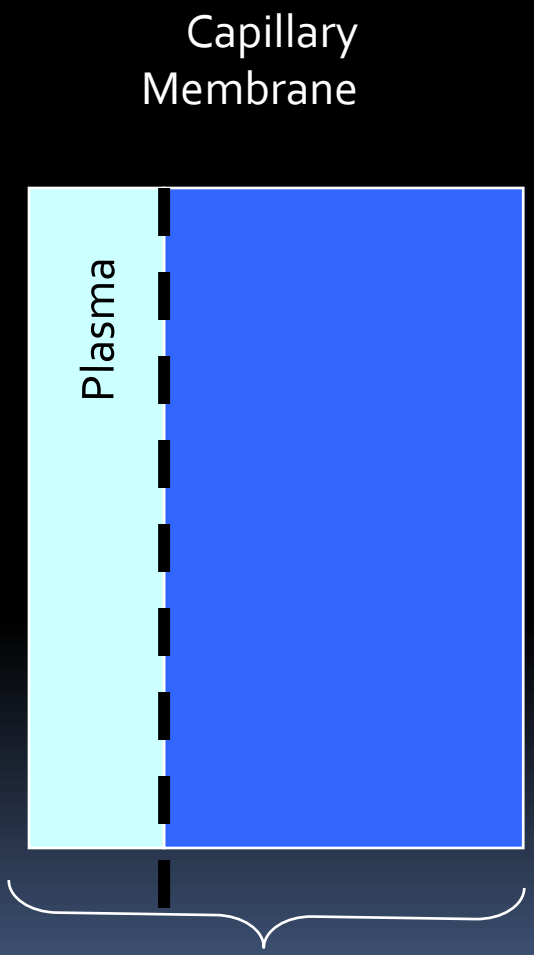
Fluid compartments



Fluid compartments



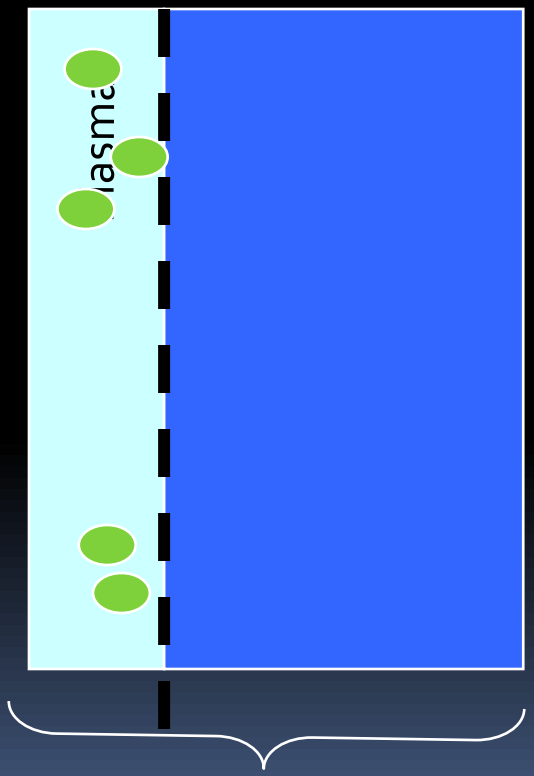
Colloid osmotic pressure



Capillary membrane freely permeable to water and electrolytes but not to large molecules such as proteins (albumin).

Colloid osmotic pressure

Capillary Membrane



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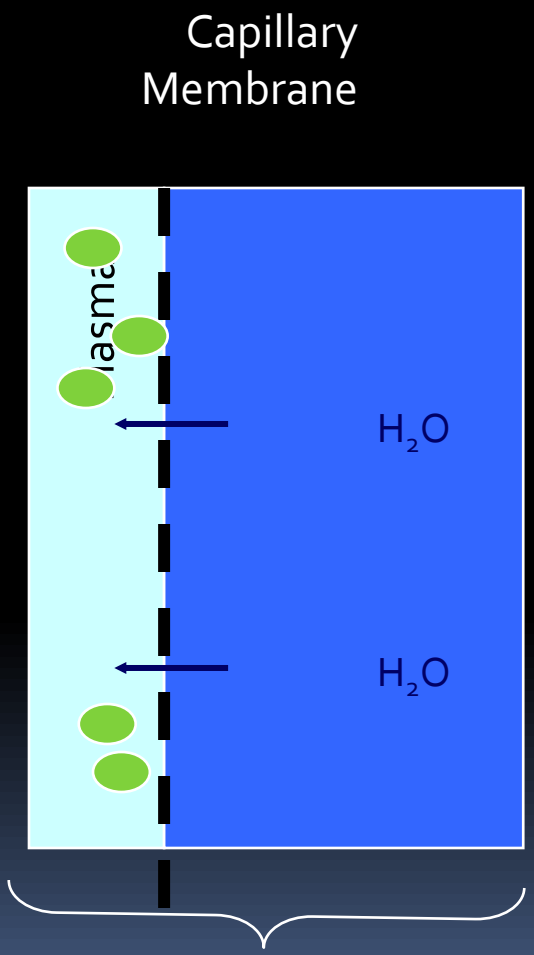
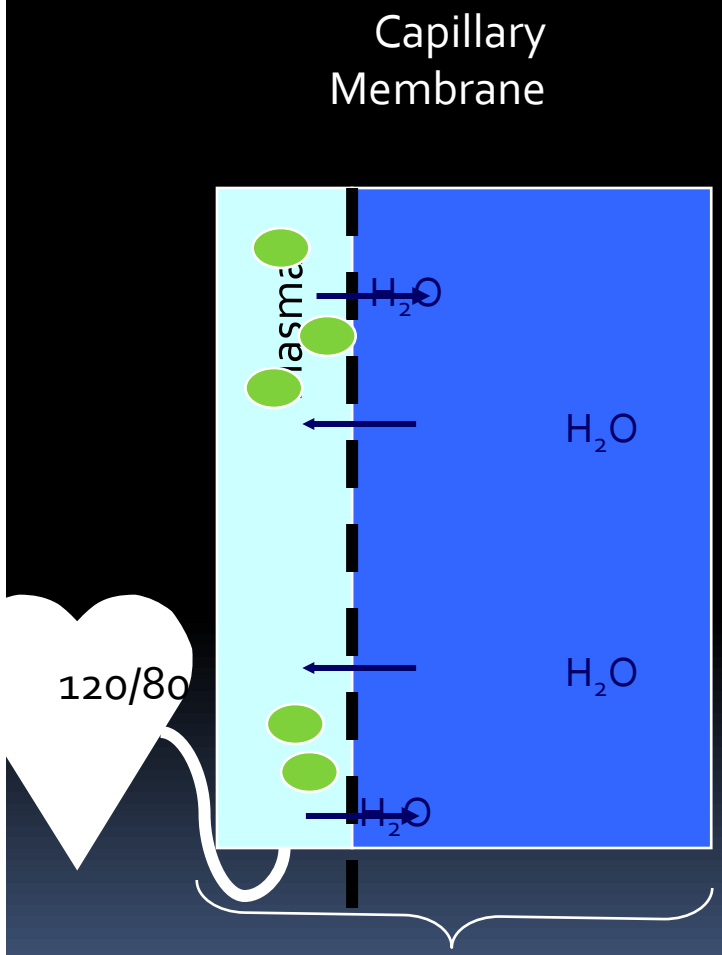
Colloid osmotic pressure



Capillary membrane freely permeable to water and electrolytes but not to large molecules such as proteins (albumin).

The albumin on the plasma side gives rise to a colloid osmotic pressure gradient favouring movement of water into the plasma

Colloid osmotic pressure

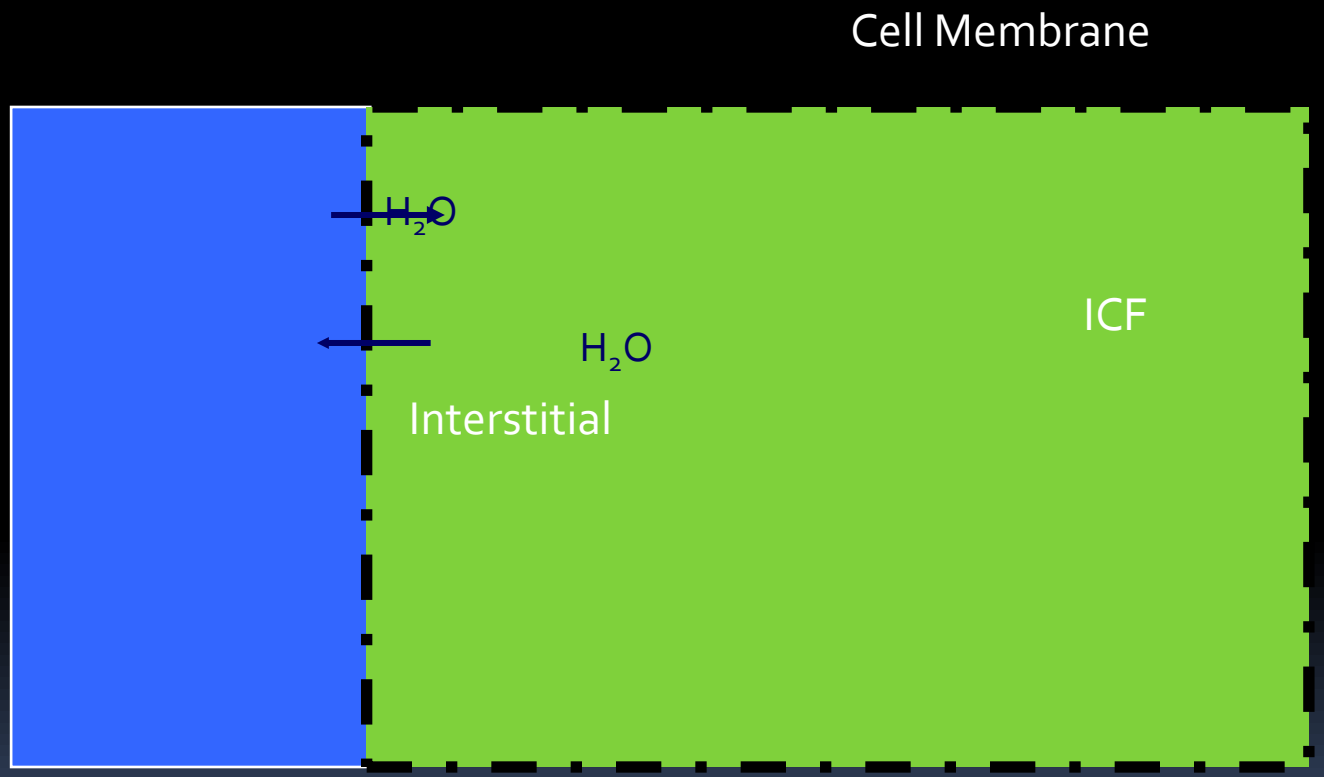


Capillary membrane freely permeable to water and electrolytes but not to large molecules such as proteins (albumin).

The albumin on the plasma side gives rise to a colloid osmotic pressure gradient favouring movement of water into the plasma

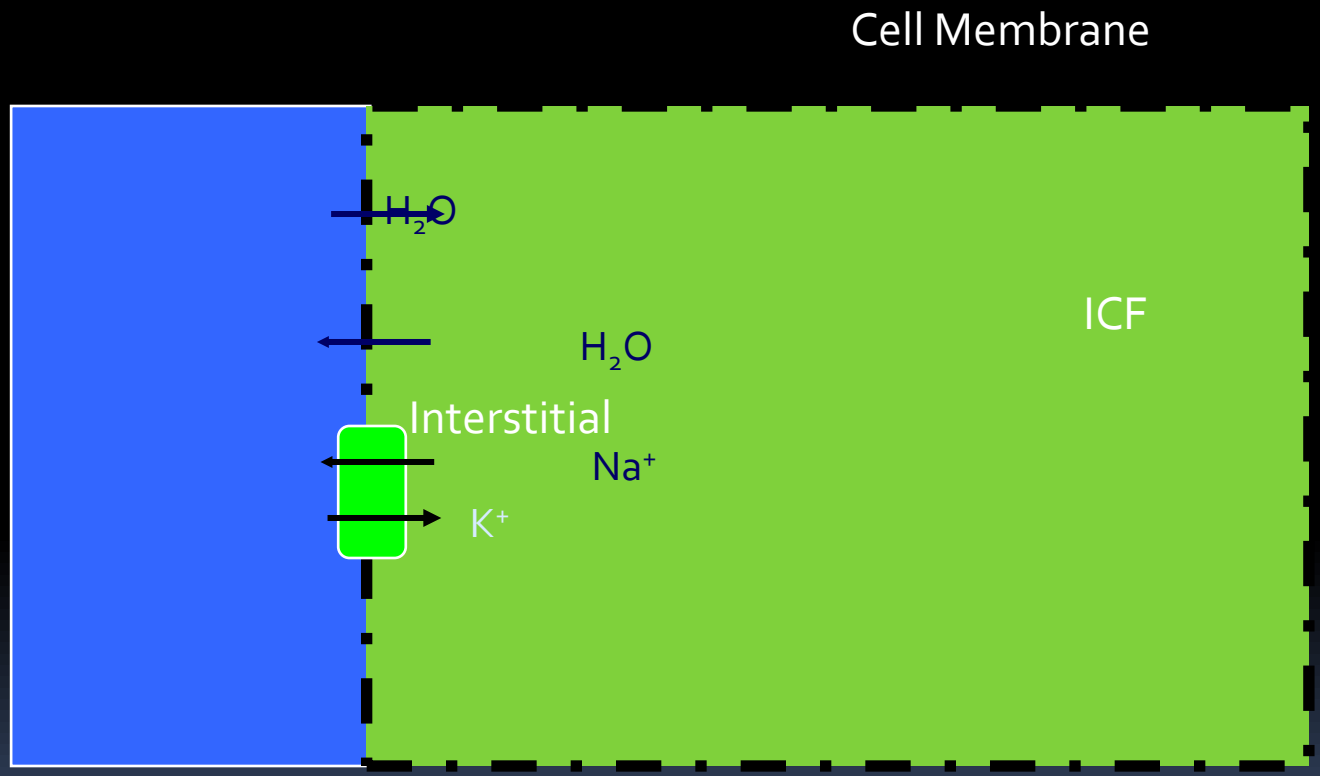
This is balanced out by the hydrostatic pressure difference

Cell Membrane



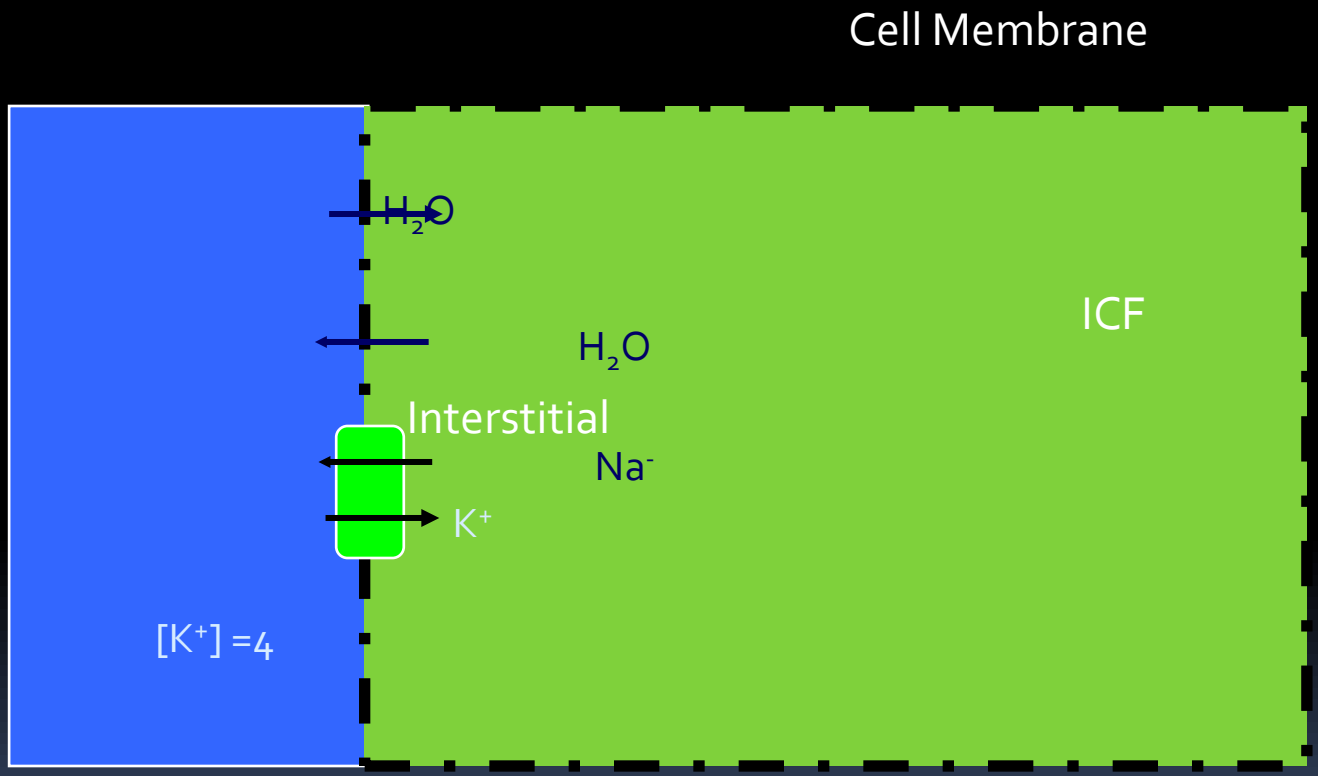
Cell membrane is freely permeable to H_2o but

Cell Membrane



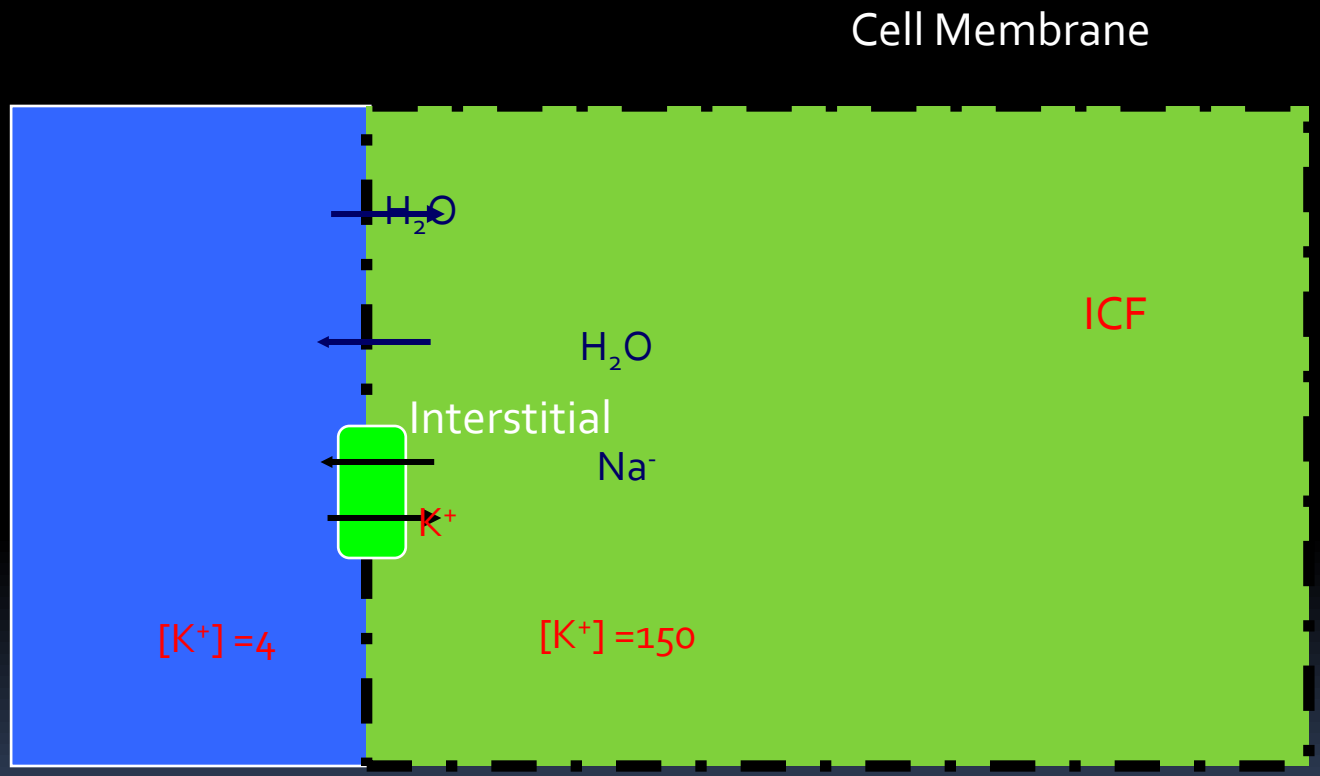
Cell membrane is freely permeable to H_2o but Na and K are pumped across this membrane to maintain a gradient!

Cell Membrane



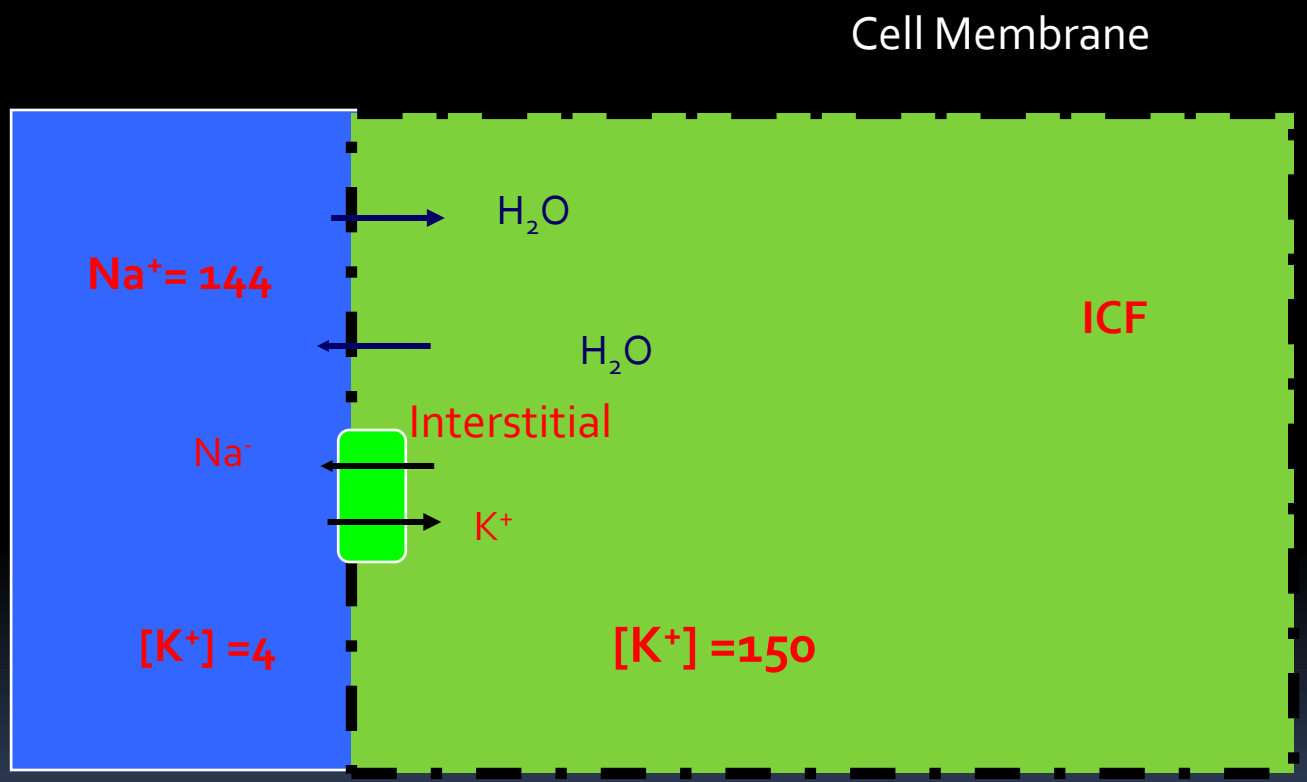
Cell membrane is freely permeable to H20 but Na and K are pumped across this membrane to maintain a gradient!

Cell Membrane



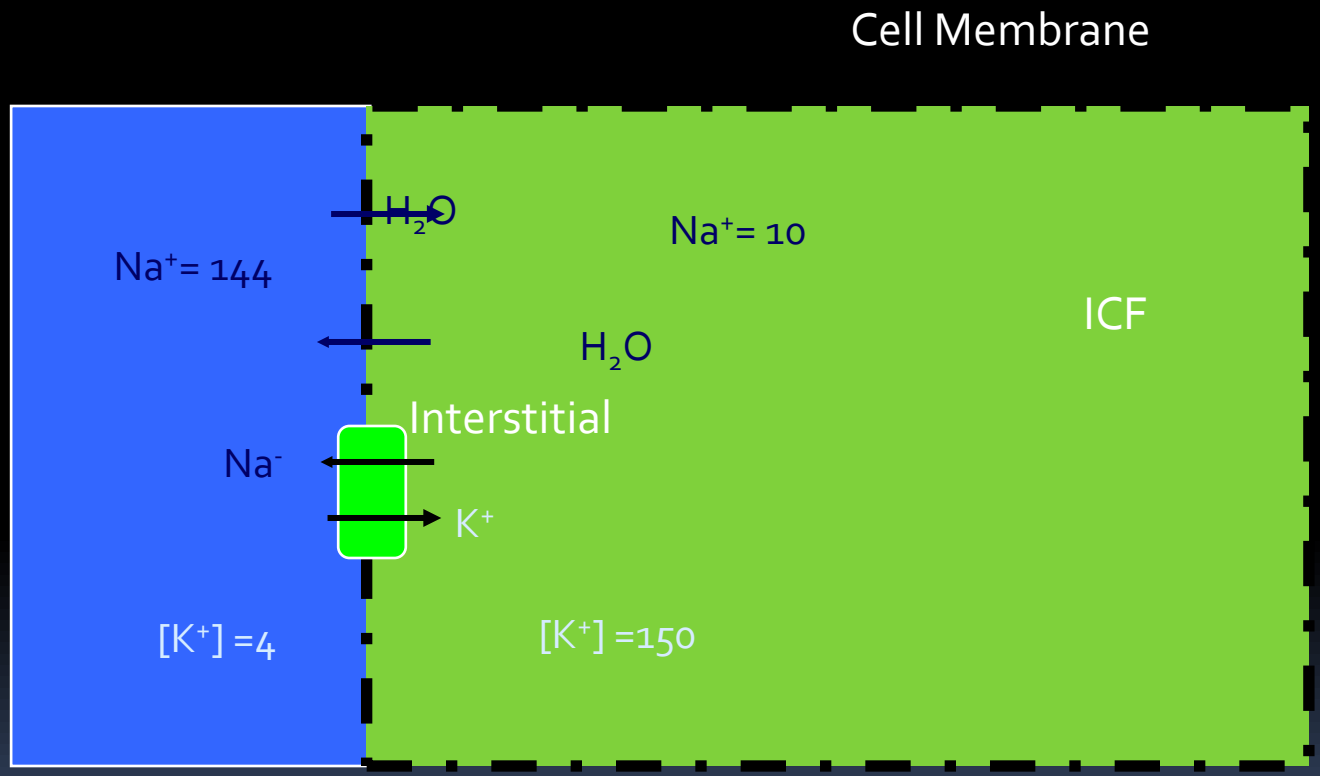
Cell membrane is freely permeable to H20 but Na and K are pumped across this membrane to maintain a gradient!

Cell Membrane



Cell membrane is freely permeable to H20 but Na and K are pumped across this membrane to maintain a gradient!

Cell Membrane



Cell membrane is freely permeable to H_2o but Na and K are pumped across this membrane to maintain a gradient!

Hypernatremia

- Manifestations
  - Thirst, lethargy, agitation, seizures, and coma
- Impaired LOC
- Produced by clinical states
  - Central or nephrogenic diabetes insipidus
- Reduce levels gradually to avoid cerebral edema

Hyponatremia

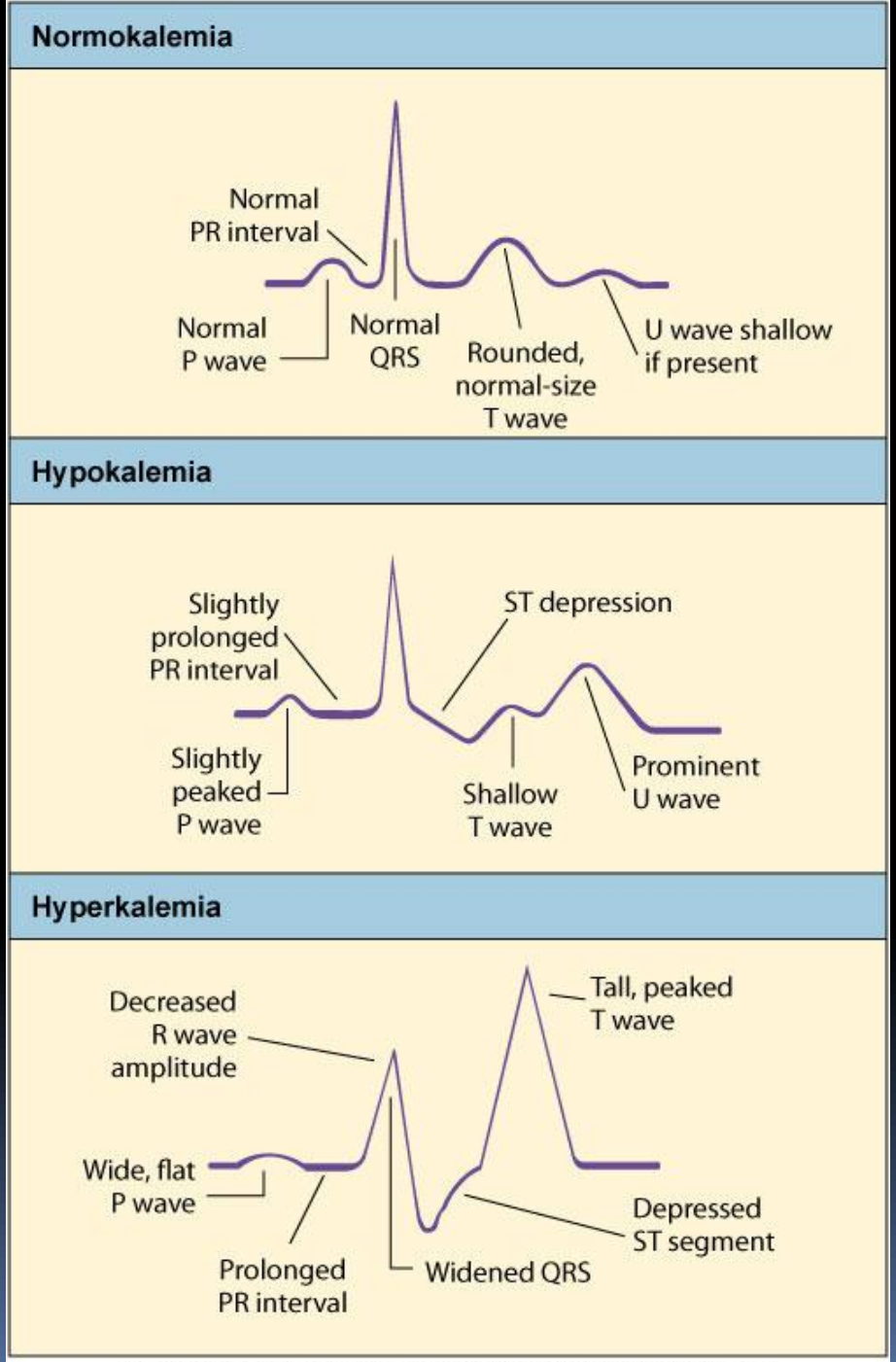
- Results from loss of sodium-containing fluids
  - Sweat, diarrhea, emesis, etc.
- Or from water excess
  - Inefficient kidneys
  - Drowning, excessive intake
- Manifestations
  - Confusion, nausea, vomiting, seizures, and coma

Hyperkalemia

- High serum potassium caused by
  - Massive intake
  - Impaired renal excretion
  - Shift from ICF to ECF (acidosis)
  - Drugs
- Common in massive cell destruction
  - Burn, crush injury, or tumor lysis
- False High: hemolysis of sample

Hyperkalemia

- Manifestations
  - Weak or paralyzed skeletal muscles
  - Ventricular fibrillation or cardiac standstill
  - Abdominal cramping or diarrhea



(Redrawn from McCance KL, Huether SE: *Pathophysiology: the biologic basis for disease in adults and children*, ed 5, St. Louis, 2006, Mosby.)

Hypokalemia

- Low serum potassium caused by
  - Abnormal losses of K^+ via the kidneys or gastrointestinal tract
  - Magnesium deficiency
  - Metabolic alkalosis

Hypokalemia

- Manifestations
  - Most serious are cardiac
  - Skeletal muscle weakness
  - Weakness of respiratory muscles
  - Decreased gastrointestinal motility

Calcium

- Obtained from ingested foods
- More than 99% combined with phosphorus and concentrated in skeletal system
- Inverse relationship with phosphorus
  - Otherwise…

Calcium

- Bones are readily available store
- Blocks sodium transport and stabilizes cell membrane
- Ionized form is biologically active
  - Bound to albumin in blood
  - Bound to phosphate in bone/teeth
  - Calcified deposits

Calcium

- Functions
  - Transmission of nerve impulses
  - Myocardial contractions
  - Blood clotting
  - Formation of teeth and bone
  - Muscle contractions

Calcium

- Balance controlled by
  - Parathyroid hormone
  - Calcitonin
  - Vitamin D/Intake
- Bone used as reservoir

Hypercalcemia

- High serum calcium levels caused by
  - Hyperparathyroidism (two thirds of cases)
  - Malignancy (parathyroid tumor)
  - Vitamin D overdose
  - Prolonged immobilization

Hypercalcemia

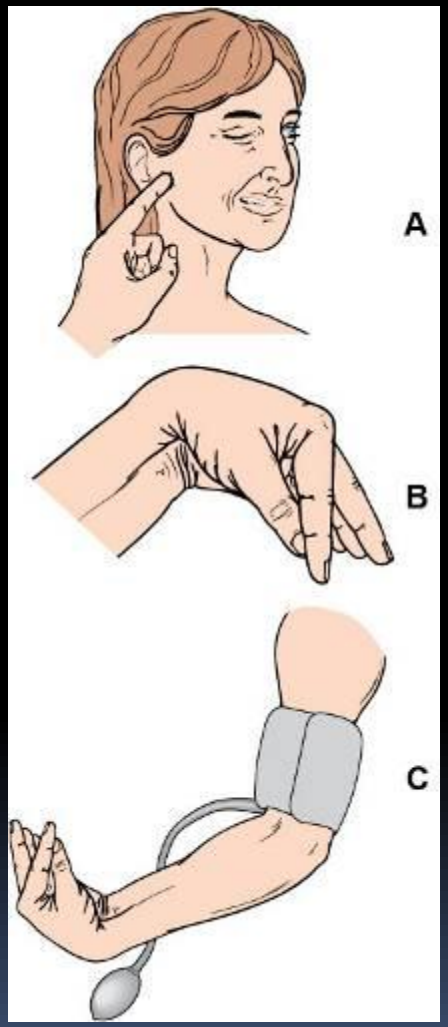
- Manifestations
  - Decreased memory
  - Confusion
  - Disorientation
  - Fatigue
  - Constipation

Hypocalcemia

- Low serum Ca levels caused by
  - Decreased production of PTH
  - Acute pancreatitis
  - Multiple blood transfusions
  - Alkalosis
  - Decreased intake

Hypocalcemia

- Manifestations
  - Weakness/Tetany
  - Positive Trousseau's or Chvostek's sign
  - Laryngeal stridor
  - Dysphagia
  - Tingling around the mouth or in the extremities



IV Fluids

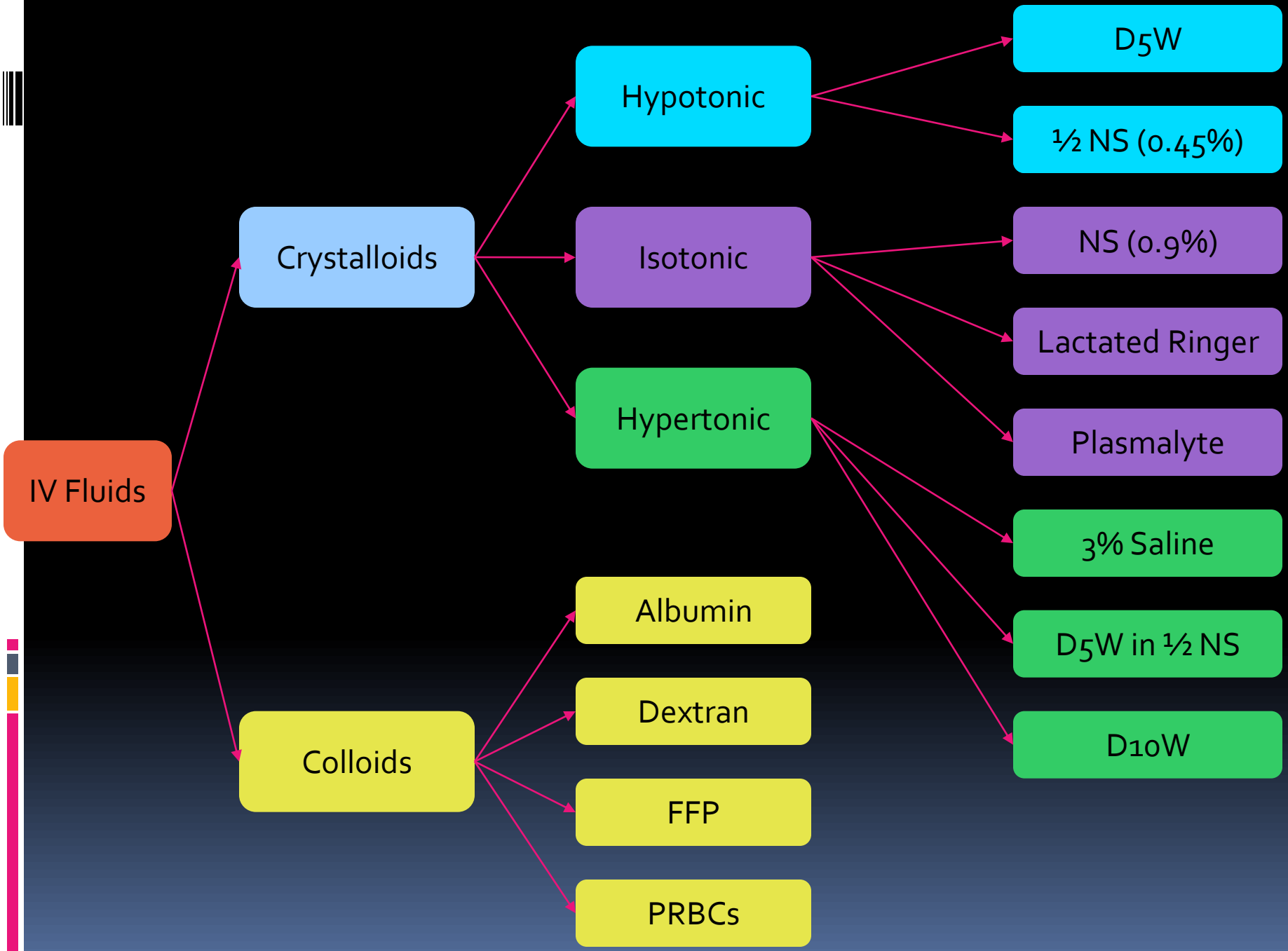
- Purposes
  1. Maintenance
     - When oral intake is not adequate
  2. Replacement
     - When losses have occurred


ABSOLUT
VODKA
IMPORTED
100 % French Roast
NO VISIT 9GAG.COM

Kinds of IV Fluid solutions

- Hypotonic - 1/2NS
- Isotonic - NS, LR, albumen
- Hypertonic – Hypertonic saline.

- Crystalloid
- Colloid


IV Fluids
Crystalloids
Colloids
Hypotonic
Isotonic
Hypertonic
Albumin
Dextran
FFP
PRBCs
D5W
½ NS (0.45%)
NS (0.9%)
Lactated Ringer
Plasmalyte
3% Saline
D5W in ½ NS
D10W

D5W (Dextrose = Glucose)

- Hypotonic
- Provides 170 cal/L
- Free water
  - Moves into ICF
  - Increases renal solute excretion
- Used to replace water losses and treat hyponatremia
- Does not provide electrolytes

Normal Saline (NS)

- Isotonic
- No calories
- More NaCl than ECF
- 30% stays in IVF
  - 70% moves out of IV space

Normal Saline (NS)

- Expands IV volume
  - Preferred fluid for immediate response
  - Risk for fluid overload higher
- Does not change ICF volume
- Blood products
- Compatible with most medications

Lactated Ringer's

- Isotonic
- More similar to plasma than NS
  - Has less NaCl
  - Has K, Ca, PO_4^{3-}, lactate (metabolized to HCO_3^-)
    - CONTRAINDICATED in lactic acidosis
- Expands ECF

Plasma Expanders

- Stay in vascular space and increase osmotic pressure
- Colloids (protein solutions)
  - Packed RBCs
  - Albumin
  - Plasma
  - Dextran

THANK YOU