REGULATION OF SODIUM

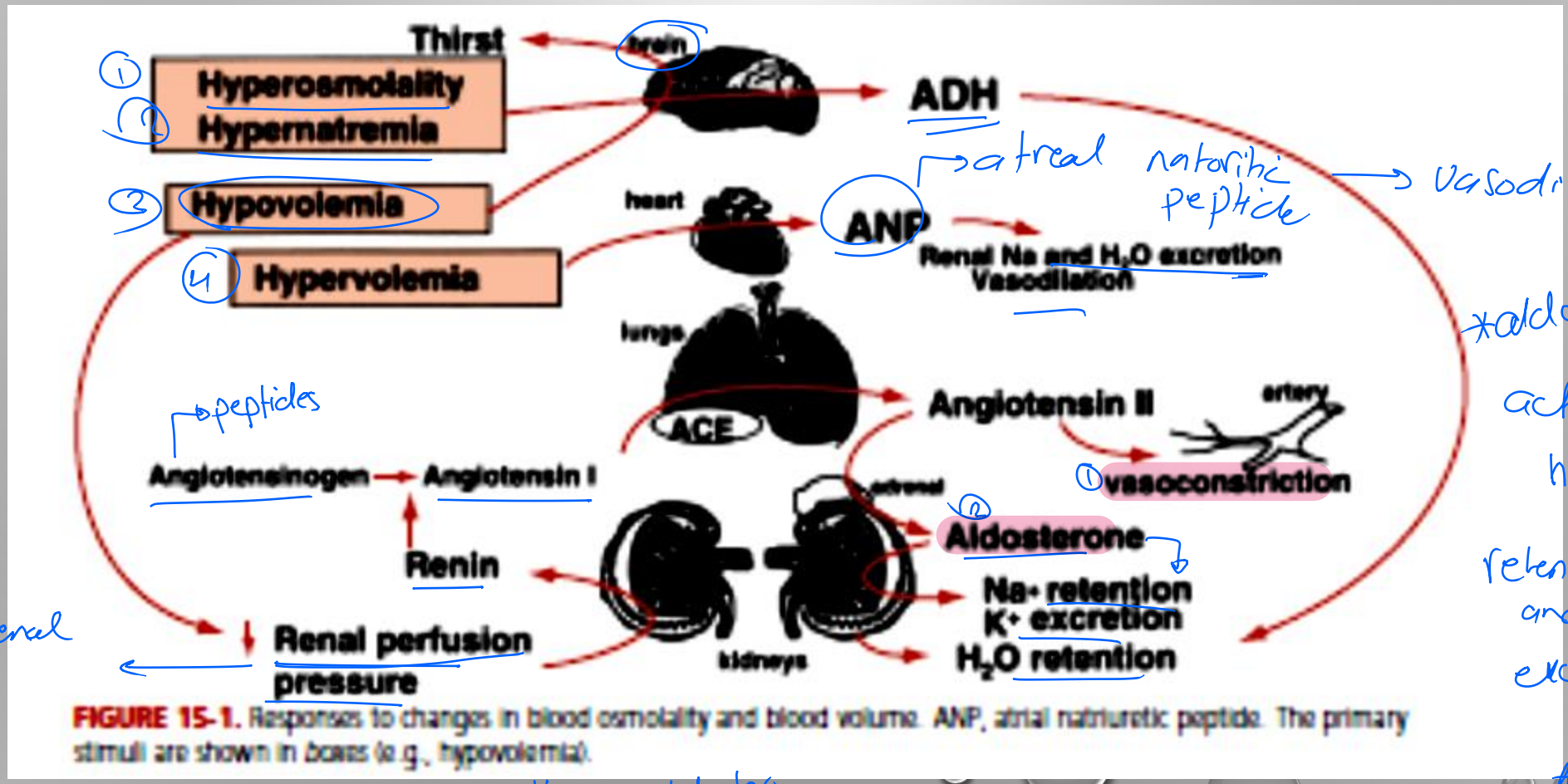

FIGURE 15-1. Responses to changes in blood osmolality and blood volume. ANP, atrial natriuretic peptide. The primary stimuli are shown in boxes (e.g., hypovolemia).

CAUSES OF HYPERNATREMIA

- Excess water loss
  - Diabetes insipidus
  - Renal tubular disorder
  - Prolonged diarrhea
  - Profuse sweating
  - Severe burns
- Decreased water intake
  - Older persons
  - Infants
  - Mental impairment
- Increased intake or retention
  - Hyperaldosteronism
  - Sodium bicarbonate excess
  - Dialysis fluid excess

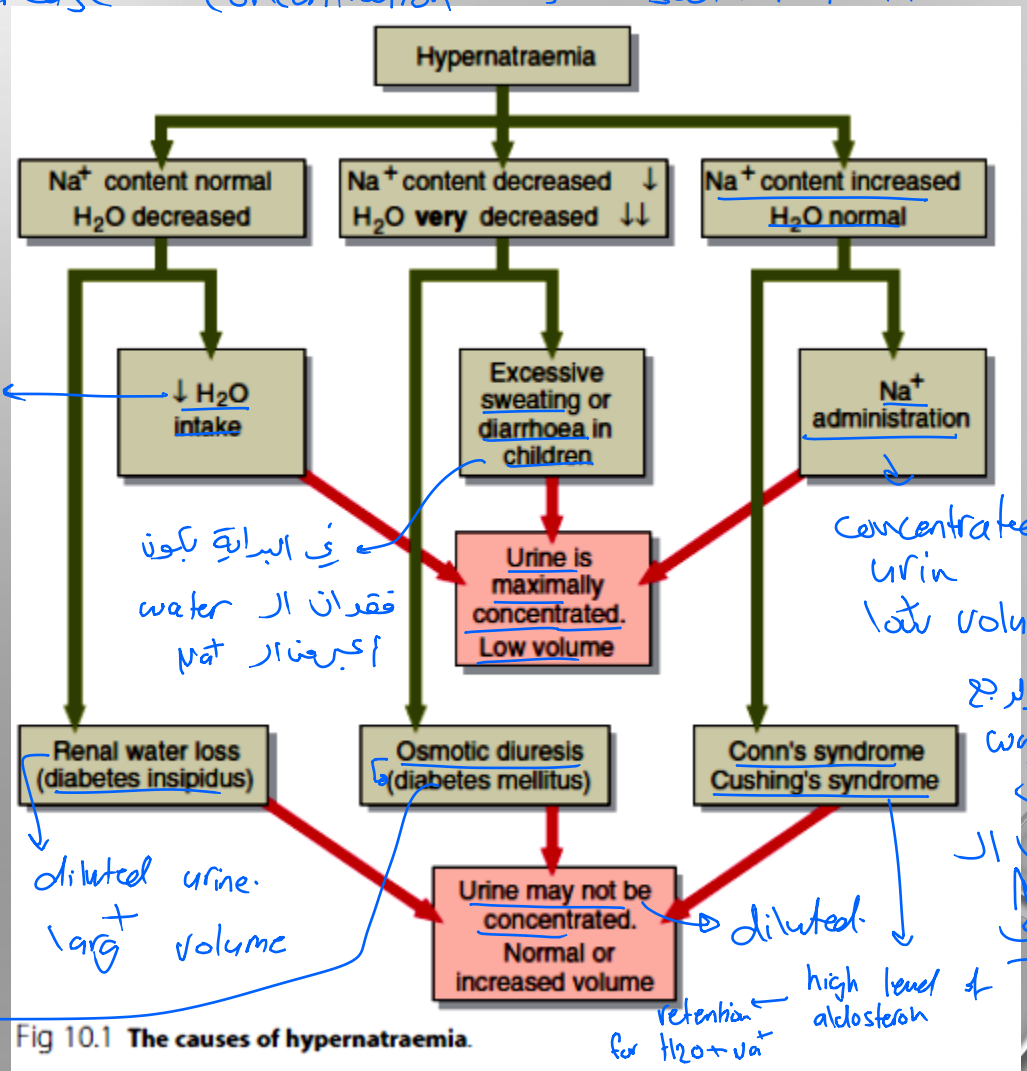

Fig 10.1 **The causes of hypernatraemia.**

HYPERNATREMIA (150 MMOL/L) RELATED TO URINE OSMOLALITY

- Urine osmolality <300 mosm/kg (diluted urine)
  - Diabetes insipidus (impaired secretion of ADH respond to ADH) or kidneys cannot
- Urine osmolality 300-700 mosm/kg
  - Partial defect in ADH release or response to ADH
  - Osmotic diuresis (diabets mellitus, high calcium level → يسحب الجسم ليسحب معها H2O , manitol.
- Urine osmolality >700 mosm/kg (concentrated urine). → low level of water in urine.
  - Loss of thirst عدم الشعور بالعطش
  - Insensible loss of water (breathing, skin) GI
  - GI loss of hypotonic fluid (vomiting, diarrhea.
  - Excess intake of sodium

SYMPTOMS OF HYPERNATREMIA → CNS symptoms.

Normal rang (135 to 145) → 150 and more → symptoms will appear.
145 to 150 → في أعراض

- ❑ Involve the central nervous system (CNS) hyperosmolar state which include: as a result of the
  1. ❑ Altered mental status → تشوش
  2. ❑ Lethargy → إرهاق
  3. ❑ Irritability
  4. ❑ Restlessness. → عدم الشعور بالراحة
  5. ❑ Seizures
  6. ❑ Muscle twitching, hyperreflexes → شرفي جزء من العضلة حتى العضلة كاملة (ليكان تحدد)
  7. ❑ Fever, nausea or vomiting
  8. ❑ Difficult respiration, and increased thirst.
- ❑ Serum sodium of more than 160 mmol/L is associated with a mortality rate of 60-75%

TREATMENT OF HYPERNATREMIA

لـ بالبداية لازم اشوف شو السبب اللي عمل زيادة للصوديوم وأعالجه

- Treatment is directed at correction of the underlying condition that caused the water depletion or sodium retention.

إذا كانت زيادة الصوديوم مش كتير كبيرة ← الحل انه يشرب water وبس خلاص.

- The speed of correction depends on the rate with which the condition developed

- Hypernatremia must be corrected gradually because too rapid a correction of serious hypernatremia (>160 mmol/L) can induce cerebral edema and death. The maximal rate should be 0.5 mmol/L per hour

لـ اذا الـ rate عالي جدًا بعمل cerebral edema

لـ IV solution without Na+

HYPONATREMIA

Lo low concentration of Sodium in blood.

- Hyponatremia is defined as a serum or plasma level <135 mmol/L.

تبلش الأعراض بعدما تقل عن 130 ←

- Levels below 130 mmol/l are clinically significant.

- Hyponatremia can be assessed by the cause for the decrease or with the osmolality level.

لازم اعرف شو السبب.

الموضوع بس تقل level Na^+ في الدم ال osmolality تقل للدم.

*we can measured the concentration of Na^+ in serum. and plasma or urin

CAUSES OF HYPONATREMIA

- **Increase sodium loss**
  - Hypoadrenalism
  - Potassium deficiency (exchange in kidney)
  - Diuretic use (thiazide)
  - Ketonuria (sodium lost with ketones)
  - Salt losing nephropathy (with some renal tubular disorders)
- **These factors will increase the conc. of Na in urine to >20 mmol/L**
  - Prolong vomiting or diarrhea
  - Severe burns
- Increased water retention
  - Renal failure
  - Nephrotic syndrome
  - Hepatic cirrhosis
  - Congestive heart failure

CAUSES OF HYPONATREMIA

- Water imbalance
  - Excess water intake (polydipsia, increased thirst): may cause mild or severe hyponatremia if water intake was chronic. In a normal individual, excess intake will not affect Na levels.
  - SIADH causes an increase in water retention because of increased ADH production which is associated with pulmonary disease, malignancies, CNS disorders, infections.
- Pseudohyponatremia by measuring Na using indirect ISE (which dilutes sample prior to analysis), in a patient with hyperproteinemia or hyperlipidemia.

CLASSIFICATION OF HYPONATREMIA BY OSMOLALITY

- With low osmolality
  1. Increased sodium loss
  2. Increased water retention
- With normal osmolality increased nonsodium cations
  1. Lithium excess
  2. Increased -γ-globulins-cationic (multiple myeloma)
  3. Severe hyperkalemia
  4. Severe hypermagnesemia
  5. Severe hypercalcemia, pseudohyponatremia
  6. Hyperlipidemia
  7. Hyperproteinemia
  8. Pseudohyperkalemia as a result of in vitro hemolysis
- With high osmolality
  1. Hyperglycemia
  2. Mannitol infusion

SYMPTOMS OF HYPONATREMIA

- Symptoms depend on the serum level.
  - Between 125 and 130 mmol/l: symptoms are gastrointestinal (Nausea and vomiting)
  - Below 125 mmol/l: more severe neuropsychiatric seen including nausea and vomiting, muscular weakness, headache, lethargy, and ataxia.
  - More severe symptoms also include seizures, coma, and respiratory depression → death.

TREATMENT OF HYPONATREMIA

- Treatment is directed correction of the condition that caused either water loss or sodium loss in excess of water loss.
- Correcting severe hyponatremia too rapidly can cause cerebral myelinolysis while too slowly can cause cerebral edema
- Appropriate management of fluid administration is critical. Fluid administration and monitoring is required during treatment of the underlying cause of the hyponatremia.
- The measurement of urine osmolality is necessary to evaluate the cause of hypernatremia
- Chronic hyponatremia in an alert patient is indicative of hypothalamic disease.

DETERMINATION OF SODIUM

- Sodium can be measured in serum, plasma, and urine.
- When plasma is used, lithium heparin, ammonium heparin, and lithium oxalate are suitable anticoagulants.
- Hemolysis does not cause significant change in serum or plasma values as a result of decreased levels of intracellular sodium. however, with marked hemolysis, levels may be decreased as a result of a dilutional effect
- Whole blood samples may be used with some analyzers.
- The specimen of choice in urine sodium analyses is a 24-hour collection.
- Sweat is also suitable for analysis.

عليها سؤال بالإمتحان وصرنا حاكيين الفكرة.

POTASSIUM → major intracellular cation.

- Potassium is the major intracellular cation in the body with a concentration 20 times greater inside the cells than outside
- Many cellular functions requires that the body maintains a low ECF concentration of K. As a result, only 2% of the body's total potassium circulates in the plasma.
- Function of potassium in the body include
  1. Neuromuscular excitability
  2. Contraction of the heart
  3. ICF volume (intracellular fluid volume) → prevent swelling or shrinking of cells.
  4. Hydrogen ion concentration

high level of K^+ ECF → الجسم بروح بسحبه لجوا الخلية

وعشان تعادل بروح 2 بطلع مكانها H^+ لل ECF ← اذا نسبة عالية تسبب acidosis.

normal level (3.5 to 5)

POTASSIUM

↑ ka → uptake by cell → يدخل هيدروجين H+ من الخلية → acidosis

↓ ka → يخرج من داخل الخلية ليرا ← عشان أعوض بيبي بفوت H^+ عالخلية ← (such as cancer) alkalosis

- The potassium ion concentration has a major effect on skeletal and cardiac muscles. A lower than normal difference increases cell excitability leading to muscle weakness.
- Severe hypokalemia can cause muscle excitability which may lead to paralysis or fatal cardiac arrhythmia
- Hypokalemia decreases cell excitability resulting in an arrhythmia or paralysis
- the heart may cease to contract in extreme case of hypokalemia or hyperkalemia
- Potassium concentration affects hydrogen ion concentration in the blood. In hypokalemia, when potassium ion is lost from the blood, sodium and hydrogen ions move to into the cells. The hydrogen ion concentration decreases in ECF resulting to alkalosis .

heart block. ↓ level of K^+ more than 10.

FACTORS AFFECT K LEVEL IN ECF

- Three factors that influence the distribution of potassium between cells and ECF are:
- (1) **Potassium loss** frequently occurs whenever the NaK ATPase pump is inhibited by conditions such as:
  - (1) hypoxia
  - (2) hypomagnesemia
  - (3) or digoxin overdose
- (2) **Insulin** promotes acute entry of K ions into skeletal muscle and liver by increasing NaK ATPase activity
- (3) **Catecholeamines** such as epinephrine (β2-stimulator), promotes cellular entry of K whereas propranolol (β-blocker) impairs cellular entry of potassium .
- With preexisting condition such as **dietary deficiency** (or excess) can enhance the degree of hypokalemia (or hyperkalemia)but rarely the primary cause.

يعطيكم العافية زميلتكم مرام الزيادي