Body Fluids 2

Ref: Textbook of Medical Physiology
Guyton and Hall, 13th Ed: pp: 305-321
12th Ed.: pp: 285-297

Regulation of Fluid volumes and osmolality

Regulation of Na+ and Water

Involves regulation of:

- Osmolality
- Volume of ECF

different regulations with many overlapping mechanisms.

Regulation of Na+ and Water

Involves regulation of:

- **Osmolality:**

Osmoregulation

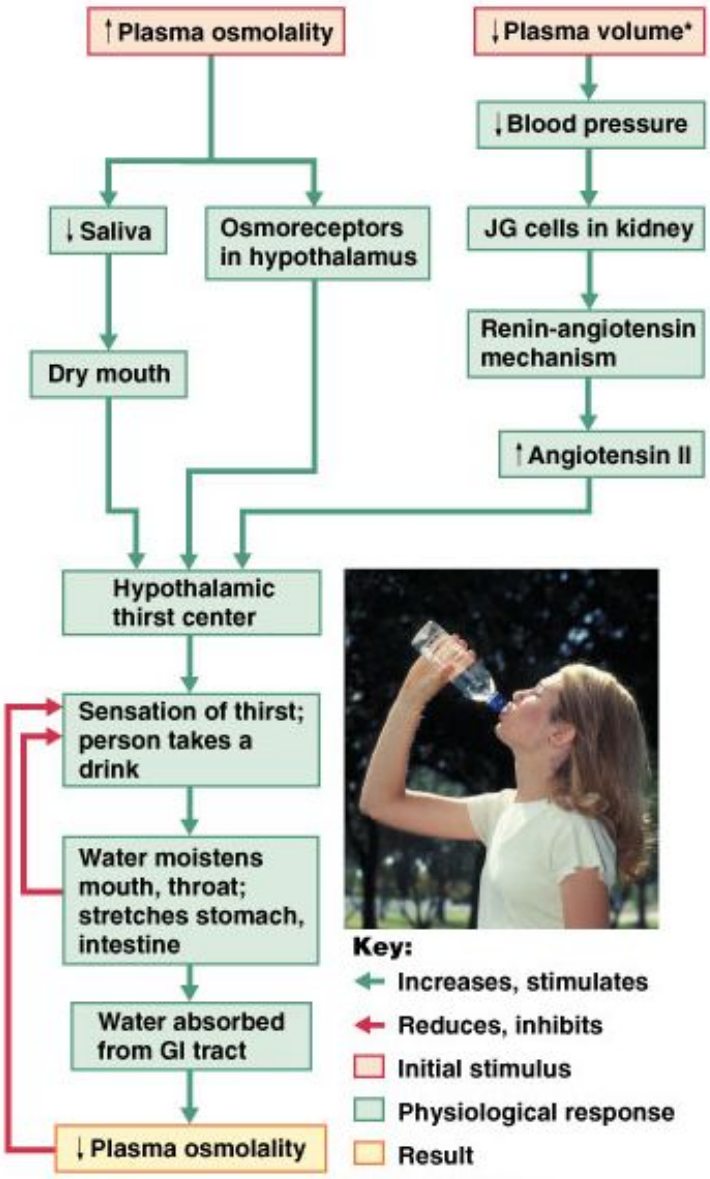
- Increased osmolality □ thirst (Increase ↑ water intake).

- Increased osmolality □ stimulates release of ADH --> acts on renal collecting ducts □ increased water reabsorption (Decrease ↓ water output)

- **Volume of ECF**

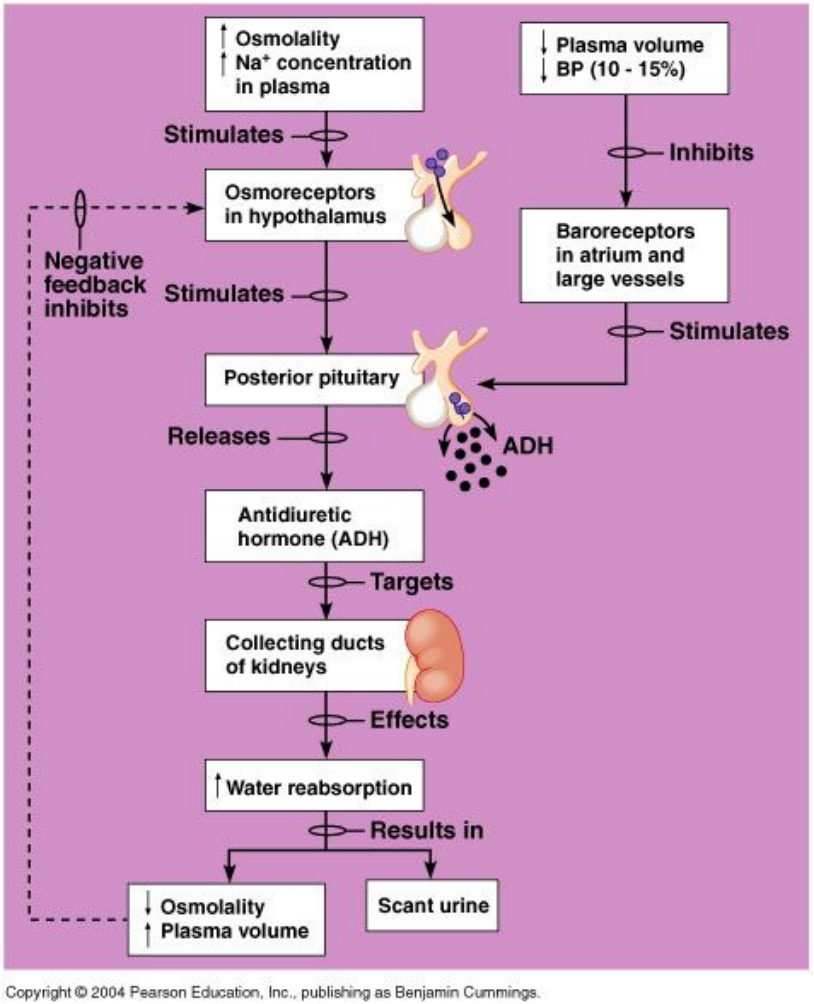
Body Water

- **Regulation of intake**
  - Regulated by hypothalamic "thirst center"
  - "Thirst center" responds to osmoreceptor impulses, angiotensin II



Body Water

- **Regulation of output**
  - Regulated by hypothalamus
    - ADH release from posterior pituitary



Body Water

- **Regulation of output**
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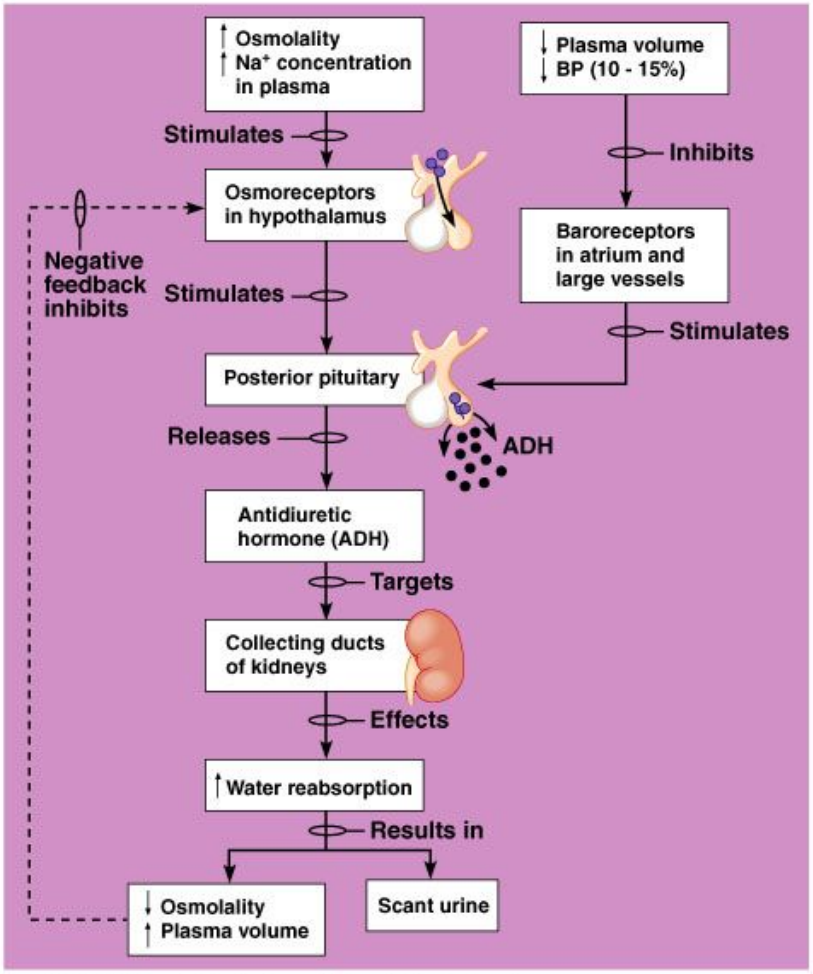
    - ADH release from posterior pituitary



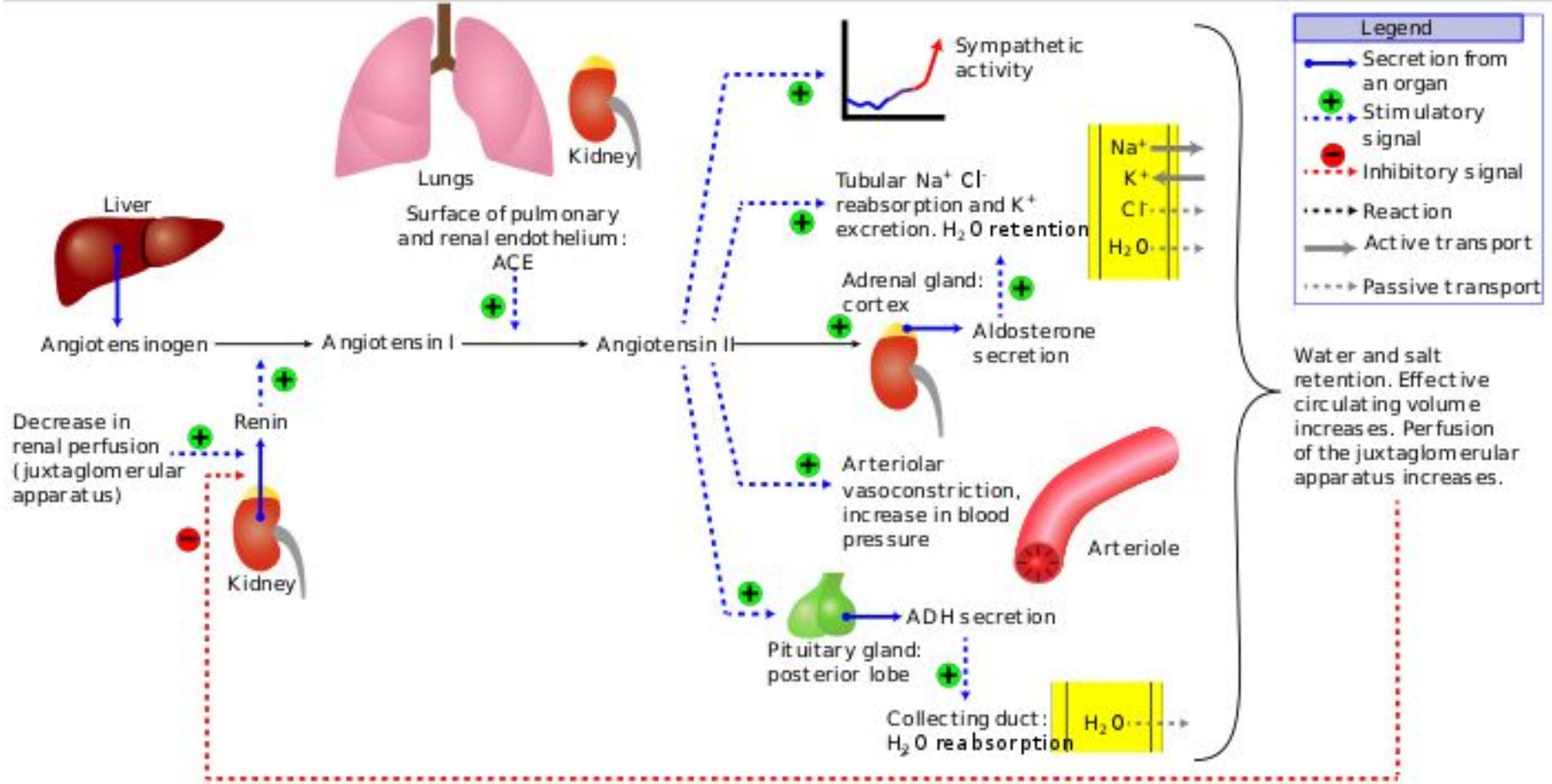
Regulation of Na+ and Water

Involves regulation of:

- **Osmolality:**
- **Volume of ECF:**
  - **Depends on Na+ excretion in urine.**
  - **Controlled by Renin-Angiotensin Aldosterone system**

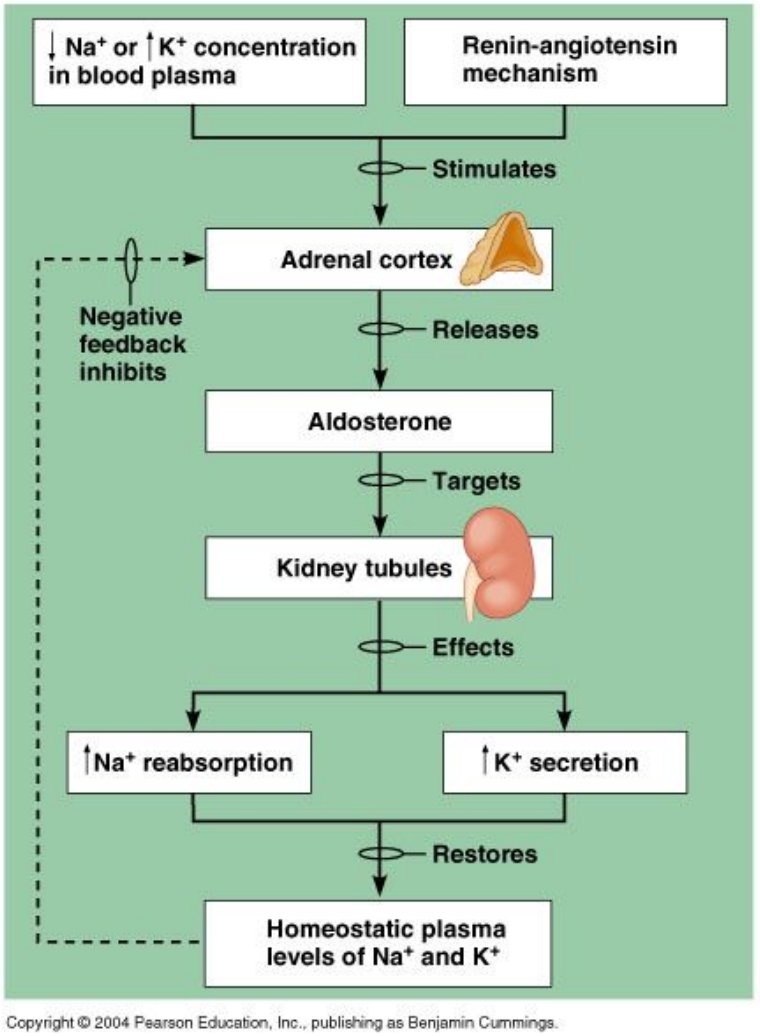
Reduced Volume merular Cells (Kidney) release Renin Angiotensinogen Angiotensin I Angiotensin II (Lung) Aldosterone

Renin-angiotensin-aldosterone system



Body Water

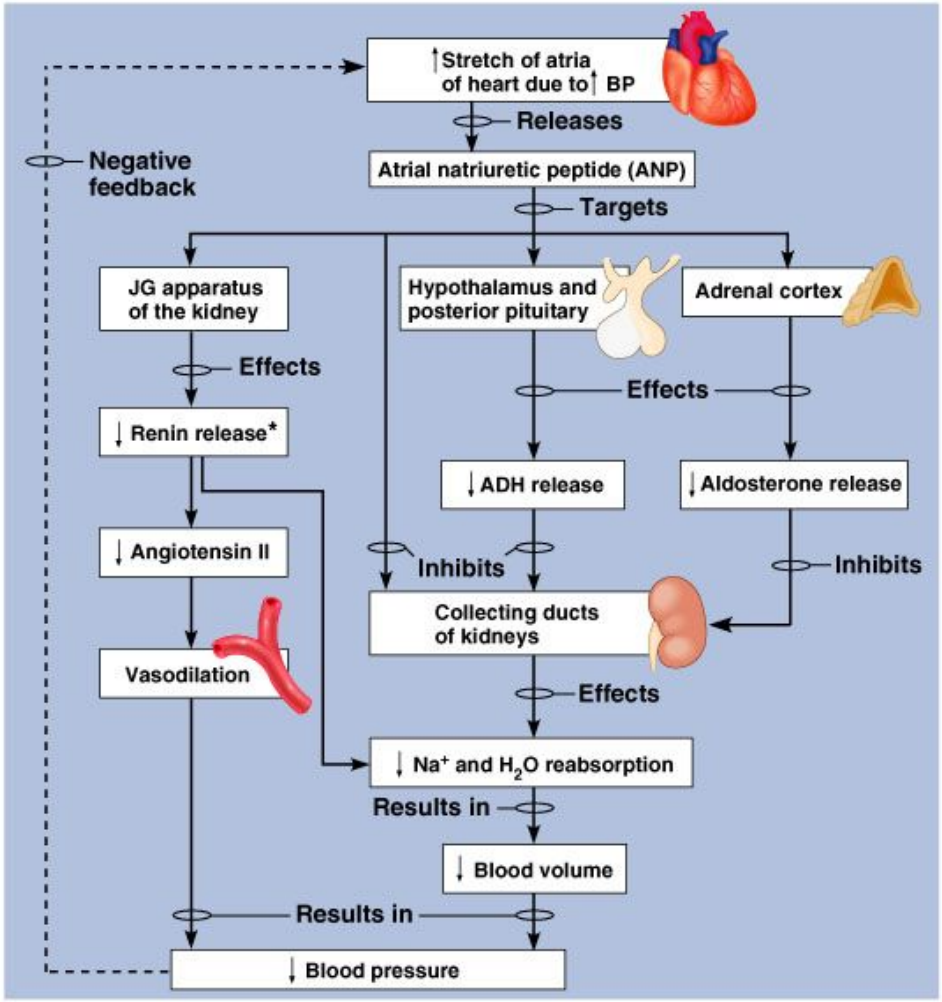
- **Regulation of output**
  - Regulated by renin-angiotensin mechanism
    - Angiotensin II stimulates aldosterone secretion



Body Water

- **Regulation of output**
  - Regulated by atrial natriuretic peptide (ANP)

Effects: reduces BP, Salts and water by effects over vessels, decrease Angiotensin II, and Aldosterone secretions



Disorders of Volumes

- **Hypovolemia**

  Results by excessive loss of fluids

- **Hypervolemia**

  Results by excessive intake or administration of fluids

Disorders of Osmolality

- **Hyponatremia**

  Results by excessive loss of Na+ or administration of hypotonic fluids.

- **Hypernatremia**

  Results by excessive intake of Na+ or administration of hypertonic fluids

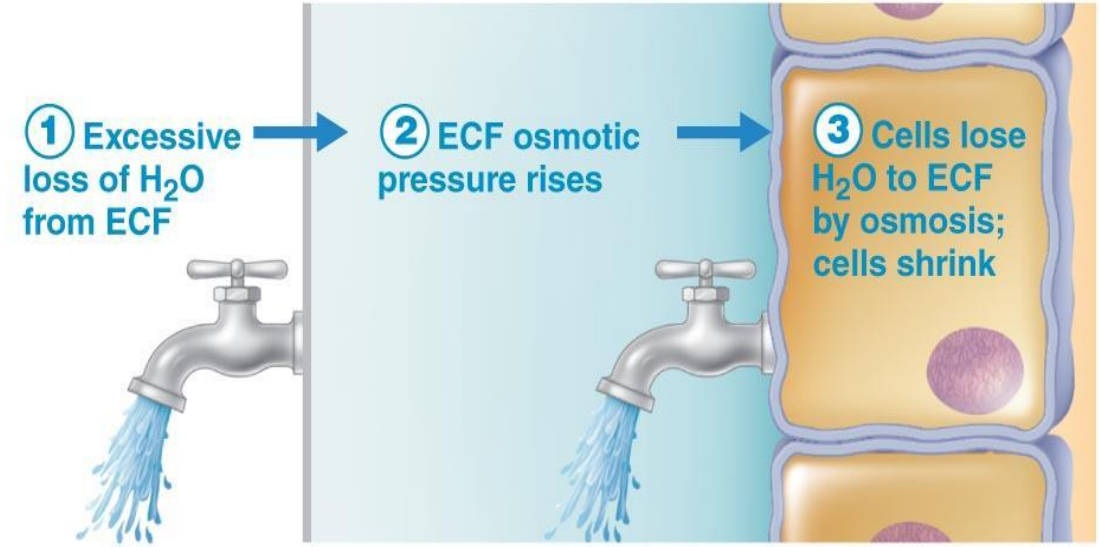
Disorders of Volumes

- **Hypovolemia**

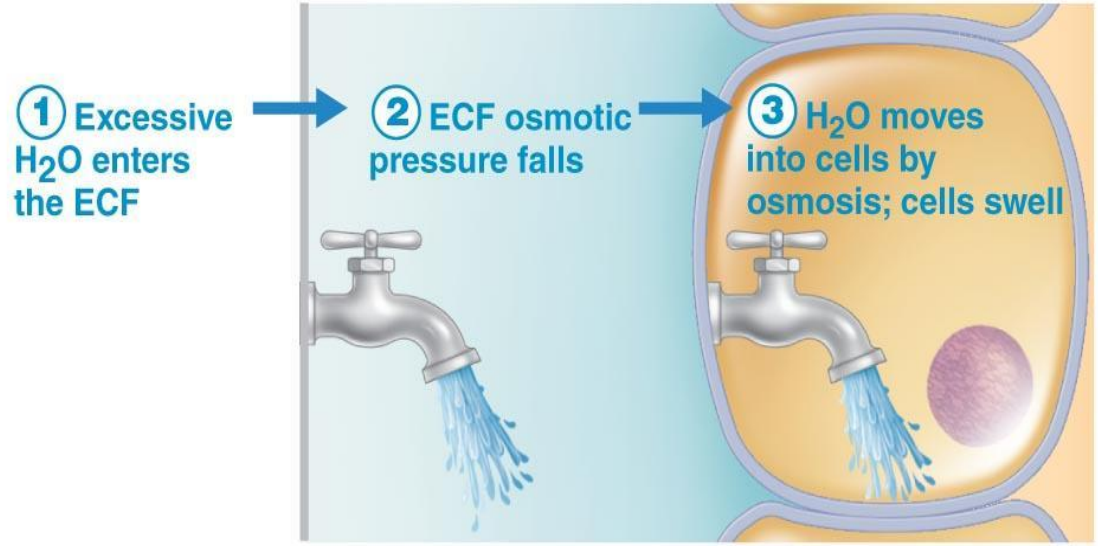
  Results by excessive loss of fluids

- Hypervolemia

  Results by excessive intake or administration of fluids



(a) Consequences of dehydration. If more water than solutes is lost, cells shrink.



(b) Consequences of hypotonic hydration (water gain). If more water than solutes is gained, cells swell.

Disorders of Volumes

- **Hypovolemia**

  Results by excessive loss of fluids

- **Hypervolemia**

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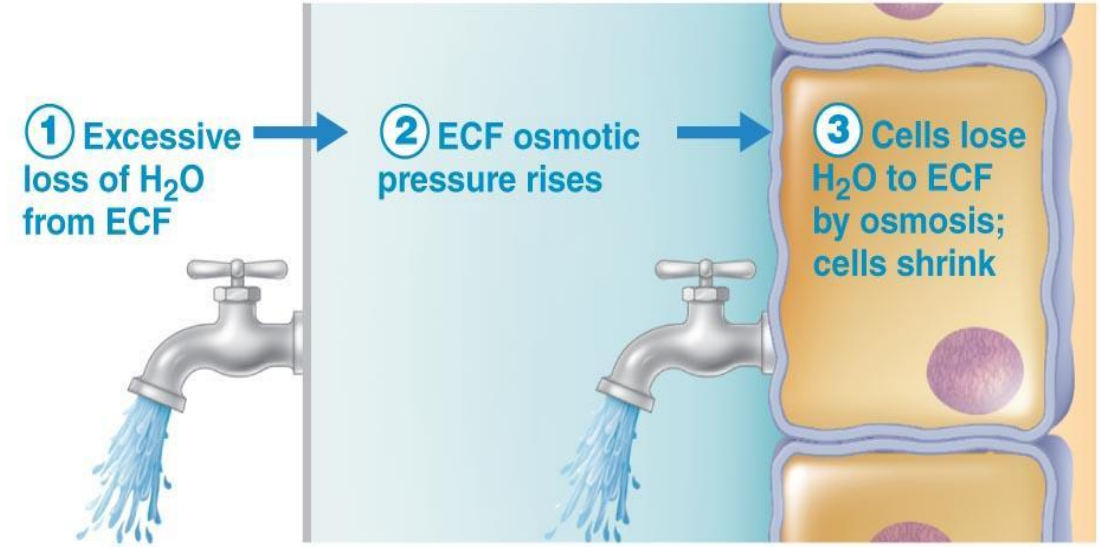

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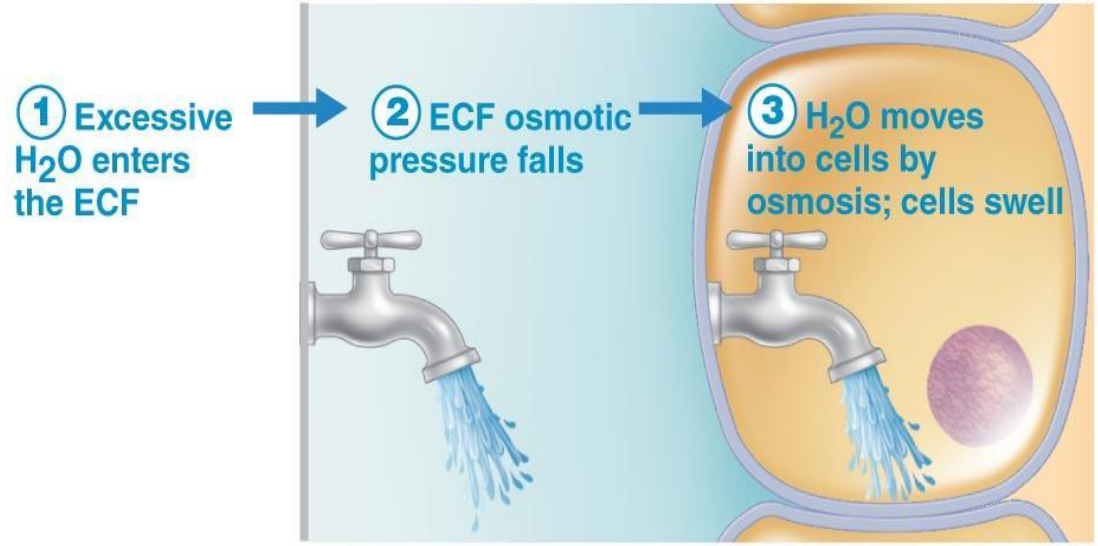


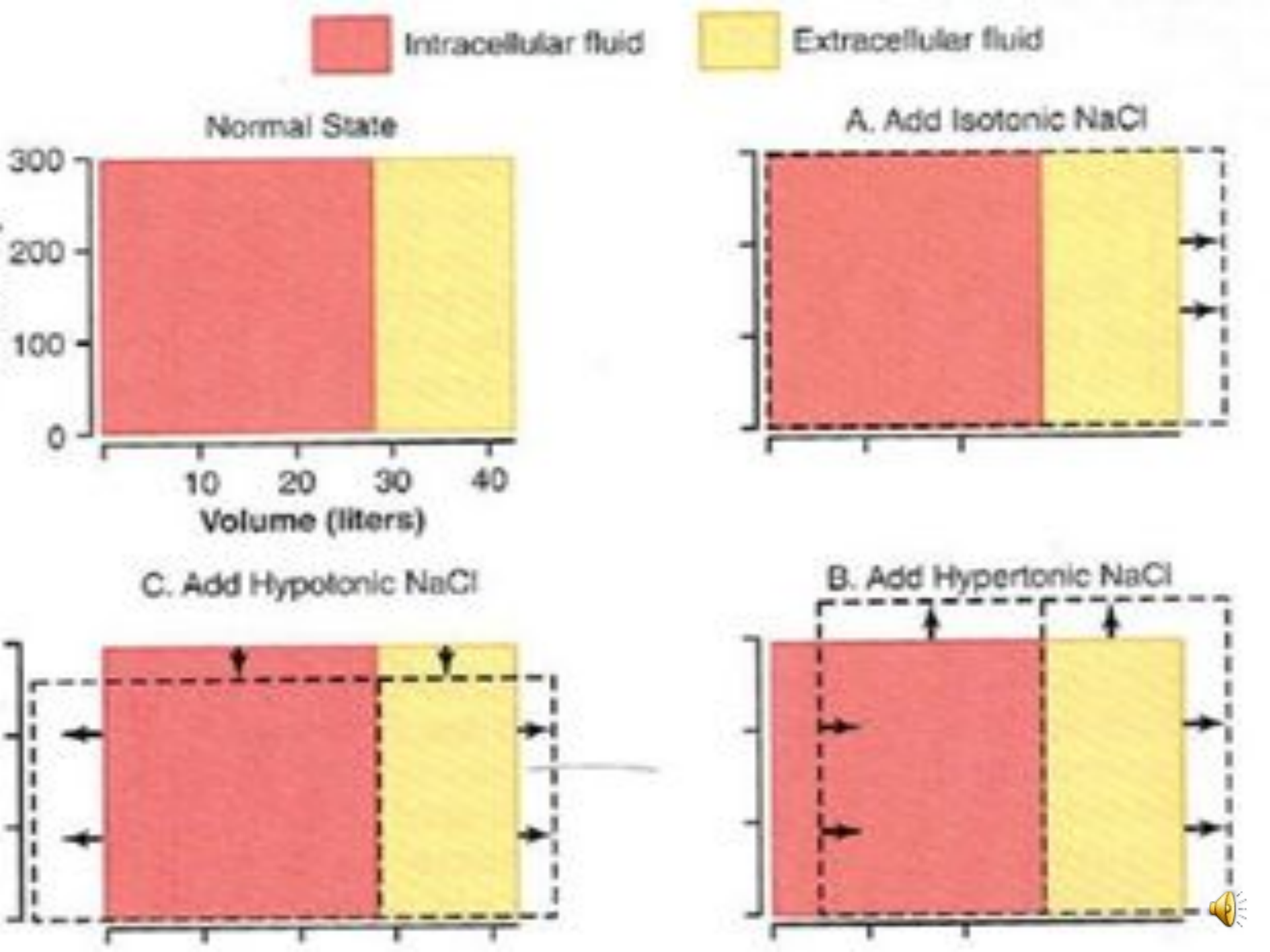
(b) Consequences of hypotonic hydration (water gain). If more water than solutes is gained, cells swell.

Disorders of Volumes and Osmolality

- Isonatremia with hypovolemia
- Isonatremia with hypervolemia
- Hyponatremia with hypovolemia
- Hyponatremia with hypervolemia
- Hyponatremia with isovolemia
- Hypernatremia with hypovolemia
- Hypernatremia with hypervolemia
- Hypernatremia with isovolemia

Disorders of Volumes and Osmolality

- Combinations are according to the fluid loss or gain: (hypo-, hyper- or isotonic)


Intracellular fluid
Extracellular fluid
Normal State
300
200
100
0
10
20
30
40
Volume (liters)
A. Add Isotonic NaCl
C. Add Hypotonic NaCl
B. Add Hypertonic NaCl

What will Happen in the following Conditions

- Increased release of ADH?
- In Diabetes Insipidus (Insufficiency of ADH release)?
- In Hyperaldosteronism (increased release of Aldosterone)?
- In Hypoaldosteronism (Aldosterone Insufficiency)?
- Excessive administration of potassium sparing diuretics?
- Excessive drinking of potable water?

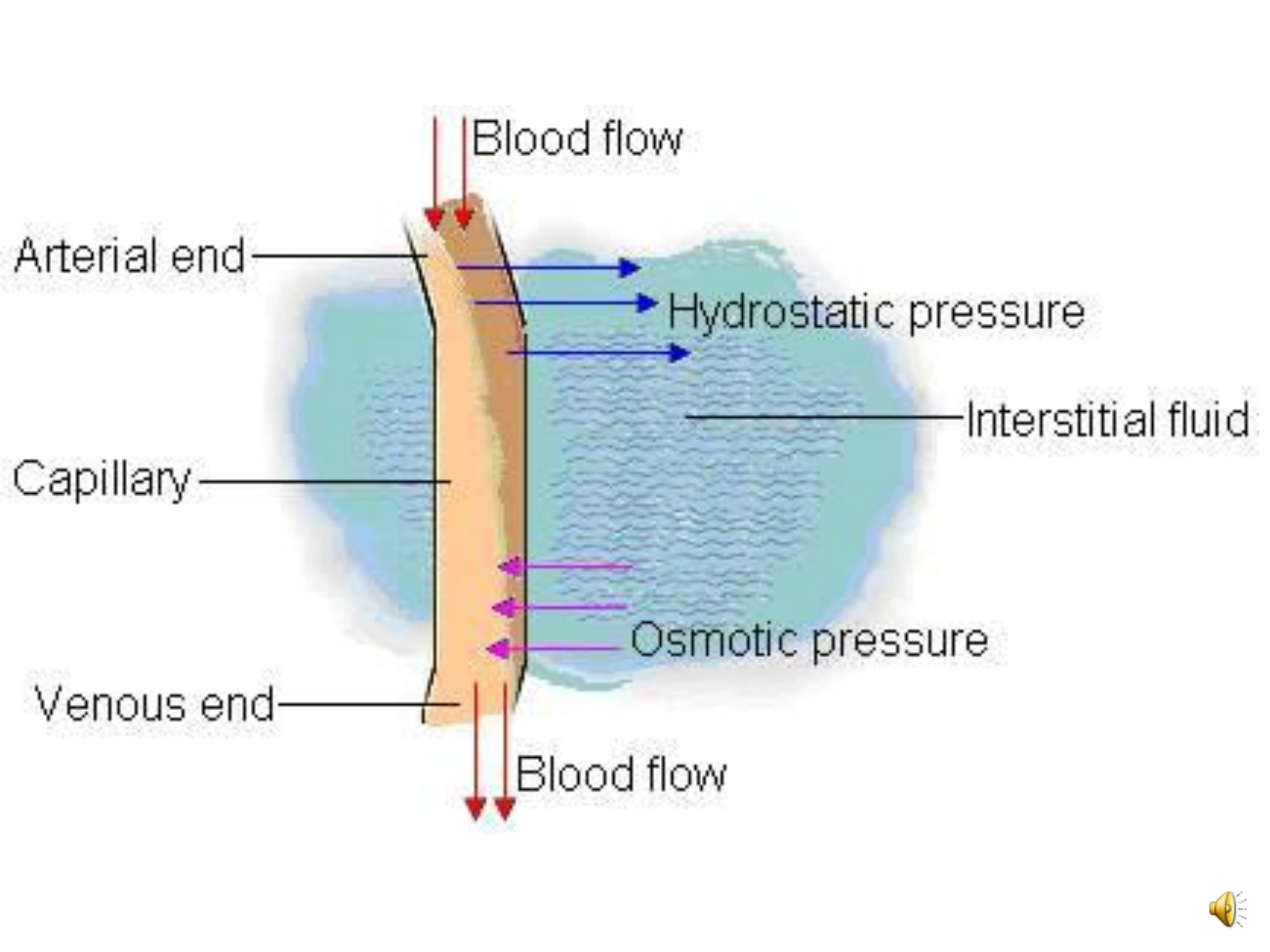
Oedema

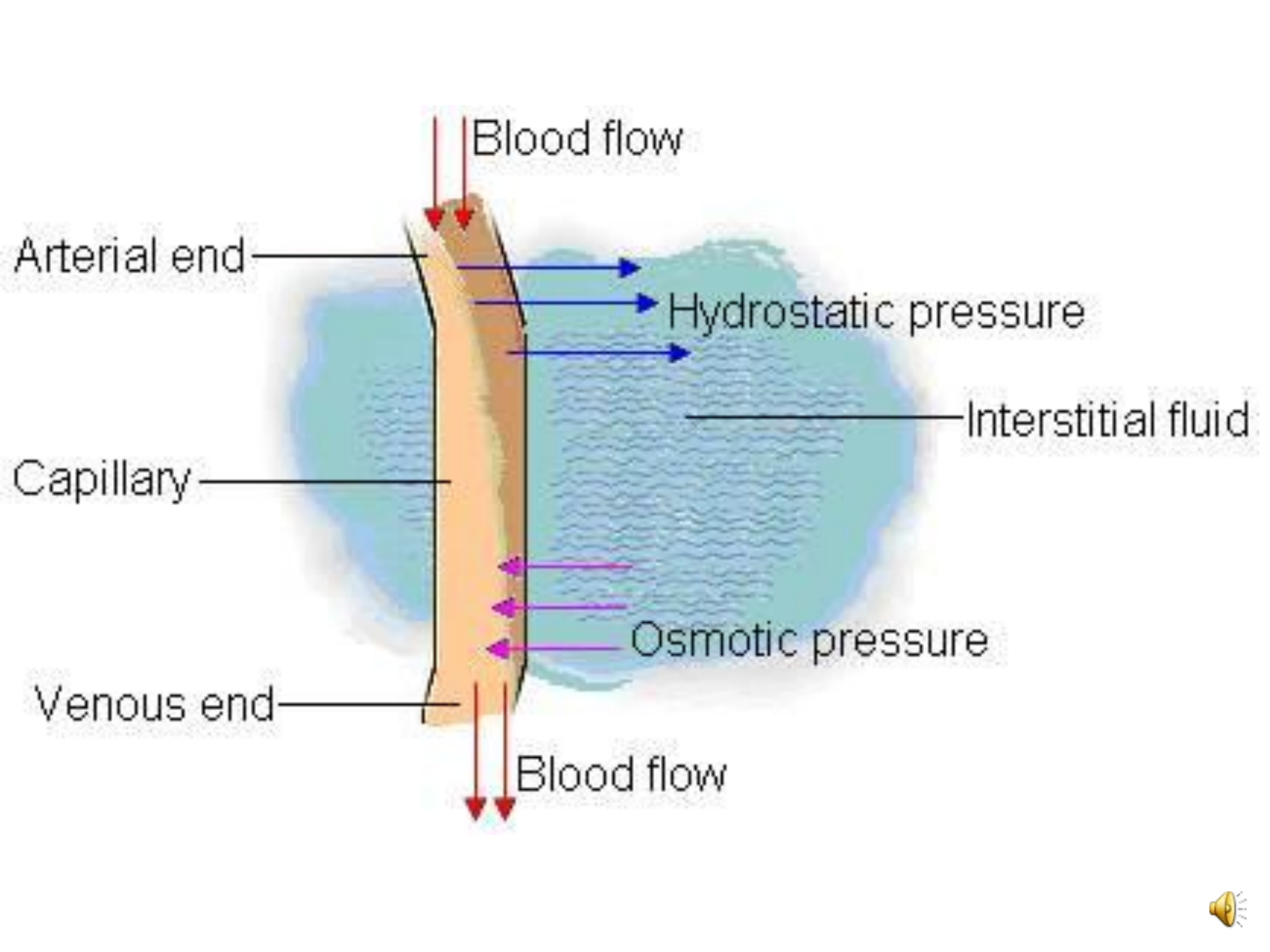
- **Causes:**

  - Increased filtration of fluids from capillaries

  or

  - Decreased reabsorption or removal of fluids from interstitial space.


Blood flow
Arterial end
Hydrostatic pressure
Interstitial fluid
Capillary
Osmotic pressure
Venous end
Blood flow


Blood flow
Arterial end
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Blood flow

Oedema

- **Causes:**
  - - Increased capillary hydrostatic pressure:
  - - Decreased oncotic pressure
  - - Increase capillary permeability
  - - Decreased lymph drainage

Oedema

- **Caused by increasing capillary filtration**:
- **Increased capillary hydrostatic pressure:**

  - Kidney causes: more retention of water and salts (Renal failure)

  - Excess of Mineralocorticoids (aldosterone)

- **High venous pressure:**

  Heart failure, decrease of Venous return (obstruction, decreased venous pump activity)

- **Decreased arteriolar resistance**

Oedema

- **Caused by increasing capillary filtration**:
- **Increased capillary hydrostatic pressure:**
- **High venous pressure:**
- **Decreased arteriolar resistance**

  (Excessive body heat, Insufficiency of sympathetic nervous system, Vasodilators)

Oedema

- **Decreased Oncotic pressure**
- **Increased loss of proteins**
  - From Kidney in nephrotic syndrome
  - from skin in burns and severe wounds
- **Decreased production of proteins:**
  - Liver diseases
  - Decreased intake of proteins in malnutrition

Oedema

- **Increase capillary permeability**

  - During immune reactions by release of histamine
  - Toxins,
  - Infections
  - Vitamin C deficiency
  - Ischemia
  - Burns

Oedema

- **Decreased lymph drainage:**

  -Cancer

  - Infections

  -Surgery

  -Absence or abnormality of lymphatic vessels

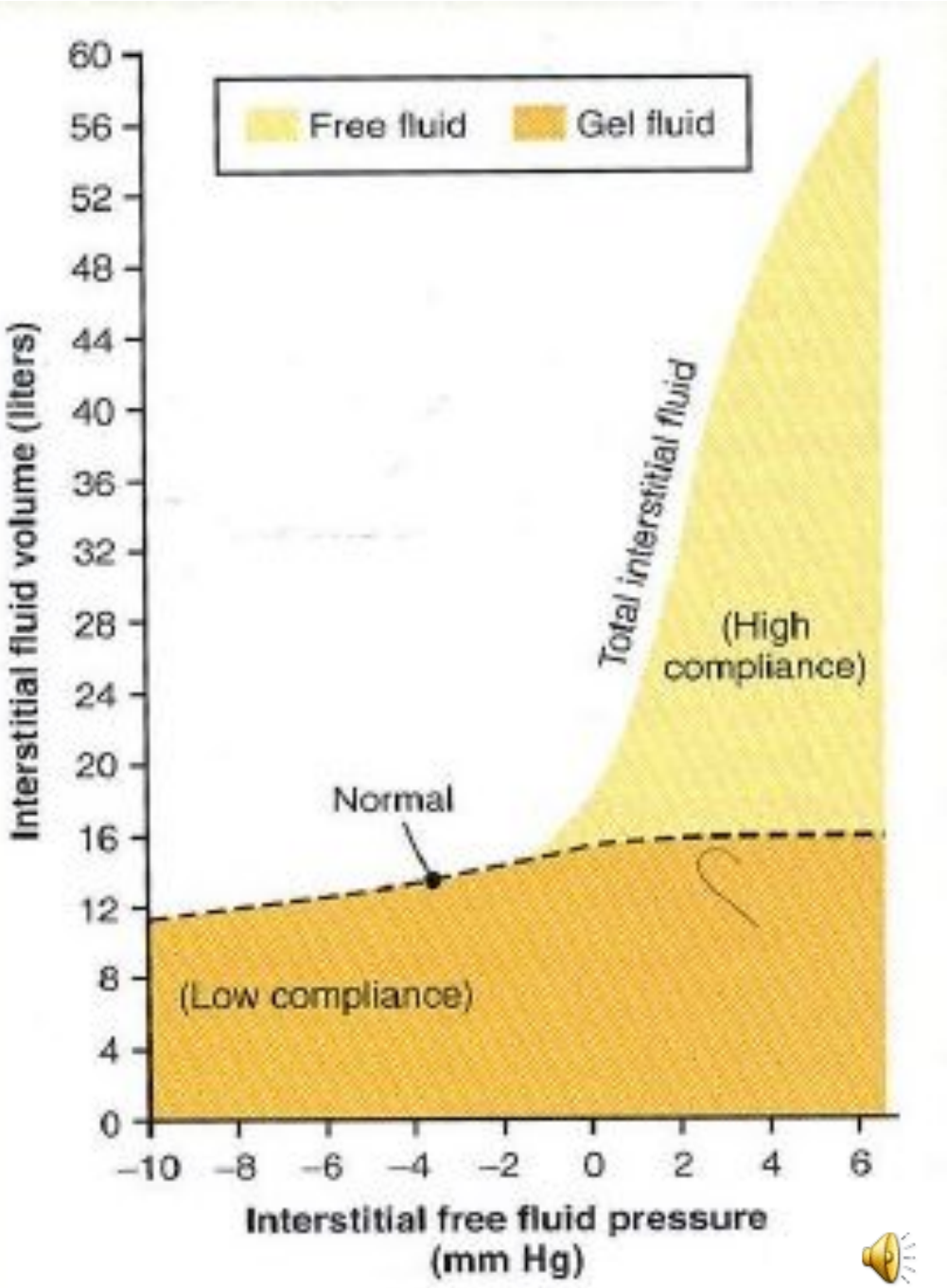
Safety factors for preventing oedema

- **Low tissue compliance**
- Increased lymph flow
- Increased protein wash-down from interstitial fluids

In negative pressure ranges

LOW compliance

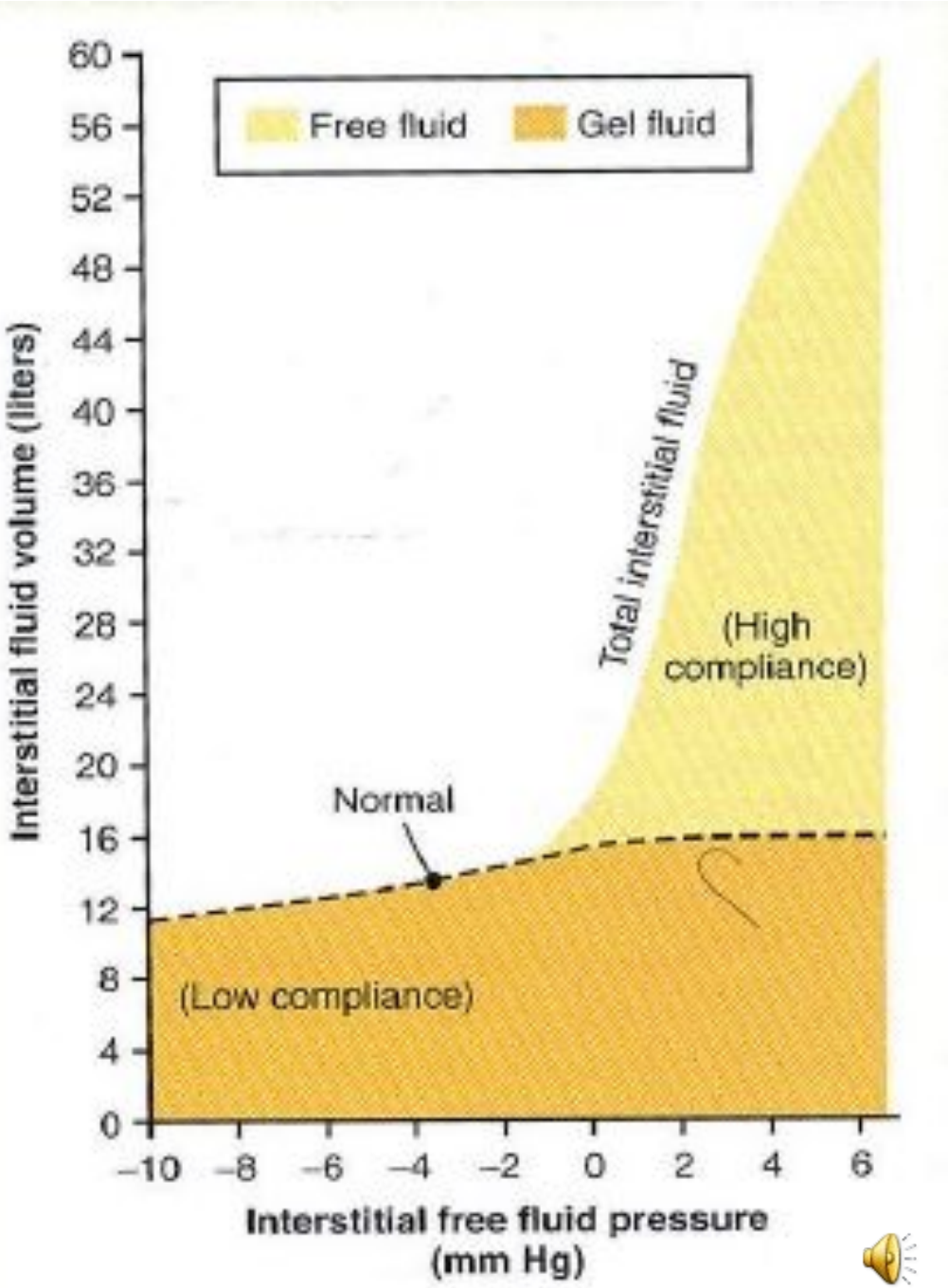
by presence of gel fluids results in relative increase in hydrostatic pressure to small changes in volume □ prevents capillary filtration



In positive pressure ranges

HIGH compliance

by accumulation of free fluids results in smaller increase in hydrostatic pressure to high changes in volume Pitting oedema



Safety factors for preventing oedema

- Low tissue compliance
- **Increased lymph flow**
- Increased protein wash-down from interstitial fluids

Increased lymph flow as safety factor

- **Lymph flow can increase** up to 10-50 folds

 Carry away large amounts of fluids prevents interstitial pressure from rising into **POSITIVE** ranges

Safety factors for preventing oedema

- Low tissue compliance
- Increased lymph flow
- **Increased protein wash-down from interstitial fluids**

Increased lymph flow increased Protein washout from interstitial fluids

- **Increased Lymph flow**

  Carry away large amounts of proteins (Protein washed out from interstitial fluids) decrease Colloid osmotic pressure in interstitial fluid Lowering net filtration forces **Prevents accumulation of fluids**

GOOD LUCK

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